

**National Marine Fisheries Service**  
**Endangered Species Act Section 7 Consultation**  
**Biological Opinion**

Agency: U.S. Environmental Protection Agency

Activities Considered: EPA's Issuance of the Office of Water's National Pollution Discharge Elimination System, Pesticides General Permit under the Clean Water Act for the District of Columbia, Idaho, Massachusetts and New Hampshire; Federal lands in Delaware, Vermont and Washington State; and Indian lands nationwide.

Consultation Conducted by: Endangered Species Division of the Office of Protected Resources, National Marine Fisheries Service

Approved by: Helen W. S. for J. H. Jacky

Date: Oct 14, 2011

Section 7(a)(2) of the Endangered Species Act of 1973, as amended (ESA; 16 U.S.C. 1536(a)(2)) requires each Federal agency to insure that any action they authorize, fund or carry out is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of critical habitat of such species. When a Federal agency's action "may affect" a protected species, that agency is required to consult formally with the National Marine Fisheries Service (NMFS) or the U.S. Fish and Wildlife Service (FWS; together, "the Services"), depending upon the endangered species, threatened species, or designated critical habitat that may be affected by the action (50 CFR 402.14(a)). Federal agencies are exempt from this general requirement if they have concluded that an action "may affect, but is not likely to adversely affect" endangered species, threatened species, or designated critical habitat and NMFS or the FWS concur with that conclusion (50 CFR 402.14(b)).

This document represents NMFS' Biological Opinion (Opinion) on the U.S. Environmental Protection Agency's (EPA's) issuance of its Pesticides General Permit and its effects on threatened and endangered species and their designated critical habitat. This Opinion is based on our review of the EPA's *Biological Evaluation for the Environmental Protection Agency's (EPA) Pesticides General Permit (PGP)*, reviews of the effectiveness of the National Pollution Discharge Elimination System (NPDES) program and compliance for existing general permits, pesticide risk assessments and Section 7 consultations on pesticide uses, species status reviews, listing documents, recovery plans, reports on the status and trends of water quality, past and current research and population dynamics modeling, published and unpublished scientific information and other sources of information as discussed in greater detail in the *Approach to the Assessment* section of this Opinion. This Opinion has been prepared in accordance with Section 7 of the ESA and associated implementing regulations.

## Consultation History

On January 9, 2009, the Sixth Circuit U.S. Court of Appeals (Sixth Circuit) vacated EPA's 2006 NPDES Pesticides Rule (National Cotton Council, *et al.*, v. EPA, 553 F.3d 927 (6<sup>th</sup> Cir. 2009)). That rule stated that a National Pollution Discharge Elimination System (NPDES) Permit, as authorized by the Clean Water Act (CWA), is not required for: 1) the application of pesticides directly to waters of the United States to control pests; and 2) the application of pesticides to control pests that are present over –including near– waters where a portion of the pesticides will unavoidably be deposited to the waters of the United States to target the pests provided that those applications are consistent with existing Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) requirements.

On June 8, 2009, the Sixth Circuit granted EPA a two-year stay until April 9, 2011 of the order to provide the Agency time to develop a general permit in order to guide States with delegated authority to implement their own NPDES permits and to provide outreach and education to regulated entities.

On November 3, 2009, EPA initiated informal consultation with NMFS on EPA's development of its NPDES Pesticides General Permit (PGP) pursuant to the Sixth Circuit's decision.

On February 3, 2010, EPA held a meeting with the Services. At that meeting the Services and EPA agreed that EPA could use a list of representative pesticides and their uses in the representative states of MA and ID for their Biological Evaluation (BE).

Between April 6, and June 7, 2010, NMFS reviewed and commented on portions of EPA's draft permit and draft BE. On June 10, 2010, NMFS sent EPA comments and concerns on the draft permit. These included: 1) Concerns over why chlorine and bromine were not evaluated in the BE; 2) A request for information on the four pesticide use patterns within the case study states; and 3) Concerns that data from the EPA's ECOTOX database indicated that species evaluated in the BE were much more sensitive to pesticides than the draft BE analyses suggested.

On July 30, 2010, EPA requested formal Section 7 consultation and sent a final BE and set of responses to NMFS' concerns.

On August 30, 2010, NMFS notified EPA that it could not initiate formal consultation because NMFS had not received all of the information necessary to initiate formal consultation on the proposed action as outlined in the regulations governing interagency consultations (50 CFR §402.14). Specifically NMFS stated that in order to complete the initiation package, EPA must provide: 1) A complete description of the action being considered; 2) A complete description of the specific area that may be affected by the action; 3) A complete description of the manner in which the action may affect any endangered or threatened species under NMFS' jurisdiction or critical habitat, and an analysis of any cumulative effects; and 4) Any other relevant studies or other information available on the action, the affected listed species, or critical habitat.

On September 15, 2010, NMFS participated in a conference call at EPA's request. NMFS reiterated its information needs required to initiate formal consultation to EPA.

On October 20, 2010, NMFS notified EPA that as of October 14, 2010, either EPA had provided all information required for initiating consultation or this information was otherwise accessible for NMFS' consideration and reference. Therefore, NMFS was confirming the initiation of formal consultation on this action and that NMFS expected to provide EPA with a final Biological Opinion no later than February 25, 2011.

On November 10, 2010 and December 8, 2010, EPA informed NMFS that EPA intended to change some permit provisions.

On December 16, 2010, NMFS and EPA met to discuss EPA's planned changes to the proposed general permit.

On January 10, 2011, NMFS notified EPA via a conference call that NMFS was likely to reach a jeopardy determination for listed species, and destruction or adverse modification to designated critical habitat determinations on the proposed action.

On January 19, 2011, NMFS gave the EPA a draft list of potential Reasonable and Prudent Alternatives (RPAs) that NMFS believes would allow EPA's action to proceed in compliance with ESA Section 7 (a)(2).

On March 1, 2011 NMFS sent a draft Biological Opinion to EPA.

On March 2, 2011, EPA filed a motion with the Sixth Circuit seeking an extension until October 31 for the purpose of, among other things, to complete consultation. As part of that motion, EPA and NMFS filed declarations committing to meet or confer by telephone at least once weekly through April 15 to attempt to reach consensus on reasonable and prudent alternatives.

From March 4 through April 29, these meetings and conference calls occurred at least once weekly, and additional informal discussion occurred frequently through this time period. Additional discussion continued after April 29 when needed.

On March 9, 2011 NMFS sent EPA detailed species location information so that EPA could identify overlap with its proposed general permit and the range of ESA listed species under NMFS' jurisdiction.

On March 28, 2011, the U.S. Court of Appeals for the Sixth Circuit granted EPA's request for an extension of the deadline for when permits will be required for pesticide pollutant discharges into U.S. waters from April 9, 2011 to October 31, 2011.

On April 1, 2011, EPA posted a pre-publication version of its draft final pesticide general permit for discharges of pesticide applications to U.S. waters on its website.

On June 17, 2011, at EPA's request, rather than providing its final Biological Opinion NMFS provided a draft Opinion to EPA for EPA to seek public comments on the RPA for the action.

On July 25, 2011 the public comment period closed.

A complete record of this consultation history is on file with NMFS.

## BIOLOGICAL OPINION

---

### Description of the Proposed Action

---

The U.S. Environmental Protection Agency's Office of Water proposes to authorize point source discharges of pesticide pollutants to<sup>1</sup> waters of the United States by issuing a Pesticides General Permit (PGP) for four use patterns:

1. Mosquito (larvicides and adulticides) and other flying insect pest control;
2. Aquatic weed, algae and pathogen control;
3. Aquatic nuisance animal and pathogen control; and
4. Forest canopy pest and pathogen control<sup>2</sup>.

The proposed PGP will authorize discharges of point source pesticide pollutants on, over or near waters of the United States from these four use patterns in those States and Territories where the EPA is the permitting authority: Alaska, American Samoa, District of Columbia, Guam, Idaho, Johnston Atoll, Massachusetts, Midway Island, New Hampshire, New Mexico, Northern Mariana Islands, Oklahoma<sup>3</sup>, Puerto Rico, and Wake Island. The EPA also proposes to use the PGP to authorize discharges of pesticide pollutants on, over or near waters of the United States resulting from pesticide applications on Federal lands located in Colorado, Delaware, Vermont and Washington, as well as Indian lands nationwide. Other States have the delegated authority to implement the NPDES program. This delegation of NPDES authority to the States by the EPA is non-discretionary and not within the scope of Section 7 of the ESA. The proposed general permit only applies to point source discharges in the four categories listed above. It does not apply to non-point sources or runoff from terrestrial agricultural pesticide applications. If EPA does not issue the PGP, none of the discharges of pesticides into the waters of the United States will be authorized pursuant to the Clean Water Act.

Because of the spatial overlap of the activities to be authorized by the proposed activities with the locations of the endangered and threatened species and designated critical habitat under NMFS' jurisdiction, this Opinion is limited only to those discharges that occur in the District of Columbia, Idaho, Massachusetts and New Hampshire; Federal lands in Delaware, Vermont and Washington State; and Indian lands nationwide.

The statutory authority for the proposed action is the National Pollution Discharge Elimination System (NPDES) of the Clean Water Act (33 U.S.C. 1342 *et seq.*; CWA). The purpose of the proposed general permit is to satisfy the

---

<sup>1</sup> Discharges to waters of the United States include discharges over and near waters of the United States, when some of the pesticide product will inevitably fall into waters. For purposes of this Opinion, the phrase "discharges to waters of the United States" includes discharges over and near waters of the United States.

<sup>2</sup> Aerial applications and applications of pesticides over water are included because a portion of the pesticides will unavoidably be deposited to the waters of the United States

<sup>3</sup> Both Alaska and Oklahoma have partial NPDES programs but are not authorized to issue NPDES permits for these applications. The State of Alaska has been authorized to administer the NPDES program but is not obligated to assume permitting responsibilities for discharges from pesticide applications until November, 2011.

goals and policies of the CWA (33 U.S.C. 1251). The EPA proposes to use the PGP to authorize discharges of pesticide pollutants on, over or near waters of the United States for five years (at the end of that five-year period, the EPA can choose to extend, suspend, revoke, or modify the proposed PGP).

In overturning EPA's rule that the discharge of pesticides in compliance with FIFRA in, over or near waters of the United States did not need a Clean Water Act permit, the Sixth Circuit Court of Appeals described "pesticide pollutants" as all biological pesticides and residues of chemical pesticides (National Cotton Council, *et al.*, v. EPA, 553 F.3d 927 (6<sup>th</sup> Cir. 2009). A pesticide residue includes any discarded, superfluous, refuse or excess chemical pesticide that no longer serves a pesticide function. In its rule, EPA defined pesticide residues to "include excess amounts of pesticide that do not reach a target organism and materials that remain after the application has completed its intended task" (71 FR 68483, 68487 [November 27, 2006]). The Court agreed with EPA's definition of pesticide residue as pollutants but extended this to include all biological pesticides because the CWA specifies pollutants to include chemical "wastes" and biological "materials." The distinction between the use of the terms "wastes" and "materials" was recognized as Congress' intent to treat biological and chemical pesticides differently. The EPA had argued that pesticide residues are not subject to the NPDES permitting program because at the time of discharge to a water of the United States, the material in the discharge must be both a pollutant, and from a point source. The court disagreed, concluding that requiring a temporal connection to a pollutant discharge to a point source "does not follow the plain language of the Clean Water Act" and "is also contrary to the purpose of the permitting program, which is "to prevent harmful discharges into the Nation's waters."

In its permit and biological evaluation, EPA has determined for purposes of the proposed general permit that it will assume that all chemical pesticides will leave either excess (for applications over or near waters) or residual (for application into the waters). Accordingly, EPA will require that for the four use categories identified, all discharges of chemical pesticides as well as all discharges of biological pesticides, in, over or near waters of the United States will require authorization under the Clean Water Act. Accordingly, our analysis will evaluate the effects of discharges of the biological and chemical pesticides, and will not be limited to analyzing solely the effects of the residual or excess chemical pesticides. NMFS' use of the term "pesticide pollutant" or "pesticide" includes the entire pesticide product, including active ingredients, degradates, adjuvants, surfactants and other additions such as other pesticide active ingredients in pesticide formulations.

NMFS must consider interrelated and interdependent actions of the proposed action. Interdependent actions are actions having no independent utility apart from the proposed action [50 CFR §402-02]. They are typically a consequence of the proposed action. For example, if our consultation were evaluating the effects of building a road, an interdependent action would be the planned construction of homes and other structures that would not be accessible without the presence of that road. Interrelated actions are actions that are part of a larger action and depend on the larger action for their justification [50 CFR §402-02]. They are actions that are typically associated with the proposed action.<sup>4</sup>

Although the proposed general permit would authorize discharges of pesticide pollutants on, over or near waters of the United States under the CWA, these discharges must be in compliance with the pesticide application uses

---

<sup>4</sup> In the case of the PGP, even if EPA were to authorize only discharge of chemical pesticide residue or chemical pesticide excess, NMFS would identify the discharges of pesticides on, over or near waters of the U.S as interrelated actions and would still evaluate the effects of authorization of pesticide pollutants and would not limit its analysis to the effects of the residues and excesses.

originally evaluated and registered under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) as amended by the Food Quality Protection Act (FQPA) of 1996 and the Pesticide Registration Improvement Act (PRIA) of 2003. The EPA administers the CWA and FIFRA through the Office of Water and the Office of Pesticide Programs, respectively. The EPA proposes to require such discharges to be authorized under the CWA and be subject to the terms of the proposed general permit but is not proposing to make any significant changes to pesticide uses currently authorized and labeled under FIFRA.

Requiring a CWA permit for these discharges provides EPA with the authority to enforce CWA requirements that may not have been addressed under FIFRA, including the ability of citizens to sue for permit violations. Therefore, in addition to understanding the proposed PGP it is also important to understand the CWA and FIFRA and the way that EPA administers each act in order to evaluate the EPA's decision making process and determine whether the EPA has insured that endangered or threatened species under NMFS' jurisdiction are not likely to be jeopardized or designated critical habitat for those species is not likely to be destroyed or adversely modified by activities authorized by the issuance of the proposed general permit. The following pages describe the proposed PGP and pertinent aspects of the CWA and FIFRA.

### **Pesticides General Permit**

The proposed PGP would authorize point-source discharges of pesticide pollutants into a wide variety of aquatic habitats from the application of pesticides on, over or near waters of the United States for the four use patterns described in the preceding subsection. The proposed permit would cover all "operators," who are defined as: (1) any entity associated with the application of pesticides, or who has day-to-day control of the application; or (2) any entity with control over the decision to perform pesticide applications including the ability to modify those decisions. For the purposes of the proposed permit, EPA defines "applicators" as those entities who perform the application of a pesticide or who has day-to-day control of the application. "Decision makers" are defined as those entities with control over the decision to perform pesticide applications including the ability to modify those decisions that result in a discharge to waters of the United States.

This proposed permit would not affect the existing CWA exemptions for irrigation agriculture return flows or agricultural stormwater runoff. These discharges are excluded from the definition of a point source under Section 502 (14) of the CWA. Agricultural stormwater runoff and irrigation agriculture return flows do not require NPDES permits. Therefore, runoff from irrigation agriculture return flows and agricultural stormwater are not considered in this Opinion.

#### ***Obtaining Authorization under the PGP***

As proposed, this general permit covers all "operators," For the purposes of the proposed general permit, the EPA defines "applicators" as those entities who perform the application of a pesticide or who has day-to-day control of the application. "Decision makers" are defined as those entities with control over the decision to perform pesticide applications including the ability to modify those decisions that result in a discharge on, over or near waters of the United States.

The PGP eligibility requirements apply to any "operator" who discharges pesticides on, over or near waters of the United States for the four use patterns described in the previous section. If a decision maker: (1) Is a State or Federal facility; (2) is a mosquito, irrigation and aquatic weed control or other pest control district; (3) intends to discharge into designated outstanding national resource (Tier 3) waters; or (4) has reason to believe that it will exceed the

annual treatment thresholds<sup>5</sup> established by the EPA as described in the permit, that decision maker is required to submit a Notice of Intent (NOI) to obtain coverage.

As proposed, the NOIs will contain a section that directs the decision maker to certify whether pesticide application activities will overlap with the distribution of endangered or threatened species or designated critical habitat, and if so:

1. Whether their pesticide applications have undergone ESA Section 7 consultations or if the operator has received an ESA Section 10(a)(1)(b) permit; and
2. To provide a list of those endangered or threatened species, or designated critical habitat whose distributions overlap with treatment areas.

In addition to these two criteria, NOIs would contain information from the decision makers that identify: 1) The name, address, type and contact information of the operator expected to discharge pollutants; and 2) The pesticide use patterns and planned locations of these applications. The decision maker would be authorized to discharge pesticide pollutants by the proposed general permit no earlier than 10 days after EPA posts a receipt of a complete and accurate NOI.

Other decision makers who do not expect to exceed the annual treatment thresholds, but otherwise meet the eligibility requirements, would be automatically authorized to discharge pesticides on, over or near waters of the United States without being required to submit an NOI. However, they would still be subject to the terms of the proposed permit. If a decision maker that was previously not required to submit an NOI discovers that they will exceed a treatment threshold, that decision maker must submit an NOI at least 10 days prior to exceeding the threshold in order to be authorized by the proposed permit. The proposed annual treatment area thresholds for the four use patterns under this permit are listed in Table 1.

Calculations of total treatment areas are to include the area of the applications made to waters of the United States and conveyances at the time of pesticide application. Individual applications for mosquito and other flying insect pest control or forest canopy pest control are cumulative on an annual basis. That is, if the total cumulative annual treatment area for all application is to exceed any treatment threshold, a decision maker must file an NOI.

This is not the case for aquatic weed and algae control or aquatic nuisance animal control. For these use patterns, the application areas are not considered cumulative. That is, a decision maker may make multiple pesticide applications onto an aquatic habitat, but as long as no single application exceeds a treatment threshold, that decision maker would not be required to file an NOI.

### **Timing**

Any decision maker that meets an NOI requirement threshold must submit an NOI by January 9, 2012. However, any discharges to waters of the United States made by that decision maker before that date would be eligible for

---

<sup>5</sup> According to the EPA in their BE for the PGP, "To determine the appropriate thresholds that would trigger the NOI requirement, EPA's Office of Water; Office of Pesticides, Pollution, and Toxic Substances; and Regional Offices, engaged in discussions with USDA, and representatives from industries including pesticide registrants, applicators, and land managers. Based on these discussions and EPA's best professional judgment, EPA developed annual treatment area thresholds that differentiate between applications to small areas and those treatments to larger areas which are believed to have a greater potential for impact on Waters of the US."

coverage under the permit. Decision makers requesting first-time coverage under the PGP must wait 30 days before discharging pesticides. If a decision maker expects to treat an area not identified in the previous NOI, that decision maker must submit an NOI at least 10 days before discharging. That operator would be authorized by the PGP no earlier than 10 days after EPA posts receipt of the complete and accurate NOI. Unless there is a change in location or use pattern, one NOI suffices for the five year duration of the permit. The NOI does not contain any requirement for notification of which pesticide product may be used or the exact location or timing of each individual discharge.

**Table 1. Proposed Annual Area Thresholds Required for Decision makers to File NOIs**

Mosquitoes and Other Flying Insect Pests <sup>1</sup>	6,400 acres of treatment area (adulticides) 640 acres (larvicides)
Aquatic Weed and Algae Control <sup>2</sup>	
In Water	80 acres of treatment area
At Water's Edge	20 linear miles of treatment area
Aquatic Nuisance Animal Control <sup>3</sup>	
In Water	80 acres of treatment area
At Water's Edge	20 linear miles of treatment area
Forest Canopy Pest Control <sup>4</sup>	6,400 acres of treatment area

<sup>1</sup>All Federal and State Agencies with a responsibility to control mosquitoes for public health, nuisance control or animal welfare, as well as Mosquito Control Districts (or similar Pest Control Districts), are required to file NOIs regardless of treatment area.

<sup>2</sup>All Federal and State Agencies with a responsibility to control aquatic nuisance vegetation, as well as Weed Control Districts (or similar Pest control Districts), are required to file NOIs regardless of treatment area.

<sup>3</sup>The control of nuisance aquatic animals usually requires that their treatment covers entire or large portions of water bodies. All Federal and State Agencies with a responsibility to control aquatic nuisance animals are required to file NOIs regardless of treatment area.

<sup>4</sup>Forest canopy pest suppression programs are designed to aerielly blanket large tracts of terrain, throughout which operators may not be able to see waters of the United States beneath the canopy. All Federal and State Agencies with a responsibility to control forest canopy pests are required to file NOIs regardless of treatment area

## Emergencies<sup>6</sup>

The PGP allows for immediate pesticide pollutant discharges for declared pest emergency situations<sup>7</sup>. There are four types of exemptions of Federal and State Agencies for use of pesticides under emergency conditions: specific, quarantine, public health and crisis exemptions. This exemption is based on a rule under Section 18 of FIFRA.

1. **Specific exemption.** A specific exemption may be authorized in an emergency condition to avert:
  - a. A significant economic loss; or
  - b. A significant risk to:
    - i. Endangered species,
    - ii. Threatened species,

<sup>6</sup> The services do not consider emergencies in their jeopardy determinations under the ESA. However, after-the-fact emergency consultations are allowed (50 CFR 402.05).

<sup>7</sup> 51 FR 1902, Jan. 15, 1986, as amended at 71 FR 4495, Jan. 27, 2006 [http://frwebgate.access.gpo.gov/cgi-bin/getpage.cgi?position=all&page=4495&dbname=2006\\_register](http://frwebgate.access.gpo.gov/cgi-bin/getpage.cgi?position=all&page=4495&dbname=2006_register)

- iii. Beneficial organisms, or
  - iv. The environment.
2. **Quarantine exemption.** A quarantine exemption may be authorized in an emergency condition to control the introduction or spread of any pest that is an invasive species, or is otherwise new to or not theretofore known to be widely prevalent or distributed within and throughout the United States and its territories.
  3. **Public health exemption.** A public health exemption may be authorized in an emergency condition to control a pest that will cause a significant risk to human health.

In these cases all decision makers must file an NOI no later than 30 days after beginning a discharge in response to a declared pest emergency.

### **Outstanding National Resource Waters (Tier 3)**

The PGP authorizes pesticide pollutant discharges into designated Tier 3 waters. States, Territories or Tribes designate outstanding national resource waters “Tier 3” and they generally include the highest quality waters of the United States. The current version of the proposed general permit requires that any discharges to these waters require an NOI along with an explanation of why such discharges are necessary. The proposed general permit states:

“Except for pesticide applications that do not degrade water quality or only degrade water quality on a short-term or temporary basis, you are not eligible for coverage under this permit for discharges from a pesticide application to waters designated by a state, territory, or tribe as Tier 3 (Outstanding National Resource Waters) for antidegradation purposes under Title 40 of the Code of Federal Regulations (CFR) 131.12(a)(3) (a list of Tier 3 waters in geographic areas covered under this permit is on EPA’s website at [www.epa.gov/npdes/pesticides](http://www.epa.gov/npdes/pesticides)).”

The EPA has not defined what is meant by pesticides applications that “do not degrade water quality or only degrade water quality on a short-term or temporary basis,” nor is there a list of designated Tier 3 waters on the website listed in the proposed general permit as of the date of this Opinion.

The EPA’s rationale is as follows:

“In some cases, in order to protect Tier 3 water quality (e.g., from invasive species) or to protect public health (e.g., from mosquito-borne illness outbreaks), pesticide application may be necessary to Tier 3 waters. The CWA says that WQS’ [Water Quality Standards] shall be such as to protect the public health and welfare, enhance the quality of the water and serve the purposes of the act.’ The national interpretation with respect to the Outstanding National Resource Water (ONRW) provision of the antidegradation policy is that it means no new or increased discharges. The only exception to this is discussed in the preamble to the water quality standards regulation to indicate that States may allow some limited activities which result in temporary and short-term changes in water quality. The preamble further discusses the rationale for why we revised the wording in the ONRW paragraph of the regulation. It clearly indicates that the change was made to allow for these temporary activities to occur and did not extend the notion of ‘significant’ changes to ONRW waters.”

When a decision maker expects to discharge pesticide pollutants into any Tier 3 water, that decision maker must submit an NOI at least 10 days before discharging unless these discharges are in response to a designated pest emergency. In such a case, the decision maker must submit an NOI no later than 30 days after discharging, but no earlier than January 9, 2012. For discharges made into Tier 3 waters not in response to declared pest emergencies, the operator would be authorized under the proposed general permit 10 days after EPA posts receipt of the complete and accurate NOI. Operators discharging into Tier 3 waters in response to a designated pest emergency would be authorized immediately.

Any decision maker that expects to discharge into any Tier 3 water not specifically identified in their most recently submitted NOI must submit an NOI at least 10 days before discharging into the newly identified Tier 3 water. That operator would be authorized under the proposed general permit no earlier than 10 days after EPA posts receipt of the new complete and accurate NOI. These requirements do not apply if such Tier 3 discharges are in response to a declared pest emergency, in which case the emergency discharge NOI requirements mentioned previously would apply.

### ***Protective Measures***

The EPA proposes several measures intended to minimize any environmental effects resulting from these discharges, including: the identification of overlap of endangered or threatened species, or designated critical habitat and pesticide applications in the NOI process, technology based effluent limitations, compliance with existing water quality standards, decision maker self-reporting of adverse incidents and annual reporting.

### **The NOI Process**

As mentioned before, decision makers who are to exceed one or more of the annual treatment area thresholds must file an NOI. Also, irrigation and aquatic weed control or other pest control districts, Federal agencies, State facilities and those intending to discharge into designated Tier 3 waters must file NOIs. The NOIs are to contain a section where the decision maker is to self-certify whether its pesticide application activities will overlap with the distribution of listed species or designated critical habitat, and if so, must state: 1) if these applications have undergone ESA Section 7 consultations or received an ESA Section 10 permit and, 2) which of these endangered or threatened species, or designated critical habitat overlap with treatment areas. In addition to ESA listed species concerns, NOIs contain information from the decision makers that identify: 1) The name, address, type and contact information of the operator expected to discharge pollutants; and 2) Pesticide use patterns and planned locations of these applications. The proposed general permit would cover the decision maker no earlier than 10 days after EPA posts a receipt of a complete and accurate NOI. Decision makers requesting first-time coverage under the PGP must wait 30 days before discharging pesticides.

### **Technology Based Effluent Limitations**

Operators would be required to implement control measures to minimize the discharge of pesticide pollutants to waters of the United States through the use of technology based effluent limitations to the extent technologically available and economically achievable and practicable. All operators must:

1. To the extent determined by the decision maker, use only the amount of pesticide and frequency of pesticide applications necessary to control the target pest, using equipment and application procedures appropriate for this task.

2. Maintain pesticide application equipment in proper operating condition, including requirements to calibrate, clean and repair such equipment and prevent leaks, spills or other unintended discharges.
3. Assess weather conditions in the treatment area to insure application is consistent with all applicable Federal requirements.

### **Pesticide Management Measures**

Decision makers must minimize the discharge of pesticides through the use of pesticide management measures. Pesticide management measures are defined as: “any practice used to meet the effluent limitations that comply with manufacturer specifications, industry standards and recommended industry practices related to the application of pesticides, relevant legal requirements and other provisions that a prudent operator would implement to reduce or eliminate pesticide pollutant discharges to waters of the United States To the extent any decision maker determines the amount of pesticide or frequency of pesticide application, the decision maker must use only the amount of pesticide and frequency of pesticide application necessary to control the target pest. Any operator must review or modify pest management measures if:

1. An unauthorized discharge occurs
2. Operators become aware that the measures are not sufficient to meet applicable water quality standards
3. Monitoring activities indicate a failure to:
  - a. Use the amount of pesticide and frequency of pesticide application necessary to control the target pest, using equipment and application procedures appropriate for this task
  - b. Maintain pesticide application equipment in proper operating condition by calibrating, cleaning and repairing such equipment and preventing leaks, spills or other unintended discharges
  - c. Assess weather conditions
4. An inspection by EPA, State, Tribal or local entities reveal modifications are necessary to meet applicable water quality standards
5. An operator is made aware of an adverse incident

An operator must make such changes before or –if not practicable– as soon as possible before discharging again.

### **Additional Pesticide Management Measures for Decision Makers Required to Submit NOIs**

In addition to these pesticide management measures, all decision makers who are required to submit NOIs must also implement the following pesticide management measures.

#### **Mosquito and Other Flying Insect Pest Control**

1. Identify the Problem

Prior to the first pesticide application, and at least once each calendar year thereafter prior to the first pesticide

application for that calendar year, for each pest management area<sup>8</sup>, decision makers must do the following:

- Establish densities for larval and adult mosquito or flying insect pest populations or identify environmental Condition(s), either current or based on historical data, to serve as action threshold(s)<sup>9</sup> for implementing pest management measures;
- Identify target pest(s) to develop pest management measures based on developmental and behavioral considerations for each pest;
- Identify known breeding sites for source reduction, larval control program, and habitat management;
- Analyze existing surveillance data to identify new or unidentified sources of mosquito or flying insect pest problems as well as sites that have recurring pest problems; and
- In the event there are no data for the pest management area in the past calendar year, use other available data as appropriate to meet the permit conditions.

## 2. Pest Management Options

The decision maker must evaluate the following management options, considering impact to water quality, impact to non-target organisms, feasibility and cost effectiveness:

- No action
- Prevention
- Mechanical or physical methods
- Cultural methods
- Biological control agents
- Pesticides

## 3. Pesticide Use

Decision makers must:

- Conduct larval and/or adult surveillance in an area that is representative of the pest problem or evaluate existing larval surveillance data, environmental conditions, or data from adjacent area prior to each pesticide application to assess the pest management area and to determine when the action threshold(s) is met;
- Reduce the impact on the environment and on non-target organisms by applying the pesticide only when the action threshold(s) has been met;
- In situations or locations where practicable and feasible for efficacious control, use larvicides as a preferred pesticide for mosquito or flying insect pest control when the larval action threshold(s) has been met; and

---

<sup>8</sup> In its draft permit, the EPA defines Pest Management Area as “The area of land, including any water, for which an operator has responsibility for and is authorized to conduct pest management activities as covered by this permit (e.g., for an operator that is a mosquito control district, the pest management area is the total area of the district).”

<sup>9</sup> Action Threshold – the point at which pest populations or environmental conditions cannot be tolerated necessitating that pest control action be taken based on economic, human health, aesthetic, or other effects. An action threshold may be based on current and/or past environmental factors that are or have been demonstrated to be conducive to pest emergence and/or growth, as well as past and/or current pest presence. Action thresholds are those conditions that indicate both the need for control actions and the proper timing of such actions.

- In situations or locations where larvicide use is not practicable or feasible for efficacious control, use adulticides for mosquito or flying insect pest control when the adult action threshold(s) has been met.

## Aquatic Weed, Algae and Pathogen Pest Control

### 1. Identify the Problem

Prior to the first pesticide application, and at least once each calendar year thereafter prior to the first pesticide application for that calendar year, for each pest management area decision makers must:

- Identify areas with pest problems and characterize the extent of the problems, including, for example, water use goals not attained (e.g. wildlife habitat, fisheries, vegetation and recreation);
- Identify target pest(s);
- Identify possible factors causing or contributing to the pest problem (e.g., nutrients, invasive species, etc);
- Establish any pest-and site-specific action threshold; and
- In the event there are no data for the pest management area in the past calendar year, use other available data as appropriate to meet the permit conditions.

### 2. Pest Management Options

The decision maker must evaluate the following management options, considering impact to water quality, impact to non-target organisms, feasibility and cost effectiveness:

- No action
- Prevention
- Mechanical or physical methods
- Cultural methods
- Biological control agents
- Pesticides

### 3. Pesticide Use

Decision makers must:

- Conduct surveillance in an area that is representative of the pest problem prior to each pesticide application to assess the pest management area and to determine when the action threshold(s) is met; and
- Reduce the impact on the environment and non-target organisms by applying the pesticide only when the action threshold has been met.

## Animal Pest and Pathogen Control

This part applies to discharges from the application of pesticides for control of animal pests as defined in Part 1.1.1.

### 1. Identify the Problem

Prior to the first pesticide application, and at least once each calendar year thereafter prior to the first pesticide application for that calendar year, for each pest management area decision makers must:

- Identify areas with pest problems and characterize the extent of the problems, including, for example, water use goals not attained (e.g. wildlife habitat, fisheries, vegetation and recreation);
- Identify target pest(s);
- Identify possible factors causing or contributing to the problem (e.g., nutrients, invasive species);
- Establish any pest-and site-specific action threshold; and
- In the event there are no data for the pest management area in the past calendar year, use other available data as appropriate to meet the permit conditions.

## 2. Pest Management Options

The decision maker must evaluate the following management options, considering impact to water quality, impact to non-target organisms, feasibility and cost effectiveness:

- No action
- Prevention
- Mechanical or physical methods
- Cultural methods
- Biological control agents
- Pesticides

## 3. Pesticide Use

Decision makers must:

- Conduct surveillance in an area that is representative of the pest problem prior to each application to assess the pest management area and to determine when the action threshold(s) is met; and
- Reduce the impact on the environment and non-target organisms by evaluating site restrictions, application timing and application method in addition to applying the pesticide only when the action threshold(s) has been met.

## Forest Canopy Pest and Pathogen Control

### 1. Identify the Problem

Prior to the first pesticide application, and at least once each calendar year thereafter prior to the first pesticide application for that calendar year, for each pest management area decision makers must:

- Establish any pest-and site-specific action threshold;
- Identify target pest(s) to develop pest management measures based on developmental and behavioral considerations for each pest;
- Identify current distribution of the target pest and assess potential distribution in the absence of pest management measures; and
- In the event there are no data for the pest management area in the past calendar year, use other available data as appropriate to meet the permit conditions.

## 2. Pest Management Options

The decision maker must evaluate the following management options, considering impact to water quality, impact to non-target organisms, feasibility and cost effectiveness:

- No action
- Prevention
- Mechanical or physical methods
- Cultural methods
- Biological control agents
- Pesticides

## 3. Pesticide Use

The decision maker must:

- Conduct surveillance in an area that is representative of the pest problem prior to each application to assess the pest management area and to determine when the pest action threshold is met;
- Reduce the impact on the environment and non-target organisms by evaluating the restrictions, application timing, and application methods in addition to applying the pesticide only when the action threshold(s) has been met; and
- Evaluate using pesticides against the most susceptible developmental stage.

### **Water Quality Based Effluent Limitations**

All operators would be required to control discharges to meet applicable numeric and narrative State, Territory, or Tribal water quality standards. If at any time the permittee becomes aware, or the EPA determines, that the discharge causes or contributes to an excursion of applicable water quality standards, the permittee must take corrective action.

### **Pesticide Discharge Management Plan (PDMP)**

Decision makers that exceed NOI thresholds (except for those made in response to a declared pest emergency) and are “large entities” must prepare a PDMP to document the selection and implementation of the control measures employed to comply with the effluent limitations described above. The permit defines “large entities” as: (1) Any public entity that serves a population greater than 10,000; or (2) A private enterprise that exceeds the Small Business Administration size standard as identified at: <http://www.sba.gov/content/table-small-business-size-standards>. Decision makers are required to retain a copy of the current PDMP, along with all supporting documents. These materials must be readily available upon request. The following information must be provided in the PDMP:

1. Pesticide discharge management team information
2. Problem identification
3. Pest management options evaluation
4. Spill and adverse incident response procedures
5. Documentation to support eligibility considerations under other Federal laws

6. Signature requirements.

### **Record Keeping and Annual Reports**

All operators must keep records of:

1. Adverse incident reports
2. Any rationale for not reporting incidents as adverse
3. A copy of corrective action determinations
4. A copy of any spill or other non-permitted discharges

In addition to the record keeping requirements for all operators, any decision maker that is not a “large entity” and is required to submit an NOI must also keep records of:

1. A copy of the NOI and any correspondence with EPA about the NOI
2. Documentation of equipment calibration (only if the decision maker is the applicator)
3. Information on each treatment area

Any decision maker that is a “large entity” and is required to submit an NOI must also keep records of:

1. A copy of the NOI and any correspondence with EPA about the NOI
2. A copy of the PDMP
3. A copy of annual reports submitted to EPA
4. Documentation of equipment calibration (only if the decision maker is the applicator)
5. Information on each treatment area

Any decision maker that is a “large entity” and is required to submit an NOI must also submit an annual report to EPA. The annual report must contain:

1. Operator contact information
2. NPDES permit tracking number
3. For each treatment area:
  - a. Description of the treatment area
  - b. Identification of any waters receiving discharged pesticides
  - c. Pesticide use patterns
  - d. Total amount by application method of each pesticide product
  - e. Whether this pest control activity was addressed in the operator’s PDMP prior to pesticide application
  - f. Any adverse incidents and a description of any corrective actions

### **Permit Inspections and Oversight**

The operator would be required to allow EPA or an authorized representative to:

1. “Enter the premises where a regulated facility or activity is located or conducted, or where records must be kept under the conditions of the permit”
2. “Have access to and copy, at reasonable times, any records that must be kept under the conditions of the permit”
3. “Inspect at reasonable times any facilities, equipment (including monitoring and control equipment), practices, or operations regulated or required under the permit”
4. “Sample or monitor at reasonable times, for the purposes of assuring permit compliance or as otherwise authorized by the Clean Water Act, any substances or parameters at any location”

## **Monitoring**

All operators would be required to monitor:

1. The amount of pesticide and frequency of pesticide applications necessary to control the target pest, using equipment and application procedures appropriate for this task
2. Pesticide application activities to insure pesticide application equipment is maintained in proper operating conditions by calibrating, cleaning and repairing such equipment and preventing leaks, spills or other unintended discharges
3. Weather conditions in the treatment area to insure application is consistent with all applicable Federal requirements

If a reportable spill occurs<sup>10</sup>, the operator must contact the National Response Center immediately. The operator must document and retain information on the spill within 30 days.

The permit would also require visual monitoring assessments for adverse incidents. These visual assessments of the application site must be performed during any operator post-application surveillance or efficacy check or during any pesticide application when safety and feasibility allows. Adverse incidents are defined in the permit as follows:

An unusual or unexpected incident that an operator has observed upon inspection or of which the operator otherwise becomes aware, in which:

1. There is evidence that a person or non-target organism has been exposed to a pesticide residue; and
2. The person or non-target organism suffered a toxic or adverse effect.

The phrase toxic adverse effects includes effects that occur within waters of the United States on non-target plants, fish or wildlife that are unusual or unexpected as a result of exposure to a pesticide residue, and may include:

- a. Distressed or dead juvenile and small fishes
- b. Washed up or floating fish
- c. Fish swimming abnormally or erratically
- d. Fish lying lethargically at water surface or in shallow water

---

<sup>10</sup> See: 40 CFR 110, 40 CFR 117, 40 CFR 302

- e. Fish that are listless or nonresponsive to disturbance
- f. Stunting, wilting or desiccation of non-target submerged or emergent aquatic plants
- g. Other dead or visibly distressed non-target aquatic organisms

Any operator that has observed or been made aware of any adverse incident must notify EPA within 24 hours of that operator becoming aware of such an incident. If an operator is unable to notify EPA within 24 hours that operator must do so as soon as possible and provide a rationale as to why the incident could not be reported earlier. The operator must then provide a written report to EPA within 30 days.

If an operator observes or is otherwise made aware of an adverse incident involving a listed resource, that operator must immediately contact either USFWS or NMFS depending on whose jurisdiction the listed resource is under.

## **Corrective Actions**

### **Situations Requiring Revision of Control Measures**

If any of the following situations occur, operators must review and revise the evaluation and selection of their control measures as necessary to insure that the situation is eliminated and will not be repeated in the future:

1. An unauthorized discharge associated with the application occurs
2. The operator becomes aware that its control measures are not sufficient to meet applicable water quality standards; or
3. Monitoring activities indicate that:
  - a. The operator failed to use the lowest amount of pesticide product per application and optimum frequency of pesticide applications necessary to control the target pest;
  - b. The operator failed to perform regular maintenance activities to reduce unintended discharges of pesticides;
  - c. The operator failed to maintain pesticide application equipment in proper operating condition;
  - d. An inspection or evaluation by an EPA official, or local, State, Territorial or Tribal entity determines that modifications to the control measures are necessary to meet the non-numeric effluent limits; or
  - e. The operator observes or are otherwise made aware of an adverse incident

If an operator determines that changes to its control measures are necessary, such changes must be made before the next pesticide application if practicable, or if not, as soon as possible thereafter.

### **Effect of Corrective Action**

The occurrence of a situations requiring revision of control measures (as defined above) may constitute a violation of the permit. Correcting the situation does not necessarily absolve the operator of liability. The EPA will consider the appropriateness and promptness of corrective action in determining enforcement responses to permit violations. The EPA or a court may impose additional requirements and schedules of compliance.

## ***Limitations on Coverage***

### **Impaired Waters**

States, Territories and Tribes are required to develop lists of impaired waters under section 303(d) of the CWA. These impaired waters do not meet water quality standards that the States, Territories and Tribes have set for them. The proposed PGP would not authorize the discharge of a pesticide pollutant to any impaired Water of the U.S. that is impaired by the specific pesticide, or degradates of the pesticide, to be permitted to be discharged. In this case, the operator would have to obtain coverage under an individual permit for such a discharge or chose some other means of pest management.

### **Discharges Covered under other Permits**

If a proposed discharge is already authorized under another permit, the operator is ineligible for coverage by the PGP permit. If the intended discharge was included in a permit that has been or is in the process of being denied, terminated or revoked by EPA in the past five years, the proposed discharge is ineligible for coverage under this permit.

---

## **Approach to the Assessment**

---

Section 7(a)(2) of the Endangered Species Act, as amended (16 U.S.C. 1536(a)(2)) requires Federal agencies, in consultation with, and with the assistance of NMFS and U.S. Fish and Wildlife Service (the Services), to insure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of critical habitat of endangered or threatened species. Section 7(a)(2) of the ESA also requires the Services and Federal action agencies to use the best scientific and commercial data available during those consultations.

### **Overview of NMFS' Assessment Framework**

NMFS uses a series of sequential analyses to determine whether Federal agencies have insured that actions they authorize, fund, or carry out are not likely to jeopardize the continued existence of endangered or threatened species under its jurisdiction, or to critical habitat that has been designated for those species. The first analysis identifies those physical, chemical or biotic aspects of proposed actions that are likely to have individual, interactive, or cumulative direct and indirect effect on the environment (we use the term “potential stressors” for these aspects of an action). As part of these analyses, we identify the spatial extent of any potential stressors and recognize that the spatial extent of those stressors may change with time (the spatial extent of these stressors is the “action area” for a consultation). During the consultation, we examine any measures an action agency proposes to use to reduce or eliminate the number of stressors or their intensity.

The second analysis determines whether endangered species, threatened species, or designated critical habitat are likely to occur in the same space and at the same time as these potential stressors. If we conclude that such co-occurrence is likely, we then try to estimate the nature of that co-occurrence (these represent our exposure analyses). In this step of our analyses, we try to identify the number, age (or life stage), and gender of the individuals that are likely to be exposed to an Action’s effects and the populations or subpopulations those individuals represent. During the consultation, we examine any measures an action agency proposes to use to insure that endangered or threatened

species or designated critical habitat are not likely to be exposed to particular stressors or to reduce the intensity, duration, frequency, or geographic extent of any exposure.

Once we identify which listed resources (endangered and threatened species and designated critical habitat) are likely to be exposed to potential stressors associated with an action and the nature of that exposure, in the third step of our analyses we examine the scientific and commercial data available<sup>11</sup> to determine whether and how those listed resources are likely to respond given their exposure (these represent our response analyses). In the final steps of our analyses we establish the risks those responses pose to ESA listed species and designated critical habitat (these represent our risk analyses).

### **Application of this Approach to this Consultation**

In this case, we have consulted with, and provided assistance to, the EPA so that they can insure that discharges of pesticides pollutants, alone or in combination, that would be authorized by their proposed PGP is not likely to jeopardize the continued existence of endangered or threatened species under NMFS' jurisdiction, or destroy or adversely modify critical habitat that has been designated for those species. However, because of the spatial and temporal scope of the proposed PGP, we were faced with substantial uncertainty about the number, location, timing, frequency and intensity of the discharges that would be authorized by the permit, the formulations associated with the discharges and the methods operators or applicators would employ during those discharges. The magnitude of this uncertainty made it impossible for us to assess whether or to what degree EPA had insured that specific discharges alone or in combination complied with the requirements of Section 7(a)(2) of the ESA.

Instead, we treated EPA's proposed permit as a "program" that would authorize a wide array of activities (discharges of pesticide pollutants) and asked whether and to what degree the EPA structured this "program" so that it could insure that individual discharges and the collection of discharges were not likely to jeopardize the continued existence of endangered and threatened species under NMFS' jurisdiction or result in the destruction or adverse modification of critical habitat that has been designated for those species.

Here, "program structure" refers to the decision-making processes, applications of standards and criteria (including standards of information and treatment of uncertainty), feedback loops (through monitoring and enforcement), and controls (including permit conditions) that agencies employ to ensure that agency decisions to authorize fund, or carry out specific actions or a class of actions are likely to fulfill the mandates of the program before the agency authorizes, funds, or carries out those actions. Generally, an agency's decision-making process involves formal procedures (such as, regulatory procedures and public noticing requirements), information standards (that is, agency "guidelines," and the judgments agency personnel make when they confront conflicting information and make judgments in the face of uncertainty).

When we conduct programmatic examinations of proposals such as the PGP, we ask whether or to what degree the Federal action agency (in this case, the EPA) has included protections for species and habitat in the selection of activities to be authorized as part of the permit.<sup>12</sup> If EPA has not done so, then we ask whether EPA has constructed

---

<sup>11</sup> Although Section 7(a)(2) of the Endangered Species Act of 1973, as amended, requires us to use the best scientific and commercial data available, at this stage of our analyses, we consider all lines of evidence, including the best scientific and commercial data as well as traditional ecological knowledge from Native American tribes and Pacific Islanders.

<sup>12</sup> EPA has not conducted ESA Section 7 consultation on the registration of most pesticide active ingredients. NMFS has issued Biological Opinions finding that use of at least 12 active ingredients in the authorized amounts is likely to jeopardize listed

a decision-making process that would consider the information, standards and criteria that NMFS would normally consider during consultations on specific actions prior to those actions proceeding. We also ask whether that decision-making process is likely to allow EPA to identify risk and produce outcomes that would reliably prevent or minimize endangered or threatened species under NMFS' jurisdiction and those species' designated critical habitat from being exposed to physical, chemical, or biotic stressors that would directly or indirectly reduce the fitness of endangered or threatened individuals, increase the extinction risks of the population(s) those individual might represent, increase the extinction risks of the species those populations comprise, or that would directly or indirectly impact the conservation value of designated critical habitat.

Specifically, we ask:

1. Has the EPA structured the proposed PGP so that the EPA will know or be able to reliably estimate the probable individual and cumulative effects of the discharges of pesticide pollutants on, over or near waters of the United States? For example, has the EPA structured the PGP so that the EPA will know or be able to reliably estimate the probable number of discharges that would be authorized by the program? Has the EPA structured the proposed PGP so that the EPA will know or be able to reliably estimate the probable location and timing of the discharges of pesticide pollutants that would be authorized by the program?
2. Has the EPA structured the proposed PGP so that the EPA will know or be able to reliably estimate the physical, chemical, or biotic stressors that are likely to be produced as a direct or indirect result of the discharges of pesticide pollutants that would be authorized by the PGP (that is, the stressors produced by the actual discharges of pesticide pollutants on, over or near waters of the United States)?

Alternatively, has the EPA structured the PGP so that the EPA will know or be able to determine reliably whether or to what degree physical, chemical, or biotic stressors that are not authorized by the PGP have been produced as a direct or indirect result of the discharges of pesticide pollutants that would be authorized by the permit; or, has the EPA's Office of Water structured the PGP so that the EPA will know or be able to reliably estimate that discharges of pesticide pollutants that would be authorized by the proposed general permit have not occurred in concentrations, frequencies, or for durations that exceed the authorization of the proposed permit?

3. Has the EPA structured the PGP so that the EPA will know or be able to determine reliably whether or to what degree operators, applicators, or decision makers have complied with the conditions, restrictions or mitigation measures the proposed general permit requires when they discharge pesticide pollutants on, over or near waters of the United States?
4. Has the EPA structured the PGP so that the EPA will know or be able to reliably estimate whether or what degree specific endangered or threatened species or designated critical habitat are likely to be exposed to:  
(a) Potentially harmful concentrations of the pesticide pollutants the proposed general permit would authorize to be discharged on, over or near waters of the United States; (b) Potentially harmful mixtures of the pesticide pollutants the proposed general permit would authorize to be discharged on, over or near

---

species, and NMFS proposed protective measures to keep compounds containing these ingredients out of waters. The PGP does not incorporate any of the protective measures from NMFS' existing biological opinions. One of those opinions is being challenged in court.

waters of the United States; or (c) To the ecological consequences of discharging pesticide pollutants on, over or near waters of the United States?

5. Has the EPA structured the PGP so that the EPA will continuously identify, collect, and analyze any information that suggests that the discharges of pesticide pollutants on, over or near waters of the United States may have exposed endangered or threatened species or designated critical habitat to pesticide pollutants at concentrations, intensities, durations, or frequencies that are known or suspected to produce physical, physiological, behavioral, or ecological responses that have potential individual or cumulative adverse consequences for individual organisms or constituent elements of critical habitat?
6. Has the EPA structured the PGP so that the EPA will employ an analytical methodology that considers: (a) The status and trends of endangered or threatened species or designated critical habitat; (b) the demographic and ecological status of populations and individuals of those species given their exposure to pre-existing stressors in different drainages and watersheds; (c) The direct and indirect pathways by which endangered or threatened species or designated critical habitat might be exposed to the discharges of pesticide pollutants on, over or near waters of the United States; and (d) The physical, physiological, behavior, sociobiological, and ecological consequences of exposing endangered or threatened species or designated critical habitat to pesticide pollutants at concentrations, durations, or frequencies that are known or suspected to produce physical, physiological, behavioral, or ecological responses, given their pre-existing demographic and ecological condition?
7. Finally, has the EPA structured the PGP so that the EPA will be able to use the knowledge above to minimize or prevent endangered or threatened species or designated critical habitat from being exposed to discharges of pesticide pollutants: (a) At concentrations, durations, or frequencies that are potentially harmful to individual listed organisms, populations, or the species; (b) In mixtures that are potentially harmful to individual listed organisms, populations, or the species; or (c) To ecological consequences that are potentially harmful to individual listed organisms, populations, the species or Primary Constituent Elements of designated critical habitat? If these protections are not included as part of the authorized action, how quickly would the EPA be able to implement preventive measures?

Our assessment focused on whether and to what degree the EPA structured the PGP in ways that would prevent endangered or threatened species or critical habitat that has been designated for those species from being exposed to pesticide pollutants because exposures commonly trigger a cascade of events with ultimate consequences difficult to prevent. For example, once individual plants and animals are exposed to a pesticide pollutant, their responses to the exposure is controlled by the concentration, duration and frequency associated with the exposure, their sensitivity to the pesticide pollutant, other physical, chemical, or biotic stressors that they are exposed to in the same time interval, their pre-existing physiological State and their constitutional endowment. Because it is so difficult to prevent free-ranging organisms from responding to anthropogenic stressors once they have been exposed, the most effective management measures are designed to influence the exposure itself. For that reason, our assessment focuses on whether and to what degree the PGP prevents endangered and threatened species and designated critical habitat from being exposed to pesticide pollutants that would be authorized by the proposed Pesticides General Permit.

A Federal agency's failure to insure that their actions comply with the requirements of Section 7(a)(2) of the ESA may not be sufficient such that endangered or threatened species or designated critical habitat would necessarily be adversely affected as a result of that failure. To address this possibility, we supplement our assessment by evaluating the probable consequences of the actions that would be authorized, funded or carried out by the Federal agency's

program for endangered and threatened species and critical habitat that has been designated for those species. Specifically, we:

1. Examine the four use patterns that would be authorized by the proposed PGP: 1) Mosquito (larvicides and adulticides) and other flying insect pest control; (2) Aquatic weed, algae and pathogen control; (3) Aquatic nuisance animal and pathogen control; and (4) Forest canopy pest and pathogen control.

These analyses summarize (a) Each use pattern; (b) The geographic distribution of use patterns (including geographic differences in pesticides -as formulated- used); (c) Seasonal patterns associated with the different use patterns in the different geographic areas; (d) The pesticides (formulations) typically used with each pattern (particularly “pesticide pollutants”); (e) Any information on application rates with the different use patterns (and with different formulations); and (f) Identify those components of the formulations that would constitute “pollutants.”

2. We determine the degree of spatial overlap between use patterns, listed species and designated critical habitat.

These analyses describe spatial overlap and any specific evidence (reports or studies) that particular endangered or threatened species or designated critical habitat have been or are likely to be exposed to those use patterns. However, this does not represent a detailed exposure analysis: we are merely establishing whether or to what degree endangered or threatened species or designated critical habitat overlap, in space and time (some pesticides may be used when migratory species are not in an area, for example). Given spatial and temporal overlap, we then have reason to ask whether or to what degree EPA’s proposed PGP can insure that these species or critical habitat are not likely to be exposed.

3. We conducted a detailed review of the literature available on the physical, physiological, behavioral, social, and ecological responses of endangered or threatened species or constituent elements of critical habitat given exposure to ingredients of pesticide formulations (active or otherwise), degradates or metabolites of those formulations, or to the ecological effects (that is, effects resulting from changes in populations of prey, predators, competitors, symbionts, etc.) of those formulations. Rather than discuss the literature for each species, it would be equally effective to organize the data using species groups (for example, Pacific Salmon; Sturgeon; Sea Turtles; etc.).

4. We *summarize* the probable consequences of the responses identified in the preceding section for endangered and threatened species and designated critical habitat. Rather than discuss the literature for each species, it would be only be necessary to discuss the risks of exposing species groups (for example, Pacific Salmon; Sturgeon; Sea Turtles; etc.).

In this Opinion, we will present the results of these analyses before we present the results of our review and evaluate EPA’s proposed PGP using the sequence of seven questions we identified at the beginning of this section. We use the results of these combined analyses to determine whether and to what degree the EPA structured the PGP in ways that would prevent jeopardy to endangered or threatened species or destruction or adverse modification of critical habitat that has been designated for those species.

### **Evidence Available for the Consultation**

We relied on two bodies of evidence for this consultation. We used the first body of evidence to determine whether

or to what degree the EPA structured the PGP so that EPA could insure that discharges of pesticide pollutants on, over or near waters of the United States were not likely to jeopardize the continued existence of endangered or threatened species or result in the destruction or adverse modification of critical habitat that has been designated for those species. After examining the proposed action for elements that insure against jeopardy, we used a second body of evidence to assess the probable consequences of PGP-authorized discharges of pesticide pollutants on, over or near waters of the United States on endangered or threatened species or critical habitat that has been designated for those species.

To build this first body of evidence, we searched for, gathered, and analyzed published and unpublished sources that examine the effectiveness of EPA's NPDES program and whether or to what degree the program has had (1) adverse consequences for natural flora and fauna that have some dependency on the quality of waters of the United States or (2) adverse consequences for species that have been listed as endangered or threatened. In particular, we considered information contained in EPA's *Biological Evaluation for the Environmental Protection Agency's (EPA) Pesticides General Permit (PGP)* and reviews of the effectiveness of the NPDES program and of existing general permits. We also considered previous ESA Section 7 consultations on pesticide uses, species status reviews, listing documents, recovery plans, reports on the status and trends of water quality, past and current research and population dynamics modeling.

We supplemented this information by searching for NPDES compliance data in the Permit Compliance System (PCS) and Integrated Compliance Information System - National Pollutant Discharge Elimination System (ICIS-NPDES) databases<sup>13</sup> of EPA's Online Tracking Information System. These databases track the number of inspections and enforcement actions over five years along with the number of quarters in non compliance and the frequency of effluent exceedances over three years. We collected the data on January 5, 2011, which contained data that were current as of October 21, 2010.

Our search targeted general and individual permits for entities where EPA was the permitting authority as identified in the Description of the Proposed Action section of this Biological Opinion. The ICIS-NPDES query was run with Compliance Status set to "on" since facilities with compliance status set to "off" may have violations that have not yet been entered into the database. The search also selected only active permits, which are those designated as "effective" or under "administrative continuation." Data were analyzed to evaluate the compliance and enforcement patterns of EPA's existing general and individual permits. To avoid bias from permits with multiple inspections due to compliance and enforcement actions, the frequency data were converted into presence/absence of inspection, compliance and enforcement events.

We used a second body of evidence to assess the probable consequences of authorizing discharges of pesticide pollutants on, over or near waters of the United States on endangered or threatened species or critical habitat that has been designated for those species. To assemble this body of information, we searched peer-reviewed scientific literature, master's theses and doctoral dissertations, government reports and studies and reports from commercial vendors. Specifically, we searched the National Library of Medicine's Hazardous Substance Data Bank, TOXNET, Toxline, EXTOXNET pesticide information profiles and EPA's National Information System for the Regional Integrated Pest Management Centers (<http://www.ipmcenters.org/Ecotox/DataAccess.cfm>) for papers on the toxicity

---

<sup>13</sup> The PCS was the original tracking mechanism for NPDES permits and currently includes data for 21 states. State by state, the data in PCS is being migrated into the newer ICIS-NPDES. The ICIS-NPDES currently tracks data for the remaining states not represented in PCS, U.S. territories, the Navajo Nation, and the St. Regis Tribe.

of representatives of the 171 active ingredients whose discharges would be authorized by the proposed PGP.

We supplemented those searches with searches of web-sites maintained by the Departments of Agriculture and mosquito control authorities of the six States, territories and Indian lands that would be included in the proposed PGP. We specifically focused on data in the States of Idaho, Massachusetts, and New Hampshire because those States overlap greatly with the distributions of clusters of endangered and threatened species under NMFS' jurisdiction (listed species of Pacific salmon in the case of Idaho and listed sturgeon in the case of Massachusetts and New Hampshire). We searched those sites for information on the active ingredients or formulations those States, Territories, and Tribal governments employ for the four use patterns included in the PGP, data on concentrations of active ingredients, degradates, and mixtures on surface waters within the jurisdictional boundaries of those areas where the EPA is the permitting authority, and data on the consequences of exposing endemic fish and wildlife to those concentrations. These searches focused on identifying recent information on the biology, ecology, distribution, status and trends of the threatened and endangered species considered in this Opinion. We considered the results of these searches based on the quality of their study design, sample sizes and study results.

---

### **Action Area**

---

EPA has defined the action area for the PGP consultation as all waters of the United States (as defined in 40 CFR 122.2) in States and Territories where the EPA is the permitting authority: Alaska, American Samoa, District of Columbia, Guam, Idaho, Johnston Atoll, Massachusetts, Midway Island, New Hampshire, New Mexico, Northern Mariana Islands, Oklahoma, Puerto Rico and Wake Island. In addition, the action area also includes all waters of the United States receiving discharges from pesticide applications on Federal lands in Colorado, Delaware, Vermont and Washington, as well as Indian lands nationwide. This area includes waters from the line of ordinary low water along the coast extending seaward to a distance of three miles.

Because endangered or threatened species that are under the jurisdiction of NMFS do not occur in all of these geographic areas (for example, New Mexico, Oklahoma, Colorado, and many Indian lands), the Action Area for this consultation encompasses the areas where the geographic areas where EPA is the permitting authority overlaps with the distribution of endangered or threatened species under NMFS' jurisdiction. As a result, we do not include New Mexico, Oklahoma, Colorado or Indian lands that do not overlap with the distribution of endangered or threatened species under NMFS' jurisdiction in the Action Area for this Opinion. NMFS' Opinion is limited to discharges that occur in the District of Columbia, Idaho, Massachusetts and New Hampshire; Federal lands in Delaware, Vermont and Washington State; and Indian lands nationwide.

Although degradates and metabolites of some of the pesticide pollutants considered in this Opinion might be transported more than three miles from our coastline at some concentration, the data we would need to follow a pesticide as it is transported from a particular application site to reservoirs in coastal waters and the open ocean are not available to us. Similarly, the data we would need to trace pesticides found in the tissues of marine and coastal animals back to particular terrestrial applications are not available. Without some data or other information, we can only acknowledge the probability of this kind of transport in our Opinion; we do not extend the action area more than three miles from the coast of the coastal states, territories, and possessions included in the proposed PGP.

---

## Status of the Species and Critical Habitat and Environmental Baseline

---

In this section of this Opinion we describe the threatened and endangered species<sup>14</sup> and their designated critical habitat that occur in the action area and may be exposed to the direct or indirect effects of discharges of pesticide pollutants authorized by the proposed PGP<sup>15</sup>. All listed species within NMFS’ jurisdiction are “aquatic” or “aquatic dependent” and may occur within portions of the action area. NMFS has determined that the following species and critical habitat “may be affected” by EPA’s proposed PGP (Table 2).

---

**Table 2. Species Listed as Threatened and Endangered and Proposed for Listing and their Designated Critical Habitat (Denoted by Asterisk) in the Action Area. Double Asterisks Denote Proposed Critical Habitat.**

---

Common Name	Scientific Name	Status
<b>Cetaceans</b>		
Beluga whale* (Cook Inlet)	<i>Delphinapterus leucas</i>	Endangered
Blue whale	<i>Balaenoptera musculus</i>	Endangered
Bowhead whale	<i>Balaena mysticetus</i>	Endangered
Fin whale	<i>Balaenoptera physalus</i>	Endangered
Humpback whale	<i>Megaptera novaeangliae</i>	Endangered
Killer Whale (Southern Resident*)	<i>Orcinus orca</i>	Endangered
North Atlantic right whale*	<i>Eubalaena glacialis</i>	Endangered
North Pacific right whale*	<i>Eubalaena japonica</i>	Endangered
Sei whale	<i>Balaenoptera borealis</i>	Endangered
Sperm whale	<i>Physeter macrocephalus</i>	Endangered
<b>Pinnipeds</b>		
Hawaiian monk seal*†	<i>Monachus schauinslandi</i>	Endangered
Steller sea lion (Eastern population*)	<i>Eumetopias jubatus</i>	Threatened
Steller sea lion (Western population*)		Endangered

---

<sup>14</sup> We use the word “species” as it has been defined in section 3 of the ESA, which include “species, subspecies, and any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature (16 U.S.C. 1533)”. Pacific salmon that have been listed as endangered or threatened were listed as “evolutionarily significant units (ESU)” which NMFS uses to identify distinct population segments (DPS) of Pacific salmon. Any ESU or DPS is a “species” for the purposes of the ESA.

<sup>15</sup> Although some ESA listed salmonid species occur only in waters of the United States in the State of California which has delegated authority to implement the NPDES program under the CWA and is thus not subject to coverage under the proposed general permit, those species may be exposed to discharges from activities that occur on Indian lands that would be authorized by the PGP. Because of this, these species are considered in this Opinion.

**Table 2. Species Listed as Threatened and Endangered and Proposed for Listing and their Designated Critical Habitat (Denoted by Asterisk) in the Action Area. Double Asterisks Denote Proposed Critical Habitat.**

Common Name	Scientific Name	Status
Guadalupe fur seal	<i>Arctocephalus townsendi</i>	Threatened
Spotted seal (southern population)	<i>Phoca largha</i>	Threatened
<b>Marine Turtles</b>		
Green sea turtle (Florida & Mexico's Pacific coast colonies)*	<i>Chelonia mydas</i>	Endangered
Green sea turtle (All other areas)*		Threatened
Hawksbill sea turtle*	<i>Eretmochelys imbricate</i>	Endangered
Kemp's ridley sea turtle	<i>Lepidochelys kempii</i>	Endangered
Leatherback sea turtle* (also **)	<i>Dermochelys coriacea</i>	Endangered
Loggerhead sea turtle	<i>Caretta caretta</i>	Threatened
Olive ridley sea turtle (Mexico's Pacific coast breeding colonies)	<i>Lepidochelys olivacea</i>	Endangered
Olive ridley sea turtle (All other areas)		Threatened
<b>Marine and Anadromous Fish</b>		
Atlantic salmon (Gulf of Maine)*	<i>Salmo salar</i>	Endangered
Bocaccio	<i>Sebastes paucispinis</i>	Endangered
Canary rockfish	<i>Sebastes pinniger</i>	Threatened
Pacific eulachon/smelt (Southern**)	<i>Thaleichthys Pacificus</i>	Threatened
Yelloweye rockfish	<i>Sebastes ruberrimus</i>	Threatened
Chinook salmon (California coastal *)	<i>Oncorhynchus tshawytscha</i>	Threatened
Chinook salmon (Central Valley spring-run*)		Threatened
Chinook salmon (Lower Columbia River*)		Threatened
Chinook salmon (Upper Columbia River spring-run*)		Threatened
Chinook salmon (Puget Sound*)		Threatened
Chinook salmon (Sacramento River winter-run*)		Endangered
Chinook salmon (Snake River fall-run*)		Threatened
Chinook salmon (Snake River spring/summer-run*)		Threatened
Chinook salmon (Upper Willamette River*)		Threatened
Chum salmon (Columbia River*)	<i>Oncorhynchus keta</i>	Threatened
Chum salmon (Hood Canal summer-run*)		Threatened

**Table 2. Species Listed as Threatened and Endangered and Proposed for Listing and their Designated Critical Habitat (Denoted by Asterisk) in the Action Area. Double Asterisks Denote Proposed Critical Habitat.**

Common Name	Scientific Name	Status
Coho salmon (Central California coast*)	<i>Oncorhynchus kisutch</i>	Endangered
Coho salmon (Lower Columbia River)		Threatened
Coho salmon (Southern Oregon & Northern California coast*)		Threatened
Coho salmon (Oregon coast*)		Threatened
Green sturgeon (Southern*)	<i>Acipenser medirostris</i>	Threatened
Gulf sturgeon*	<i>Acipenser oxyrinchus desotoi</i>	Threatened
Shortnose sturgeon	<i>Acipenser brevirostrum</i>	Endangered
Smalltooth sawfish*	<i>Pristis pectinata</i>	Endangered
Sockeye salmon (Ozette Lake*)	<i>Oncorhynchus nerka</i>	Threatened
Sockeye salmon (Snake River*)		Endangered
Steelhead (Central California coast*)	<i>Oncorhynchus mykiss</i>	Threatened
Steelhead (California Central Valley*)		Threatened
Steelhead (Lower Columbia River*)		Threatened
Steelhead (Middle Columbia River*)		Threatened
Steelhead (Northern California*)		Threatened
Steelhead (Puget Sound)		Threatened
Steelhead (Snake River*)		Threatened
Steelhead (South-Central California Coast*)		Threatened
Steelhead (Southern California*)		Endangered
Steelhead (Upper Columbia River*)		Threatened
Steelhead (Upper Willamette River*)		Threatened
<b>Marine Invertebrates</b>		
Black abalone**	<i>Haliotis cracherodii</i>	Endangered
White abalone	<i>Haliotis sorenseni</i>	Endangered
Elkhorn coral*	<i>Acropora palmata</i>	Threatened
Staghorn coral*	<i>Acropora cervicornis</i>	Threatened

**Table 2. Species Listed as Threatened and Endangered and Proposed for Listing and their Designated Critical Habitat (Denoted by Asterisk) in the Action Area. Double Asterisks Denote Proposed Critical Habitat.**

Common Name	Scientific Name	Status
<b>Marine Plant</b>		
Johnson's seagrass*	<i>Halophila johnsonii</i>	Threatened

† Proposed for revision (74 FR 27988).

NMFS and the U.S. Fish and Wildlife Service have joint jurisdiction over sea turtles, gulf sturgeon and Atlantic salmon. To avoid redundancy, the U.S. Fish and Wildlife Service is generally responsible for endangered and threatened sea turtles above mean higher high water (when they are on their nesting beaches as opposed to when they are in or beyond the surf zone) and for Gulf sturgeon and Atlantic salmon when they are in fresh water (as opposed to when they are in estuarine or marine water). Because the FWS is responsible for assessing the effects of Federal actions on gulf sturgeon and Atlantic salmon while they are in fresh water and the proposed action constitutes such a Federal action, the FWS is responsible for assessing the effects of EPA's proposal on gulf sturgeon, Atlantic salmon, and critical habitat that has been designated for gulf sturgeon pursuant to Section 7 (a)(2) of the Act. We do not consider these species further in this Opinion.

#### **Species and Critical Habitat Not Likely to be Adversely Affected by the Proposed Action**

As described in the *Approach to the Assessment*, NMFS uses two criteria to identify those endangered or threatened species or critical habitat that are not likely to be adversely affected by discharges of pesticide pollutants that would be authorized by the proposed PGP. The first criterion is *exposure* or some reasonable expectation of a co-occurrence between one or more discharges of the pesticide pollutants that would be authorized by the proposed PGP and a particular listed species or designated critical habitat. If we conclude that a listed species or designated critical habitat is not likely to be exposed to those discharges through direct or indirect exposure pathways, we must conclude that the critical habitat is not likely to be adversely affected by those activities. The second criterion is the probability of a *response* given exposure, which considers *susceptibility*: species that may be exposed to the discharges of pesticide pollutants that would be authorized by the proposed PGP, but that exposure is not likely to have adverse physical, physiological, behavioral or ecological consequences for individuals that are likely to be exposed. We applied these criteria to the species listed at the beginning of this section; the subsections that immediately following this introductory paragraph summarize the results of those evaluations.

Based upon our analyses, we concluded that many of the endangered or threatened species listed in Table 2 are either not likely to be exposed to discharges of pesticide pollutants that would be authorized by the proposed PGP or are not likely to respond upon being exposed to those pesticide pollutants. Specifically, we would not expect the following threatened or endangered species to respond physically, physiologically, behaviorally, or ecologically given exposure to discharges associated with the proposed PGP:

#### **Marine Mammals**

Blue whales, bowhead whales, fin whales, humpback whales, North Atlantic right whales, North Pacific right whales, sei whales, sperm whales, Guadalupe fur seals, Hawaiian monk seals, spotted seal, western population of Steller sea lion, and eastern population of Steller sea lion all occur or have been reported to occur within three miles of the coast of one or more of the states, territories, or possessions that are included in the proposed PGP. As a

result, they occur within the Action Area for this consultation. Nevertheless, these species are either not likely to be exposed to the direct or indirect effects of the discharges that would be authorized by the proposed PGP or they are not likely to respond given exposure.

In North America, bowhead whales occur in the Beaufort, Bering and Chukchi Seas. Discharges associated with the four use patterns authorized by the proposed PGP have not traditionally occurred in coastal areas of the U.S. portions of the Beaufort and Chukchi Seas or the freshwater rivers that drain into the U.S. portions of the Beaufort and Chukchi Seas, so bowhead whales are not likely to be exposed to pesticide residues in those geographic areas. Similarly, discharges of pesticide pollutants are not likely to occur in coastal areas of the Bering Sea, although they might occur in rivers that drain into the Bering Sea from the U.S. (for example, discharges associated with forest treatments in the upper Yukon or Kuskokwim River basins). However, because bowhead whales do not appear to feed while wintering, they are not likely to be exposed to pesticide pollutants through their diets or because of changes in the distribution or abundance of their forage base while in the Bering Sea. As a result, we conclude that bowhead whales are not likely to be exposed to the direct or indirect effects of the proposed action and we will not discuss this species further in this Opinion.

Because they breathe air (rather than respire through gills or similar anatomical structures), blue whales, fin whales, humpback whales, North Atlantic right whales, North Pacific right whales, sei whales, sperm whales, Guadalupe fur seals, Hawaiian monk seals, members of the western population of Steller sea lions, members of the eastern population of Steller sea lions and spotted seals would only be exposed to pesticide pollutants through their diets or because of changes in the distribution or abundance of their prey (trophic exposure). Because the distances that would separate the foraging areas of these species from discharges of pesticide pollutants are substantial and any pesticide pollutants would be degraded by exposure to sunlight, microbial action, and chemical processes in the freshwater ecosystems, estuaries, and coastal areas before they would enter the diets or affect the prey base of these species, residual concentrations of those pesticide pollutants would probably be below concentrations that would have no observed adverse effect on the marine mammals or their prey. As a result, we conclude that these species might be exposed to residual concentrations of pesticide pollutants associated with the proposed PGP, but they are not likely to be exposed at concentrations that are likely produce adverse physical, chemical, physiological, behavioral or ecological responses in those species. As a result, these species are not likely to be adversely affected by the proposed action and we will not discuss them further in this Opinion.

### ***Sea Turtles***

Green sea turtles, hawksbill sea turtles, Kemp's ridley sea turtles, leatherback sea turtles, loggerhead sea turtles and olive ridley sea turtles all occur or have been reported to occur within three miles of the coast of one or more of the states, territories, or possessions that are included in the proposed PGP. As a result, they occur within the Action Area for this consultation. Nevertheless, these species are either not likely to be exposed to the direct or indirect effects of the discharges that would be authorized by the proposed PGP or they are not likely to respond given exposure.

Because, like marine mammals, sea turtles breathe air they could only be exposed to pesticide pollutants through their diets or because of changes in the distribution or abundance of their prey (trophic exposure). Because the distances that would separate the foraging areas of these species from discharges of pesticide pollutants are substantial and any pesticide pollutants would be degraded by exposure to sunlight, microbial action, and chemical processes in the freshwater ecosystems, estuaries, and coastal areas before they would enter the diets or affect the prey base of these species, concentrations of those pesticide pollutants would probably be below concentrations that

would have no observed adverse effect on the sea turtles or their prey. As a result, we conclude that these species might be exposed to concentrations of pesticide pollutants associated with the proposed PGP, but they are not likely to be exposed at concentrations that are likely produce adverse physical, chemical, physiological, behavioral or ecological responses. As a result, these species are not likely to be adversely affected by the proposed action and we will not discuss them further in this Opinion.

### **Marine Fish**

Bocaccio, canary rockfish, yelloweye rockfish and smalltooth sawfish all occur or have been reported to occur in coastal waters of the Action Area for this consultation. Nevertheless, these species are either not likely to be exposed to the direct or indirect effects of the discharges that would be authorized by the proposed PGP or they are not likely to respond given exposure.

Adult Georgia Basin bocaccio are most common at depths between 50 and 250 meters (160 and 820 feet); Georgia Basin yelloweye rockfish are most common at depths between 91 and 180 meters (300 to 580 feet), although they may occur in waters 50 to 475 meters (160 and 1,400 feet) deep; and canary rockfish are most common at depths between 50 and 250 meters (160 and 820 feet) and may occur at depths of 425 meters (1,400 feet). The larvae of these rockfish occur over areas that extend several hundred miles offshore where they are passively dispersed by ocean currents and remain in larval form and as small juveniles for several months (Moser and Boehlert, 1991; Auth and Brodeur, 2006). They appear to concentrate over the continental shelf and slope, but have been captured more than 250 nautical miles offshore of the Oregon coast (Richardson *et al.*, 1980; Moser and Boehlert, 1991). Larval rockfish have been reported to be uniformly distributed at depths of 13, 37 and 117 meters below surface, so they occur at depths that would bring them into sound fields produced by mid-frequency active sonar (Lenarz *et al.*, 1991). Larval bocaccio had highest abundance at depths of 13 meters, but were also captured in the 117-meter samples. Larval canary rockfish were captured at all three depths, but their densities were highest at the 37- and 177-meter depths (Lenarz *et al.*, 1991).

Because of the small size of the adult, breeding population of endangered and threatened rockfish, the large area over which those larvae are likely to disperse, and their low relative frequency (that is, their density as a percent of the density of the larvae of the more abundance species of rockfish), the density of larvae of endangered or threatened rockfish will be very small offshore. Of the three species, Georgia Basin bocaccio are likely to have the smallest densities because the size of the adult, breeding population in this species is very small and they have the lowest fecundities of the three species. Nevertheless, the density of Georgia Basin canary rockfish and Georgia Basin yelloweye rockfish are also very small relative to the densities of other, non-listed rockfish that have much larger adult population sizes and fecundities that overlap with those of yelloweye rockfish (which are the most fecund of the endangered or threatened rockfish).

Because of their geographic distribution and distance from source of pesticide applications, these species are not likely to be exposed to the direct or indirect effects of the discharges that would be authorized by the proposed PGP or they are not likely to be exposed at concentrations that would elicit adverse physical, chemical, physiological, behavioral or ecological responses. As a result, these species are not likely to be adversely affected by the proposed action and we will not discuss them further in this Opinion.

Smalltooth sawfish are tropical, marine and estuarine fish that inhabit shallow waters of inshore bars, mangrove edges and seagrass beds, although they are occasionally found in deeper coastal waters (NMFS, 2000). Historically, this species was common in the shallow waters of the Gulf of Mexico and along the eastern seaboard of the United States to North Carolina (rare sightings of this sawfish occurred as far north as New York). Their current range is

limited to peninsular Florida, where they are only found with any regularity off the extreme southern portion of the peninsula (off Everglades National Park and Florida Bay).

The proposed PGP would not apply to any of the states within the geographic distribution of smalltooth sawfish, but it would apply to Indian lands within southern Florida (for example, Miccosukee Tribal lands and Seminole Tribal lands). Any discharges of pesticide pollutants on those Tribal lands would have to be transported through Everglades National Park or Big Cypress National Park where they would be degraded by exposure to sunlight, microbial action and chemical processes in the wetlands that form those parks before they would enter the diets or affect smalltooth sawfish or their prey base. Because of those processes, concentrations of these pesticide pollutants would probably be below concentrations that would have no observed adverse effect on smalltooth sawfish or their prey. As a result, we conclude that smalltooth sawfish might be exposed to concentrations of pesticide pollutants associated with the proposed PGP, but they are not likely to be exposed at concentrations that are likely to produce adverse physical, chemical, physiological, behavioral or ecological responses in this species. As a result, smalltooth sawfish are not likely to be adversely affected by the proposed action and we will not discuss them further in this Opinion.

### ***Marine Invertebrates***

Elkhorn coral, staghorn coral, black abalone, and white abalone all occur or have been reported to occur in coastal waters of the Action Area for this consultation. Nevertheless, these species are either not likely to be exposed to the discharges that would be authorized by the proposed PGP or they are not likely to respond given exposure.

Elkhorn and staghorn coral are found on coral reefs in southern Florida (particularly the Florida Keys), the Bahamas, and throughout the Caribbean (Puerto Rico, St. John, St. Thomas, and St. Croix). The northern limit for elkhorn coral is Biscayne National Park, Florida, and it extends south to Venezuela; it is not found in Bermuda. The northern limit for staghorn coral is around Boca Raton, Florida.

The proposed PGP would not apply to Florida, but it would apply to Indian lands within southern Florida (for example, Miccosukee Tribal lands and Seminole Tribal lands). In Florida, any discharges of pesticide pollutants on those Tribal lands would have to be transported through Everglades National Park or Big Cypress National Park where they would be degraded by exposure to sunlight, microbial action and chemical processes in the wetlands that form those parks before they would enter Florida Bay where they might interact with the Florida Keys. Because of those processes, concentrations of these pesticide pollutants would probably be below concentrations that would have no observed adverse effect on these coral. In Puerto Rico, the location of the elkhorn and staghorn corals are far enough from the location of potential discharge sites, the pesticide residues would be degraded by exposure to sunlight, microbial action and chemical processes before they would enter the coastal waters in which the coral are located. As a result, we conclude that elkhorn and staghorn coral might be exposed to concentrations of pesticide pollutants associated with the proposed PGP, but they are not likely to be exposed at concentrations that are likely to produce adverse physical, chemical, physiological, behavioral or ecological responses in this species. As a result, elkhorn and staghorn coral are not likely to be adversely affected by the proposed action and we will not discuss them further in this Opinion.

Historically, black abalone occurred from about Point Arena in northern California to Bahia Tortugas and Isla Guadalupe, Mexico. Black abalone are rare north of San Francisco and south of Punta Eugenia, and unconfirmed sightings have been reported as far north as Coos Bay, Oregon. The northernmost documented record of black abalone (based on museum specimens) is from Crescent City (Geiger, 2004). Most experts agree that the current range of black abalone extends from Point Arena (Mendocino County, California, USA) south to Northern Baja California, Mexico. Black abalone may exist, but are considered extremely rare, north of San Francisco to Crescent

City, California, USA and south of Punta Eugenia to Cabo San Lucas, Baja California, Mexico (P. Raimondi, personal communication).

Historically, white abalone occurred from Point Conception, California to Punta Abreojos, Baja California, Mexico. They are the deepest-living of the west coast abalone species (Hobday and Tegner, 2000): they had been caught at depths of 20-60 m (66-197 ft) but had been reported as having had the highest abundance at depths of 25-30 m (80-100 ft (Cox, 1960). At these depths, white abalone are found in open low relief rock or boulder habitat surrounded by sand (Tutschulte, 1976). Over the past 30 years, the white abalone populations have declined precipitously in abundance primarily as a result of exploitation. Surveys conducted at Tanner and Cortez Banks have yielded numbers of white abalone in the low hundreds (Butler *et al.*, 2006).

Because of their geographic distribution and distance from source of pesticide applications, these species are not likely to be exposed to the direct or indirect effects of the discharges that would be authorized by the proposed PGP or they are not likely to be exposed at concentrations that would elicit adverse physical, chemical, physiological, behavioral or ecological responses. As a result, these species are not likely to be adversely affected by the proposed action and we will not discuss them further in this Opinion.

### ***Johnson's Seagrass***

Johnson's seagrass and the critical habitat for this species occur in Indian River lagoon along the Atlantic coast of southern Florida. The proposed PGP would not apply to Florida, but it would apply to Indian lands within southern Florida (for example, Miccosukee Tribal lands and Seminole Tribal lands). Any discharges of pesticide pollutants on those Tribal lands would have to be transported through Everglades National Park or Big Cypress National Park, not east to Indian River lagoon. As a result, Johnson's seagrass are not likely to be exposed to the proposed action and, therefore, is not likely to be adversely affected by the proposal. We will not discuss this species further in this Opinion.

## **Climate Change<sup>16</sup>**

There is now widespread consensus within the scientific community that atmospheric temperatures on earth are increasing (warming) and that these increases will continue for at least the next several decades (IPCC, 2001). The Intergovernmental Panel on Climate Change (IPCC) estimated that average global land and sea surface temperature has increased by 0.6°C (± 0.2) since the mid-1800s, with most of the change occurring since 1976. This temperature increase is greater than what would be expected given the range of natural climatic variability recorded over the past 1,000 years (Crowley and Berner, 2001). The IPCC reviewed computer simulations of the effect of greenhouse gas emissions on observed climate variations that have been recorded in the past and evaluated the influence of natural phenomena such as solar and volcanic activity. Based on their review, the IPCC concluded that natural phenomena are insufficient to explain the increasing trend in land and sea surface temperature, and that atmospheric warming observed over the last 50 years is probably attributable to human activities (IPCC, 2001). Climatic models estimate that global temperatures would increase between 1.4 to 5.8°C from 1990 to 2100 if humans do nothing to reduce greenhouse gas emissions from current levels (IPCC, 2001).

In the Northeast, annual average temperatures have increased by 2°F since 1970, with winter temperatures

---

<sup>16</sup> The threats posed by the direct and indirect effects of global climatic change are or will be common to all of the species we discuss in this Opinion. Because of this commonality, we present this single narrative rather than in each of the species-specific narratives that appear later in this section of our Opinion.

increasing by up to 4°F (Karl *et al.*, 2009). Over the same time interval, the Northeast has experienced more days with temperatures greater than 90°F, a longer growing season, increased heavy precipitation, more winter precipitation falling as rain than as snow, reduced snowpack, earlier breakup of winter ice on lakes and rivers, earlier spring snowmelt resulting in earlier peak river flows, rising sea surface temperatures and sea level.

Over the next several decades, the Northeast is expected to experience temperature increases of another 2.5 to 4°F during the winter season and 1.5 to 3.5°F during the summer season as a result of carbon emissions that have already occurred (Burakowski *et al.*, 2008; Karl *et al.*, 2009). Forecasts beyond the middle of this century are sensitive to the level of carbon emissions produced today. If carbon emissions are not reduced, the length of the winter snow season would be cut in half across northern New York, Vermont, New Hampshire, and Maine, and reduced to a week or two in southern parts of the region; the Northeast would have fewer cold days during the winter and experience more precipitation (Hayhoe *et al.*, 2007; Karl *et al.*, 2009).

Cities in the Northeast that currently experience temperatures greater than 100°F for a few days each summer would experience an average of 20 days of such temperatures each summer; some cities in the Northeast -- Hartford, Connecticut, and Philadelphia, Pennsylvania, for example -- would experience an average of 30 days of such temperatures each summer (Karl *et al.*, 2009). Hot summer conditions would arrive three weeks earlier and last three weeks longer into the fall. Droughts lasting from one- to three-months are projected to occur as frequently as once each summer in the Catskill and Adirondack Mountains, and across the New England states. Finally, sea levels in this region are projected to rise more than the global average, which would increase coastal flooding and coastal erosion (Kirshen *et al.*, 2008; Karl *et al.*, 2009).

In the Pacific Northwest, annual average temperatures have increased by about 1.5°F over the past century with some areas experiencing increases of up to 4°F (Karl *et al.*, 2009; Littell *et al.*, 2009; Elsner and Hamlet, 2010). Higher temperatures during the cool season (October through March) have caused more precipitation to fall as rain rather than snow and contribute to earlier snowmelt. The amount of snowpack remaining on April 1, which is a key indicator of natural water storage available for the warm season, has declined substantially throughout the Northwest region. In the Cascade Mountains, for example, the snowpack remaining on April 1 declined by an average of 25 percent over the past 40 to 70 years; most of this decline is attributed to the 2.5°F increase in temperatures during the winter season over the time interval (Payne *et al.*, 2004; Christensen *et al.*, 2007).

Over the next century, average temperatures in the Northwest Region are projected to increase by another 3 to 10°F, with higher emissions scenarios resulting in warming in the upper end of this range (Christensen *et al.*, 2007; Karl *et al.*, 2009). Increases in winter precipitation and decreases in summer precipitation are projected by many climate models, though these projections are less certain than those are for temperature.

There is consensus within the scientific community that warming trends will continue to alter current weather patterns and patterns of natural phenomena that are influenced by climate, including the timing and intensity of extreme events such as heat-waves, floods, storms, and wet-dry cycles. Oceanographic models project a weakening of the thermohaline circulation resulting in a reduction of heat transport into high latitudes of Europe, an increase in the mass of the Antarctic ice sheet, and a decrease in the Greenland ice sheet, although the magnitude of these changes remain unknown (Schmittner *et al.*, 2005; Levermann *et al.*, 2007). As ice melts in the Earth's polar regions in response to increases in temperature, increases in the distribution and abundance of cold water are projected to influence oceanic currents, which would further alter weather patterns. In addition to influencing atmospheric temperatures and weather patterns, increases in greenhouse gases in the Earth's atmosphere have begun to increase rates of carbon capture and storage in the oceans: as carbon dioxide levels in the oceans increase, the waters will

become more acidic, which would affect the physiology of large marine animals and cause structures made of calcium carbonate (for example, corals) to dissolve (IPCC, 2001; Royal Society of London, 2005).

Climate change is projected to have substantial direct and indirect effects on individuals, populations, species, and the structure and function of marine, coastal, and terrestrial ecosystems in the foreseeable future (McCarthy *et al.*, 2001; Parry *et al.*, 2007) (see Table 3). Climate-mediated changes in the global distribution and abundance are expected to reduce the productivity of the oceans by affecting keystone prey species in marine ecosystems such as phytoplankton, krill, cephalopods.

Increasing atmospheric temperatures have already contributed to changes in the quality of the freshwater, coastal and marine ecosystems that are essential to the survival and recovery of salmon populations and have contributed to the decline of populations of endangered and threatened species (Mantua *et al.*, 1997; Karl *et al.*, 2009; Littell *et al.*, 2009). Since the late 1970s, sea surface temperatures have increased and coastal upwelling -which is recognized as an important mechanism governing the production of both phytoplankton and zooplankton- has decreased resulting in reduced prey availability and poorer marine survival of Pacific salmon. Changes in the number of Chinook salmon escaping into the Klamath River between 1978 and 2005 corresponded with changes in coastal upwelling and marine productivity and the survival of Snake River spring/summer Chinook salmon and Oregon coho salmon has been predicted using indices of coastal ocean upwelling (Karl *et al.*, 2009; Littell *et al.*, 2009; Elsner and Hamlet, 2010). The majority (90%) of year-to-year variability in marine survival of hatchery reared coho salmon between 1985 and 1996 can be explained by coastal oceanographic conditions.

Changes in temperature and precipitation projected over the next few decades are projected to decrease snow pack, affect stream flow and water quality throughout the Pacific Northwest region (Stewart *et al.*, 2004; Knowles *et al.*, 2006; Mote *et al.*, 2008; Rauscher *et al.*, 2008). Warmer temperatures are expected to reduce snow accumulation and increase stream flows during the winter, cause spring snowmelt to occur earlier in the year causing spring stream flows to peak earlier in the year, and reduced summer stream flows in rivers that depend on snow melt (most rivers in the Pacific Northwest depend on snow melt). As a result, seasonal stream flow timing will likely shift significantly in sensitive watersheds (Littell *et al.*, 2009).

The States of Idaho, Oregon, and Washington, are likely to experience increased forest growth over the next few decades followed by decreased forest growth as temperature increases overwhelm the ability of trees to make use of higher winter precipitation and higher carbon dioxide. In coastal areas, climate change is forecast to increase coastal erosion and beach loss (caused by rising sea levels), increase the number of landslides caused by higher winter rainfall, inundate areas in southern Puget Sound around the city of Olympia, Washington (Littell *et al.*, 2009).

**Table 3. Phenomena associated with projections of global climate change including levels of confidence associated with projections (adapted from IPCC 2001 and Campbell-Lendrum Woodruff 2007)**

Phenomenon	Confidence in Observed Changes (observed in the latter 20 <sup>th</sup> Century)	Confidence in Projected Changes (during the 21 <sup>st</sup> Century)
Higher maximum temperatures and a greater number of hot days over almost all land areas	Likely	Very likely
Higher minimum temperatures with fewer cold days and frost days over almost all land areas	Very likely	Very likely
Reduced diurnal temperature range over most land areas	Very likely	Very likely
Increased heat index over most land areas	Likely over many areas	Very likely over most areas
More intense precipitation events	Likely over many mid- to high-latitude areas in Northern Hemisphere	Very likely over many areas
Increased summer continental drying and associated probability of drought	Likely in a few areas	Likely over most mid-latitude continental interiors (projections are inconsistent for other areas)
Increase in peak wind intensities in tropical cyclones	Not observed	Likely over some areas
Increase in mean and peak precipitation intensities in tropical cyclones	Insufficient data	Likely over some areas

Rising stream temperatures will likely reduce the quality and extent of freshwater salmon habitat. The duration of periods that cause thermal stress and migration barriers to salmon is projected to at least double by the 2080s for most analyzed streams and lakes (Littell *et al.*, 2009). The greatest increases in thermal stress (including diseases and parasites which thrive in warmer waters) would occur in the Interior Columbia River Basin and the Lake Washington Ship Canal. The combined effects of warming stream temperatures and altered stream flows will very likely reduce the reproductive success of many salmon populations in Washington watersheds, but impacts will vary according to different life-history types and watershed-types. As more winter precipitation falls as rain rather than snow, higher winter stream flows scour streambeds, damaging spawning nests and washing away incubating eggs for Pacific Northwest salmon. Earlier peak stream flows flush young salmon from rivers to estuaries before they are physically mature enough for transition, increasing a variety of stressors including the risk of being eaten by predators.

As a result of these changes, about one third of the current habitat for either the endangered or threatened Northwest salmon species will no longer be suitable for them by the end of this century as key temperature thresholds are exceeded (Littell *et al.*, 2009). As summer temperatures increase, juvenile salmon are expected to experience reduced growth rates, impaired smoltification and greater vulnerability to predators.

Ocean acidification caused by increasing amounts of carbon dioxide (CO<sub>2</sub>) in the Earth's atmosphere poses a more wide-spread threat because virtually every major biological function has been shown to respond to acidification changes in seawater, including photosynthesis, respiration rate, growth rates, calcification rates, reproduction, and recruitment (London, 2005; Smith, 2008).

At the same time as these changes in regional weather patterns and ocean productivity are expected to occur, the

oceans are expected to be increasingly acidic. Over the past 200 years, the oceans have absorbed about half of the CO<sub>2</sub> produced by fossil fuel burning and other human activities. This increase in carbon dioxide has led to a reduction of the pH of surface seawater of 0.1 units, equivalent to a 30 percent increase in the concentration of hydrogen ions in the ocean. If global emissions of carbon dioxide from human activities continue to increase, the average pH of the oceans is projected to fall by 0.5 units by the year 2100 (Royal Society of London, 2005).

Although the scale of these changes would vary regionally, this resulting pH would be lower than the oceans have experienced over at least the past 420,000 years and the rate of change is probably one hundred times greater than the oceans have experienced at any time over that time interval. More importantly, it will take tens of thousands of years for ocean chemistry to return to a condition similar to that occurring at pre-industrial times (Royal Society of London, 2005).

Marine species such as fish, larger invertebrates, and some zooplankton take up oxygen and lose respired carbon dioxide through their gills. Increased carbon dioxide levels and decreased pH would have a major effect on this respiratory gas exchange system because oxygen is much harder to obtain from surface seawater than it is from air (primarily because concentrations of oxygen are lower in water). The processes involved in supplying oxygen to the gills means that more carbon dioxide is removed from these aquatic animals than is removed from air breathing animals of a similar size. This more ready removal of carbon dioxide from body fluids means that the level and range of CO<sub>2</sub> concentration in the bodies of water-breathing animals are much lower than is the case for air-breathing animals. As a result, large water breathing marine animals are more sensitive to changes in the carbon dioxide concentration in the surrounding seawater than are large air-breathing animals.

This has important implications because higher ambient levels of carbon dioxide would acidify the body tissues and fluids of these species and affect the ability of their blood to carry oxygen. Experimental studies have demonstrated that acidosis of tissues decrease cellular energy use, lower respiratory activity, and lower rates of protein synthesis (Pörtner *et al.*, 2000; Pörtner *et al.*, 2004)(Pörtner *et al* 2000, 2004). These changes would reduce the performance of almost every physiological process of larger animals including their growth and reproduction (Langenbuch and Pörtner, 2002, 2003). By itself, this effect of climate change poses severe risks for endangered and threatened anadromous and marine species. In combination with changes in seasonal temperatures, formation of snow pack in terrestrial ecosystems, upwelling phenomena, and ocean productivity, ocean acidification would lead us to expect the status of endangered and threatened anadromous, coastal, and marine species to trend toward increasing decline over the next three or four decades.

In addition to these changes, climate change may affect agriculture and other land development as rainfall and temperature patterns shift. Pest pressures are also likely to change over time. Both the shifts in land use and pest pressure could change pesticide use patterns.

### **Species and Critical Habitat Likely to be Adversely Affected by the Proposed Action**

The species' narratives that follow focus on attributes of a species' life history and distribution that influence the manner and likelihood that a particular species may be exposed to the proposed action, as well as the species potential response and risk when exposure occurs. Subsequent narratives summarize a larger body of information on worldwide distribution, as well as localized movements within fresh water, estuarine, intertidal, and ocean waters, population structure, feeding, diving and social behaviors.

Each species' narrative is followed by a description of its critical habitat (if applicable) with particular emphasis on

any essential features of the habitat that may be exposed to the proposed action and may warrant special attention.

## **Anadromous Fish Species**

### **Southern Pacific Eulachon**

Eulachon are small smelt native to eastern North Pacific waters from the Bering Sea to Monterey Bay, California, or from 61° N to 31° N (1944; Eschmeyer *et al.*, 1983; Minckley *et al.*, 1986; Hay and McCarter, 2000). Eulachon that spawn in rivers south of the Nass River of British Columbia to the Mad River of California comprise the southern population of Pacific eulachon. This species is designated based upon timing of runs and genetic distinctions (Hart and McHugh, 1944; McLean *et al.*, 1999; Hay and McCarter, 2000; McLean and Taylor, 2001; Beacham *et al.*, 2005).

Adult eulachon are found in coastal and offshore marine habitats (Allen and Smith, 1988; Hay and McCarter, 2000; Willson *et al.*, 2006). Larval and post larval eulachon prey upon phytoplankton, copepods, copepod eggs, mysids, barnacle larvae, worm larvae, and other eulachon larvae until they reach adult size (WDFW and ODFW, 2001). The primary prey of adult eulachon are copepods and euphausiids, malacostracans and cumaceans (Smith and Saalfeld, 1955; Barraclough, 1964; Drake and Wilson, 1991; Sturdevant *et al.*, 1999; Hay and McCarter, 2000).

Although primarily marine, eulachon return to freshwater to spawn. Adult eulachon have been observed in several rivers along the west coast (Odemar, 1964; Moyle, 1976b; Minckley *et al.*, 1986; Emmett *et al.*, 1991; Jennings, 1996; Wright, 1999; Larson and Belchik, 2000; Musick *et al.*, 2000; WDFW and ODFW, 2001). For the southern population of Pacific eulachon, most spawning is believed to occur in the Columbia River and its tributaries as well as in other Oregonian and Washingtonian rivers (Emmett *et al.*, 1991; Musick *et al.*, 2000; WDFW and ODFW, 2001). Eulachon take less time to mature and generally spawn earlier in southern portions of their range than do eulachon from more northerly rivers (Clarke *et al.*, 2007).

Spawning is strongly influenced by water temperatures, so the timing of spawning depends upon the river system involved (Willson *et al.*, 2006). In the Columbia River and further south, spawning occurs from late January to March, although river entry occurs as early as December (Hay and McCarter, 2000). Further north, the peak of eulachon runs in Washington State is from February through March while Alaskan runs occur in May and river entry may extend into June (Hay and McCarter, 2000). Females lay eggs over sand, coarse gravel or detrital substrate. Eggs attach to gravel or sand and incubate for 30 to 40 days after which larvae drift to estuaries and coastal marine waters (Wydoski and Whitney, 1979).

Eulachon generally die following spawning (Scott and Crossman, 1973). The maximum known lifespan is 9 years of age, but 20 to 30% of individuals live to 4 years and most individuals survive to 3 years of age, although spawning has been noted as early as 2 years of age (Barraclough, 1964; Parente and Snyder, 1970; Langer *et al.*, 1977; Wydoski and Whitney, 1979a; Barrett *et al.*, 1984; Hugg, 1996; Hay and McCarter, 2000; WDFW and ODFW, 2001). The age distribution of spawners varies between river and from year-to-year (Willson *et al.*, 2006).

### **Status and Trends**

The southern population of Pacific eulachon was listed as threatened on March 18, 2010 (75 FR 13012). It is considered to be at moderate risk of extinction throughout its range because of a variety of factors, including predation, commercial and recreational fishing pressure (directed and bycatch), and loss of habitat. Further population decline is anticipated to continue as a result of climate change and bycatch in commercial fisheries.

However, because of their fecundity, eulachon are assumed to have the ability to recover quickly if given the opportunity (Bailey and Houde, 1989).

Eulachon formerly experienced widespread, abundant runs and have been a staple of Native American diets for centuries along the northwest coast. However, such runs that were formerly present in several California rivers as late as the 1960s and 1970s (i.e., Klamath River, Mad River and Redwood Creek) no longer occur (Larson and Belchik, 2000). This decline likely began in the 1970s and continued until, in 1988 and 1989, the last reported sizeable run occurred in the Klamath River and no fish were found in 1996, although a moderate run was noted in 1999 (Larson and Belchik, 2000; Moyle, 2002). Eulachon have not been identified in the Mad River and Redwood Creek since the mid-1990s (Moyle, 2002).

### **Critical Habitat**

Critical habitat has been proposed for the southern population of Pacific eulachon (76 FR 515).

### **Threats**

*Natural threats.* Numerous predatory fishes, marine mammals, birds and terrestrial mammals prey on eulachon (Clemens *et al.*, 1936; Hart, 1973; Scott and Crossman, 1973; Jeffries, 1984; Drake and Wilson, 1991; Yang and Nelson, 1999; Willson *et al.*, 2006). The high fat content of eulachon make them a valuable prey for white sturgeon in the Columbia and Fraser rivers during winter (Willson *et al.*, 2006).

*Anthropogenic threats.* Fisheries harvests are likely a major contributor to eulachon decline. The best available information for catches comes from the Columbia River, where catches have been as high as 5.7 million pounds per year, but averaged near 2 million pounds from 1938 to 1993 (Wydoski and Whitney, 1979). Since 1993, catches have not exceeded 1 million pounds annually and the median catch has been 43,000 pounds (97.7% reduction in catch), even when effort is accounted for (WDFW and ODFW, 2001). Bycatch from fishing along U.S. and Canadian coasts has also been high, composing up to 28% of the total catch by weight (Hay and McCarter, 2000; DFO, 2008).

Construction projects have also had a negative impact on eulachon stocks. Dams, such as the Bonneville Dam on the Hood River, have blocked eulachon from moving into former spawning habitat (Smith and Saalfeld, 1955). Such damming projects also alter sedimentation and flow dynamics that eulachon have developed around in their evolution. River substrate composition, likely critical to successful spawning, is also altered by dams. The impoundment of water tends to raise water temperatures; a factor that spawning eulachon are particularly sensitive to (NMFS, 2008c). Eulachon ecotoxicological studies show high contaminant burdens, particularly of arsenic and lead (Futer and Nassichuk, 1983; Rogers *et al.*, 1990; EPA, 2002).

### **Sturgeon**

Sturgeon (*Acipenseridae*) are one of the oldest *Osteichthyes* (bony fish) families in existence. They are native to rivers and coastal areas of North America. The two listed sturgeon, discussed below, are part of the genus *Acipenser* and share some common characteristics. Members of the genus have a characteristic external morphology distinguished by the inferior mouth typical of bottom-feeders. Most species are anadromous, although a few species are entirely fresh water and many species can survive if they become land-locked. Both listed species (discussed below) are anadromous and tend to remain in coastal waters. As an anadromous fish, sturgeon spawn in fresh water and feed and rear in marine or estuarine waters. Sturgeon are capable of many reproductive cycles and tend to be very long-lived.

## Threats

*Natural Threats.* Birds and larger freshwater fish feed on eggs and larvae, while sharks, pinnipeds and other large predators prey on marine adult and subadult fish.

*Anthropogenic Threats.* In general sturgeon have declined from the combined effects from the construction of dam and water diversion projects, dredging and blasting, water pollution and fisheries. The longevity, slow rate of growth, delayed maturation, and bottom-feeding habits of sturgeon makes them susceptible to over-harvest and exposure to (and the accumulation of) contaminants. Many sturgeon also do not spawn on an annual basis, but may spawn every other year or even more infrequently. Thus even small increases in mortality can affect population productivity (Heppell, 2007). While sturgeon will be exposed to dissolved contaminants in the water column their body form, feeding habits and affinity with bottom sediments may expose them to a different suite of contaminants than pelagic fish. The sediment exposure pathway may be more significant. Benthic dwelling fish such as sturgeon may be exposed through the direct contact with sediment and its boundary layer and commonly have a higher rate of exposure through incidental ingestion.

## Southern Green Sturgeon

Green sturgeon occur along the west coast of North America from Mexico to the Bering Sea (Adams *et al.*, 2002; Colway and Stevenson, 2007). Distinguished primarily according to genetic differences and spawning locations, NMFS recognizes two species of green sturgeon: a northern species whose populations are relatively healthy, and a Southern species that has undergone significant decline (Adams *et al.*, 2007). NMFS listed the Southern species of green sturgeon as threatened in 2006 (71 FR 17757).

Green sturgeon are considered one of the most marine-oriented sturgeon species, spending much of their lives in coastal marine waters, estuaries and bays. Early life stages rear in fresh water, and adults return to fresh water when they are 15 years old or older to spawn. Across the species' range only three rivers contain documented spawning (Moyle *et al.*, 1992; CDFG, 2002). Outside of natal rivers, the distribution of southern green sturgeon and northern green sturgeon overlap. Both the northern species and southern species of green sturgeon occupy coastal estuaries and coastal marine waters from southern California to Alaska, including Humbolt Bay, the lower Columbia River estuary, Willapa Bay, Grays Harbor and southeast Alaska. In general, green sturgeon are more common north of Point Conception, California.

Green sturgeon are spring spawners and initiate spawning migrations as early as March. Fish in the Klamath River have been observed initiating migrations between April and June, Rogue River fish between May and July, whereas Heublein *et al.*, (2009) observed Sacramento River fish making their upstream migrations between March and April. Spawning generally occurs in deep pools of large rivers or off-channel coves (Moyle *et al.*, 1992; Moyle *et al.*, 1995; Rien *et al.*, 2001; Heublein *et al.*, 2009). Fish then tend to aggregate in deep pools, where they will over-summer before outmigrating in the fall, although some fish have been observed outmigrating relatively soon after presumed spawning events (Heublein *et al.*, 2009). In the Sacramento River adult green sturgeon spawn in late spring and early summer (Heublein *et al.*, 2009). It appears that specific habitat for spawning includes large cobblestones (where eggs can settle between), although spawning is known to occur over clean sand or bedrock.

Green sturgeon are a long-lived fish and likely live for 60 to 70 years (Moyle, 2002). Age at first maturation for green sturgeon is at least 15 years old, after which adults likely return every 2 to 5 years to spawn (Adams *et al.*, 2002; Van Eenennaam *et al.*, 2006). Most male spawners are young (17 to 18 years) while females on the spawning grounds are often older (27 to 28 years).

Green sturgeon spend their first 1 to 4 years in their natal streams and rivers (Nakamoto *et al.*, 1995; Beamesderfer and Webb, 2002), although they are believed to be physiologically adapted to sea water survival at 6 months of age (Allen and Cech, 2007; Allen *et al.*, 2009). Larvae are active at night, a behavior that likely reduces predation and avoids being moved downstream more than necessary (Cech Jr. *et al.*, 2000). Green sturgeon larvae grow very rapidly, reaching about 300 mm by age one (Deng, 2000). While in fresh water, juveniles feed on a variety of fishes and invertebrates (Moyle *et al.*, 1992). One juvenile from the Sacramento-San Joaquin estuary was found to have preyed most commonly upon opisthobranch mollusks (*Philline* sp.), with bay shrimp (*Crangon* sp.) and overbite clams (*Potamocorbula amurensis*) as secondary prey. Other juveniles in the Sacramento River delta feed on opossum shrimp (*Neomysis mercedis*) and *Corophium* amphipods (Radtke, 1966).

Upon outmigration from fresh water, subadult green sturgeon disperse widely along through continental shelf waters of the west coast within the 110 meter contour (Moyle *et al.*, 1992; Erickson and Hightower, 2007). It appears that green sturgeon generally distribute north of the river mouth from whence they emerge as juveniles during fall and move into bays and estuaries during summer and fall (Moser and Lindley, 2007; Israel *et al.*, 2009). The limited feeding data available for subadult and adult green sturgeon show that they consume benthic invertebrates including shrimp, clams, chironomids, copepods, mollusks, amphipods and small fish ((Houston, 1988; Moyle *et al.*, 1992). Sturgeon use electroreception to locate prey. Olfaction and taste may also be important to foraging, while vision is thought to play a minor role in prey capture (Miller, 2004).

#### Status and Trends

NMFS listed the southern population of the North American green sturgeon as threatened on April 7, 2006 (71 FR 17757). Trend data for green sturgeon is severely limited. Available information comes from two predominant sources, fisheries and tagging. Only three data sets were considered useful for the population time series analyses by NMFS' biological review team: the Klamath Yurok Tribal fishery catch, San Pablo sport fishery tag returns and Columbia River commercial landings (NMFS, 2005c). Using San Pablo sport fishery tag recovery data, the California Department of Fish and Game produced a population time series estimate for the southern species. San Pablo data suggest that green sturgeon abundance may be increasing, but the data showed no significant trend. The data set is not particularly convincing, however, as it suffers from inconsistent effort and since it is unclear whether summer concentrations of green sturgeon provide a strong indicator of population performance (NMFS, 2005c). Although there is not sufficient information available to estimate the current population size of southern green sturgeon, catch of juveniles during State and Federal salvage operations in the Sacramento delta are low in comparison to catch levels before the mid-1980s.

#### Critical Habitat

On October 9, 2009, NMFS designated critical habitat for southern green sturgeon (74 FR 52300). The geographical area identified as critical habitat is based upon the overlapping distribution of the southern and northern species, and encompasses all areas where the presence of southern green sturgeon have been confirmed or where their presence is likely. Therefore the geographical area defined as critical habitat is the entire range of the biological species, green sturgeon, from the Bering Sea, AK, to Ensenada, Mexico. Specific fresh water areas include the Sacramento River, Feather River, Yuba River and the Sacramento-San Joaquin Delta. Specific coastal bays and estuaries include estuaries from Elkhorn Slough, California, to Puget Sound, Washington. Coastal marine areas include waters along the entire biological species' range within a depth of 60 fathoms. The principal biological or physical constituent elements essential for the conservation of southern green sturgeon in fresh water include: food resources; substrate of sufficient type and size to support viable egg and larval development; water flow, water quality such that the chemical characteristics support normal behavior, growth and viability; migratory corridors; water depth; and

sediment quality. Primary constituent elements of estuarine habitat include food resources, water flow, water quality, migratory corridors, water depth and sediment quality. The specific primary constituent elements of marine habitat include food resources, water quality and migratory corridors.

Critical habitat of the Southern species of green sturgeon is threatened by several anthropogenic factors. Four dams and several other structures currently are impassible for green sturgeon to pass on the Sacramento, Feather and San Joaquin rivers, preventing movement into spawning habitat. Threats to these riverine habitats also include increasing temperature, insufficient flow that may impair recruitment, the introduction of striped bass that may eat young sturgeon and compete for prey, and the presence of heavy metals and contaminants in the river.

### Final Protective Regulations

The final 4(d) rule for southern green sturgeon was issued June 2, 2010, and became effective July 2, 2010 (75 FR 30714). Under this rule, the prohibitions listed under ESA sections 9(a)(1)(A) through 9(a)(1)(G) are applied for the Southern species, including all the ESA section 9(a)(1)(B) and 9(a)(1)(C) prohibitions except for: 1) Certain Federal, State or private-sponsored research or monitoring activities; 2) Emergency fish rescue and salvage activities; 3) Habitat restoration activities; 4) Commercial and recreational fisheries activities, if conducted under approved Fisheries Management and Evaluation Plans; and 5) Certain Tribal fishery management activities.

### Threats

*Natural Threats.* Green sturgeon eggs and larvae are likely preyed upon by a variety of larger fish and animals, while sub-adult and adult sturgeon may occasionally be preyed upon by shark sea lions, or other large body predators (NMFS, 2005c).

*Anthropogenic Threats.* The principle threat to southern green sturgeon comes from a drastic reduction in available spawning area from impassible barriers (e.g., Oroville, Shasta and Keswick dams). Other threats include potentially lethal temperature limits, harvest, entrainment by water projects and toxins and invasive species (Adams *et al.*, 2007; Erickson and Webb, 2007; Lackey, 2009). Since this species is composed of a single spawning population within the Sacramento River, stochastic variation in environmental conditions and significant fluctuations in demographic rates increases the risk of extinction for this species.

Studies from other sturgeon species indicate that sturgeon readily bioaccumulate contaminants. White sturgeon from the Kootenai River have been found to contain aluminum, arsenic, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, selenium, zinc, DDE, DDT, PCBs and other organochlorines (Kruse and Scarnecchia, 2001). Mercury has also been identified from white sturgeon of the lower Columbia River (Webb *et al.*, 2006). Numerous organochlorines, including DDT, DDD, DDE, chlordane and dieldrin have also been identified in these fish (Foster *et al.*, 2001). Observed concentrations are likely sufficient to influence reproductive physiology.

### Shortnose Sturgeon

Shortnose sturgeon occur along the Atlantic Coast of North America, from the St. John River in Canada, south to the St. Johns River in Florida. NMFS' recovery plan (1998) recognized 19 wild populations based on their strong fidelity to their natal streams and several captive populations (from a Savannah River broodstock) that are maintained for educational and research purposes (NMFS, 1998).

Shortnose sturgeon are generally anadromous, but may migrate between fresh and salt water for reasons other than spawning. They can also maintain freshwater resident populations. In general, shortnose sturgeon are benthic fish that occupy the deep channel sections of large rivers or estuarine waters of their natal rivers and will migrate

considerable distances. Dadswell (1979 in Dadswell *et al.* 1984) observed shortnose sturgeon traveling up 160 km between tagging and recapture in the St. John estuary and it is not uncommon for adults to migrate 200 km or more to reach spawning areas (Kynard, 1997). After spawning in the spring, adults tend to migrate rapidly downstream to feeding areas in the estuary or to tidally influenced fresh water (see Dadswell *et al.*, 1984a).

Young-of-the year shortnose sturgeon move downstream after hatching, remaining in fresh water for about 1 year (Kynard, 1997). Initially, young shortnose sturgeon will reside short distances from spawning areas and as they grow will tend to move further downstream (see Dadswell *et al.*, 1984a). By age 3 or older juvenile sturgeon will spend a large portion of their year at the salt- and fresh water interface of coastal rivers (NMFS, 1998b).

Habitat use in fresh water during summer and winter months overlaps between adult and age-1 shortnose sturgeon (O'Herron II *et al.*, 1993; Kynard *et al.*, 2000; Moser *et al.*, 2000). Kynard *et al.*, (2000) found that both age classes preferred deep-water curves with sand and cobble to higher velocity runs, particularly during winter months and shifted to channel habitat as water temperatures rose in summer months. In the Connecticut River and the Merrimack, Kynard *et al.*, (2000) found shortnose generally used water about 3 meters deep, ranging from less than a meter to about 15 meters deep.

Female shortnose sturgeon spawn every three to five years. Males spawn every other year, although some may spawn in consecutive years (Dovel *et al.*, 1992; Collins and Smith, 1993; Kieffer and Kynard, 1993; NMFS, 1998). Spawning typically occurs during the spring, between mid-March and late May. Spawning areas are often located just below the fall line at the farthest accessible upstream reach of the river (NMFS, 1998).

Male shortnose sturgeon in southern rivers will first spawn between ages 2 and 5, while fish as far north as the St. John River, Canada first spawn at about 10 to 11 years of age (Dadswell *et al.*, 1984a; NMFS, 1998). Age at first spawning for female shortnose sturgeon varies from about age 6 to 18 years, like males, varying on a latitudinal cline (Dadswell *et al.*, 1984a; NMFS, 1998). In general, fish in the northern portion of the species' range live longer than individuals in the southern portion of the species' range (Gilbert, 1989). The maximum age reported for a shortnose sturgeon in the St. John River in New Brunswick is 67 years (for a female), 40 years for the Kennebec River, 37 years for the Hudson River, 34 years in the Connecticut River, 20 years in the Pee Dee River and 10 years in the Altamaha River (Gilbert, 1989). Male shortnose sturgeon appear to have shorter life spans than females (Gilbert, 1989).

Like all sturgeon, shortnose have ventrally located, sucker-like mouths, structured for feeding on benthos. Foraging generally occurs in areas with abundant macrophytes, where juvenile and adult shortnose sturgeon feed on amphipods, polychaetes and gasteropods (Dadswell *et al.*, 1984b; Moser and Ross, 1995; NMFS, 1998). Sturgeon use electroreception to identify prey. Olfaction and taste are also likely important to foraging, while vision is thought to play a minor role (Miller, 2004). As adults, a significant portion of a shortnose sturgeon's diet may consist of freshwater mollusks (Dadswell *et al.*, 1984b). Based on observations by Kynard *et al.*, (2000), shortnose sturgeon will consume the entire mollusk, excreting the shell after ingestion.

### Status and Trends

Shortnose sturgeon were listed as endangered on March 11, 1967, under the Endangered Species Preservation Act (32 FR 4001) and remained on the endangered species list with enactment of the ESA of 1973, as amended. Pollution and overfishing, including bycatch in the shad fishery, were listed as principal reasons for the species' decline. Shortnose sturgeon are listed as an endangered species throughout all of its range

Northern shortnose sturgeon population abundances are generally larger than southern populations (Kynard, 1997). Updated population estimates also suggest that three of the largest populations (Kennebec, Hudson and Delaware River) may be increasing or stable, although data is limited. The New York (Hudson River) shortnose sturgeon population is the largest extant population of this species and, based on available data, appears to have increased (Bain *et al.*, 2000). The most recent population estimate indicates this population consists of about 61,000-shortnose sturgeon (95% confidence interval [CI] was between 52,898 and 72,191 fish (Bain *et al.*, 2000). A comparison of the Bain estimate to the 1979/1980 population estimate of spawning adults by Dovel *et al.*, (1992); about 13,000 fish) led Bain *et al.*, (2000) to conclude that the population had made a dramatic increase (about 400% increase) between 1979 and 1997. While still evidence of an increasing population, a comparison of total population estimates (30,000:60,000) would suggest the population has only doubled in size during the study years. Similarly, the Kennebec River population appears to be increasing. The most recent estimate for this population is about 9,500 fish (Squiers, 2003), suggesting the population has increased by about 30% in about a twenty year period.

Data from the Delaware River suggest that the population may be stable. Brundage and O'Herron (2006) estimate that the current population for the Delaware River is 12,047 adult fish (1999-2003; 95% CI: 10,757-13,589), which is similar to the 1981/84 estimate by Hastings *et al.*, (1987) of 12,796 fish (95% CI: 10,288-16367). The recent capture of several fish that were tagged as adults by Hastings *et al.*, (1987) suggests that older fish may comprise a substantial portion of the Delaware River population. Based on studies from other sturgeon species we know of no evidence of senescence in sturgeon and we would expect that these fish are reproductively active (Paragamian *et al.*, 2005). Despite their longevity, the viability of sturgeon populations is sensitive to variability in juvenile recruitment and survival (Anders *et al.*, 2002; Gross *et al.*, 2002; Secor *et al.*, 2002). Although interannual variation in juvenile recruitment would be expected as a result of stochastic factors that influence spawning and egg/larval survival, if the mean population size does not change over the long-term it then it would appear there is sufficient juvenile survival to provide at least periodic recruitment into the adult age classes. Data on juvenile recruitment or age-1+ survival would, however, establish whether this population is at a stable equilibrium.

South of Chesapeake Bay, populations are relatively small compared to their northern counterparts. The largest of the southern populations of shortnose sturgeon is the Altamaha River population. Population estimates have been calculated several times for sturgeon in the Altamaha since 1993. Total population estimates shown pretty sizeable interannual variation is occurring; estimates have ranged from as low as 468 fish in 1993 to over 6,300 fish in 2006 (NMFS, 1998; DeVries, 2006). The Ogeechee River is the next most studied river south of Chesapeake Bay and abundance estimates indicate that the shortnose sturgeon population in this river is considerably smaller than that in the Altamaha River. The highest point estimate in 1993 using a modified Schnabel technique resulted in a total population estimate of 361 shortnose sturgeon (95% CI: 326-400). In contrast the most recent survey resulted in an estimate of 147 shortnose sturgeon (95% CI: 104-249), suggesting that the population may be declining.

Throughout the species range there are other extant populations, or at least evidence that several other basins are used periodically. Shortnose sturgeon have been documented in the St. Johns River (FL), the St. Mary's River, Chesapeake Bay, Potomac River, Piscataqua River, the Housatonic River and others. Some basins probably previously contained shortnose populations, but recent sampling has been largely unsuccessful. Despite the occasional observations of shortnose sturgeon, populations may be extinct in several basins (e.g., St. John's (FL), St. Mary's, Potomac, Housatonic and Neuse rivers). Those few fish that have been observed in these basins are generally presumed to be immigrants from neighboring basins. In some cases, (e.g. Chesapeake Bay) migratory information collected from tagged fish and genetic evidence confirms that fish captured in Chesapeake Bay were part of the Delaware River population (Grunwald *et al.*, 2002; Wirgin *et al.*, 2005).

## Threats

*Natural Threats.* Yellow perch, sharks and seals are predators of shortnose sturgeon juveniles (NMFS, 1998). The effects of disease and parasites are generally unknown.

*Anthropogenic Threats.* Historic fishery harvests, as well as the incidental harvest in current fisheries, have had lasting effects on shortnose sturgeon. In the late nineteenth and early twentieth centuries shortnose sturgeon were harvested incidental to Atlantic sturgeon (NMFS, 1998). The effects of these harvests may have long-lasting impacts on some populations. At present there is no legal directed fishing effort for shortnose sturgeon in the U.S., although some illegal poaching is suspected. Additionally, shortnose sturgeon are often caught incidental to other fisheries. For instance, shortnose are caught incidentally by bass anglers, and incidentally to alewife/gaspereau and shad fisheries in the St. John River in Canada, shad fisheries in the Altamaha River, Hudson River, and others (COSEWIC, 2005).

Habitat alterations from discharges, dredging or disposal of material into waterways and other developmental activities along riverine and estuarine systems threaten shortnose sturgeon habitat. Periodic maintenance of harbors and rivers likely results in the direct take of some sturgeon, but perhaps of greater impact is the manner in which dredging alters benthic topography and community structure and water quality (increase in suspended sediments). Shoreline development may increase the potential of ship strikes. In the Bay of Fundy, a tidal turbine killed at least three Atlantic salmon in the 1980s and may be a threat to shortnose sturgeon as well (Dadswell and Rulifson, 1994). Although currently the only example of this type of turbine in North America, increasing interests in finding alternative energy sources is expected to result in an increase in the number of marine turbines along the coast.

Shortnose sturgeon and other benthic organisms are regularly in direct contact with legacy pollutants, as well as a suite of common contaminants added from more current industrial and agricultural practices. Studies demonstrate that shortnose sturgeon carry a wide number of potentially hazardous contaminants. Individuals from the Delaware River contain numerous metals (mercury, aluminum, antimony, barium, cadmium, calcium, chromium, copper, iron, magnesium, manganese, nickel, potassium, sodium, vanadium and zinc), PCDDs, PCDFs, PCBs, DDE, DDD, bis (2-ethylhexyl) phthalate, di-n-butylphthalate and chlordane (ERC, 2002). Most of these metals, PCDDs, PCDFs and PCBs were also found in shortnose sturgeon in the Kennebec River (ERC, 2003).

## Critical Habitat

NMFS has not designated critical habitat for shortnose sturgeon.

## **Salmonid Fish Species**

### **Protective Regulations for Threatened Salmonid Species**

Since 1997 NMFS promulgated a total of 29 limits to the ESA section 9(a) take prohibitions for 21 threatened Pacific salmon and steelhead species (62 FR 38479, July 18, 1997; 65 FR 42422, July 10, 2000; 65 FR 42485, July 10, 2000; 67 FR 1116, January 9, 2002; 73 FR 7816, February 11, 2008). On June 28, 2005, as part of the final listing determinations for 16 species of West Coast salmon, NMFS amended and streamlined the 4(d) protective regulations for threatened salmon and steelhead (70 FR 37160). NMFS took this action to provide appropriate flexibility to ensure that fisheries and artificial propagation programs are managed consistently with the conservation needs of threatened salmon and steelhead. Under this change, the section 4(d) protections apply to natural and hatchery fish with an intact adipose fin, but not to ESA listed hatchery fish that have had their adipose fin removed prior to release into the wild.

Additionally, NMFS made several simplifying and clarifying changes to the 4(d) protective regulations including updating an expired limit (§ 223.203(b)(2)), providing a temporary exemption for ongoing research and enhancement activities, and applying the same set of 14 limits to all threatened Pacific salmon and steelhead species. These limits are:

1. Activities conducted in accordance with ESA section 10 incidental take authorization (50 CFR § 223.203(b)(1))
2. Ongoing scientific and conservation activities for which a permit application has been timely submitted, and treaty and non-treaty fisheries for which a comanager's management plan has been timely submitted (§ 223.203(b)(2))
3. Emergency actions related to injured, stranded, or dead salmonids (§ 223.203(b)(3))
4. Fishery management activities (§ 223.203(b)(4))
5. Hatchery and genetic management programs (§ 223.203(b)(5))
6. Activities in compliance with joint Tribal/State plans (§ 223.203(b)(6))
7. Scientific research activities conducted or permitted by the States (§ 223.203(b)(7))
8. State, local and private habitat restoration activities (§ 223.203(b)(8))
9. Properly screened water diversion devices (§ 223.203(b)(9))
10. Routine road maintenance activities (§ 223.203(b)(10))
11. Certain park pest management activities (§ 223.203(b)(11))
12. Certain municipal, residential, commercial and industrial development and redevelopment activities (§ 223.203(b)(12))
13. Forest management activities on State and private lands within the State of Washington (§ 223.203(b)(13))
14. Activities undertaken consistent with an approved Tribal resource management plan (§ 223.204).

## **Chinook Salmon**

Chinook salmon are the largest of the Pacific salmon and historically ranged from the Ventura River in California to Point Hope, Alaska in North America, and in northeastern Asia from Hokkaido, Japan to the Anadyr River in Russia (Healey, 1991). In this section, we discuss the distribution, status and critical habitats of the nine species of endangered and threatened Chinook salmon separately, and summarize their common dependence on waters of the United States. However, because Chinook salmon species share many characteristics, we begin this section describing those common characteristics.

Chinook salmon exhibit one of the most varied and complex life history strategies. The “stream-type” of Chinook salmon resides in freshwater for a year or more following emergence and the “ocean-type” migrates to the ocean within their first year. The ocean-type typifies populations north of 56°N (Healey, 1991). The Chinook salmon life

cycle spans fresh and marine waters. Chinook salmon are semelparous (i.e. they die after spawning). Spawning migrations generally occur in the spring and fall, and temperature and stream flow can significantly influence the timing of migrations and spawning and the selection of spawning habitat (Geist *et al.*, 2009; Hatten and Tiffan., 2009). Spawning typically occurring earlier in the spring/summer at northern latitudes and later in southern latitudes (Healey, 1991).

While in fresh water, juvenile Chinook salmon are often found in the lower reaches of a river near its estuary in areas of low water velocity. As they grow, they tend to move to deeper waters where the velocity is higher (Healey, 1991). Generally, Chinook salmon outmigrants (smolts) are about 2 to 5 inches long when they enter saline (often brackish) waters. The process of smoltification enables salmon to adapt to the ocean environment (Wedemeyer *et al.*, 1980). Several factors can affect smoltification process, not only at the interface between fresh water and salt water, but higher in the watershed the process of transformation begins long before fish enter salt waters including: exposure to chemicals such as heavy metals and elevated water temperatures (Wedemeyer *et al.*, 1980).

Chinook salmon feed on a variety of prey organisms depending upon life stage. Adult oceanic Chinook salmon eat small fish, amphipods and crab megalops (Healey, 1991). Fish, in particular herring, make up the largest portion of an adult Chinook salmon's diet. In estuaries, Chinook salmon smolts tend to feed on chironomid larvae and pupae, *Daphnia*, *Eogammarus*, *Corphium* and *Neomysis*, as well as juvenile herring, sticklebacks and other small fish. In fresh water, Chinook salmon juveniles feed on adult and larval insects including terrestrial and aquatic insects such as dipterans, beetles, stoneflies, chironomids and plecopterans (Healey, 1991).

### Threats

*Natural Threats.* Chinook salmon are prey for pelagic fishes, birds and marine mammals, including harbor seals, sea lions and killer whales. There have been recent concerns that the increasing size of tern, seal and sea lion populations in the Pacific Northwest may have reduced the survival of some salmon species.

*Anthropogenic Threats.* Salmon survive only in aquatic ecosystems and, therefore, depend on the quantity and quality of those ecosystems. Chinook salmon have declined under the combined effects of multiple anthropogenic stressors. Examples of these include fishery over-harvest, competition from hatchery fish and non-native species, the effects of dams, water diversions, destruction or degradation of riparian habitat and land use practices that destroy or degrade wetland and riparian ecosystems (Buhle *et al.*, 2009).

Salmon along the west coast of the U.S. share many of the same threats. Therefore, anthropogenic threats for all species and populations are summarized here. Population declines have resulted from several human-mediated causes, but the greatest negative influence has likely been the establishment of waterway obstructions such as dams, power plants and sluiceways for hydropower, agriculture, flood control and water storage. These structures have blocked salmon migration to spawning habitat or resulted in direct mortality and have eliminated entire salmon runs as a result. While some of these barriers remain, others have been reengineered, renovated or removed to allow for surviving runs to access former habitat, but success has been limited. These types of barriers alter the natural hydrograph of basins, both upstream and downstream of the structure and significantly reduce the availability and quality of spawning and rearing habitat (Hatten and Tiffan., 2009). Many streams and rivers, particularly in urban or suburban areas, suffer from streamside development, which contributes sediment, chemical pollutants from pesticide applications and automobile or industrial activities, altered stream flows, loss of streamside vegetation and allochthonous materials to name a few. These factors can directly cause mortality, reduce reproductive success or affect the health and fitness of all salmon life stages.

Fishing pressure has also negatively affected salmon populations. Fishing reduces the number of individuals within a population and can lead to uneven exploitation of certain populations and size classes (Reisenbichler, 1997). Targeted fishing of larger individuals results in excluding the most fecund individuals from spawning (Reisenbichler, 1997). Genetic changes that promote smaller body sizes have occurred in heavily exploited populations in response to size-selective harvest pressures (Reisenbichler, 1997). Fishing pressure can reduce age at maturity in fished populations as the fished populations compensate for the reductions in the numbers of spawning adults (Reisenbichler, 1997).

Pacific salmon species are exposed to a number of contaminants throughout their range and life history cycle. Exposure to pollution is also of significant concern for all life stages, but is likely particularly significant for freshwater life stages. Organic pollutants, particularly PCBs, DDT and its congeners, pesticides and endocrine disruptors are of particular concern. These chemicals can inhibit smell, disrupt reproductive behavior and physiology, impair immune function and lead to mortality through impairment of water balance when traveling between fresh and salt water systems (Varanasi *et al.*, 1993). Diffuse and extensive population centers contribute increased contaminant volumes and variety from such sources as wastewater treatment plants and sprawling development. Urban runoff from impervious surfaces and roadways often contains oil, copper, pesticides, PAHs and other chemical pollutants and flow into surface waters. Point and nonpoint pollution sources entering rivers and their tributaries affect water quality in available spawning and rearing habitat for salmon. Juvenile salmonids that inhabit urban watersheds often carry high contaminant burdens, which is partly attributable to the biological transfer of contaminants through the food web (Varanasi *et al.*, 1993).

Changes in hydrological regimes are closely linked to salmon abundance (Hicks *et al.*, 1991). From studies that have examined the effects of changes in land use patterns, we know that changes in hydrology can profoundly affect salmon abundance and the amount and availability of quality habitat. Hydrology is strongly correlated to early survival and can lead to the displacement of young fish as well as altering immigration and emigration timing which impacts the relative abundance of salmon within a watershed, as well as the relative abundance of age-classes (Hicks *et al.*, 1991; Gregory and Bisson, 1997). Such ecosystem changes are also likely to alter macroinvertebrate communities and habitats, affecting important forage for salmon and trout (McCarthy *et al.*, 2009; Williams *et al.*, 2009).

### **California Coastal Chinook Salmon**

The California Coastal Chinook salmon species includes all naturally spawned populations of Chinook salmon from rivers and streams south of the Klamath River to the Russian River, California. Seven artificial propagation programs are part of this species. California Coastal Chinook salmon are a fall-run, ocean-type fish. A spring-run (river-type) component existed historically, but is now considered extinct (Bjorkstedt *et al.*, 2005).

### **Status and Trends**

NMFS listed California Coastal Chinook salmon as threatened on September 16, 1999 (64 FR 50393) and they retained their threatened status on June 28, 2005 (70 FR 37160). California Coastal Chinook salmon were listed due to the combined effect of dams that prevent them from reaching spawning habitat, logging, agricultural activities, urbanization and water withdrawals in the river drainages that support them. Historical estimates of escapement, based on professional opinion and evaluation of habitat conditions, suggest abundance was roughly 73,000 in the early 1960s with the majority of fish spawning in the Eel River (Good *et al.*, 2005). Since its original listing and status review, little new data are available or suitable for analyzing trends or estimating changes in this population's growth rate (Good *et al.*, 2005).

Long-term trends in Sprowl and Tomki creeks (tributaries of the Eel River), however, are negative. Good *et al.*, (2005) caution against making inferences on the basin-wide status of these populations as they may be weak because the data likely include unquantified variability due to flow-related changes in spawners' use of mainstem and tributary habitats.

### **Critical Habitat**

NMFS designated critical habitat for California Coastal Chinook salmon on September 2, 2005 (70 FR 52488). Specific geographic areas designated include the following CALWATER hydrological units: Redwood Creek, Trinidad, Mad River, Eureka Plain, Eel River, Cape Mendocino, Mendocino Coast and the Russian River. These areas are important for the species' overall conservation by protecting quality growth, reproduction and feeding. The critical habitat designation for this species identifies primary constituent elements that include sites necessary to support one or more Chinook salmon life stages. Specific sites include freshwater spawning sites, freshwater rearing sites, freshwater migration corridors, nearshore marine habitat and estuarine areas. The physical or biological features that characterize these sites include water quality and quantity, natural cover, forage, adequate passage conditions and floodplain connectivity. The critical habitat designation (70 FR 52488) contains additional details on the sub-areas that are included as part of this designation and the areas that were excluded from designation.

In total, California Coastal Chinook salmon occupy 45 watersheds (freshwater and estuarine). The total area of habitat designated as critical includes about 1,500 miles of stream habitat and about 25 square miles of estuarine habitat, mostly within Humboldt Bay. This designation includes the stream channels within the designated stream reaches and includes a lateral extent as defined by the ordinary high water line. In areas where the ordinary high-water line is not defined the lateral extent is defined as the bankfull elevation. In estuarine areas the lateral extent is defined by the extreme high water because extreme high tide areas encompass those areas typically inundated by water and regularly occupied by juvenile salmon during the spring and summer, when they are migrating in the nearshore zone and relying on cover and refuge qualities provided by these habitats and while they are foraging. Of the 45 watershed reviewed in NMFS' assessment of critical habitat for California Coastal Chinook salmon, eight watersheds received a low rating of conservation value, 10 received a medium rating and 27 received a high rating of conservation value for the species.

Critical habitat in this species consists of limited quantity and quality summer and winter rearing habitat, as well as marginal spawning habitat. Compared to historical conditions, there are fewer pools, limited cover and reduced habitat complexity. The limited instream cover that does exist is provided mainly by large cobble and overhanging vegetation. Instream large woody debris, needed for foraging sites, cover and velocity refuges is especially lacking in most of the streams throughout the basin. NMFS has determined that these degraded habitat conditions are, in part, the result of many human-induced factors affecting critical habitat including dam construction, agricultural and mining activities, urbanization, stream channelization, water diversion and logging, among others.

### **Central Valley Spring-Run Chinook Salmon**

The Central Valley spring-run Chinook salmon species includes all naturally spawned populations of spring-run Chinook salmon in the Sacramento River and its tributaries in California. This species includes one artificial propagation program. Central Valley spring-run Chinook salmon species includes Chinook salmon entering the Sacramento River from March to July and spawning from late August through early October, with a peak in September. Spring-run fish in the Sacramento River exhibit an ocean-type life history, emigrating as fry, sub-yearlings and yearlings. Central Valley spring-run Chinook salmon require cool freshwater while they mature over the summer.

## Status and Trends

NMFS originally listed Central Valley spring-run Chinook salmon as threatened on September 16, 1999 (64 FR 50393), a classification this species retained on June 28, 2005 (70 FR 37160). This species was listed because dams isolate them from most of their historic spawning habitat and the habitat remaining to them is degraded. Historically, spring-run Chinook salmon were predominant throughout the Central Valley occupying the upper and middle reaches (1,000 to 6,000 feet) of the San Joaquin, American, Yuba, Feather, Sacramento, McCloud and Pit Rivers, with smaller populations in most tributaries with sufficient habitat for over-summering adults (Stone, 1874; Rutter, 1904; Clark, 1929).

The Central Valley drainage as a whole is estimated to have supported spring-run Chinook salmon runs as large as 700,000 fish between the late 1880s and the 1940s (Fisher, 1994), although these estimates may reflect an already declining population, in part from the commercial gillnet fishery that occurred in this species (Good *et al.*, 2005). Before construction of Friant Dam, nearly 50,000 adults were counted in the San Joaquin River alone (Fry, 1961). Following the completion of Friant Dam, the native population from the San Joaquin River and its tributaries (i.e., the Stanislaus and Mokelumne Rivers) was extirpated. Spring-run Chinook salmon no longer exist in the American River due to the operation of Folsom Dam. Naturally spawning populations of Central Valley spring-run Chinook salmon currently are restricted to accessible reaches of the upper Sacramento River, Antelope Creek, Battle Creek, Beegum Creek, Big Chico Creek, Butte Creek, Clear Creek, Deer Creek, Feather River, Mill Creek and Yuba River (CDFG, 1998). Since 1969, the Central Valley spring-run Chinook salmon species (excluding Feather River fish) has displayed broad fluctuations in abundance ranging from 25,890 in 1982 to 1,403 in 1993 (Good *et al.*, 2005).

As noted by Good *et al.*, (2005), the average abundance for the species was 12,499 for the period of 1969 to 1979, 12,981 for the period of 1980 to 1990 and 6,542 for the period of 1991 to 2001. In 2003 and 2004, total run size for the species was 8,775 and 9,872 adults respectively, well above the 1991 to 2001 average. Evaluating the species as a whole, however, masks significant changes that are occurring among populations that comprise the species (metapopulation). For example, the mainstem Sacramento River population has undergone a significant decline while the abundance of many tributary populations increased. Average abundance of Sacramento River mainstem spring-run Chinook salmon recently declined from a high of 12,107 for the period 1980 to 1990, to a low of 609 for the period 1991 to 2001, while the average abundance of Sacramento River tributary populations increased from a low of 1,227 to a high of 5,925 over the same periods.

Abundance time series data for Mill, Deer, Butte and Big Chico creeks spring-run Chinook salmon confirm that population increases seen in the 1990s have continued through 2001 (Good *et al.*, 2005). Habitat improvements, including the removal of several small dams and increases in summer flows in the watersheds, reduced ocean fisheries, and a favorable terrestrial and marine climate, have likely contributed to this. All three spring-run Chinook salmon populations in the Central Valley have long- and short-term positive population growth.

## Critical Habitat

NMFS designated critical habitat for Central Valley spring-run Chinook salmon on September 2, 2005 (70 FR 52488). Specific geographic areas designated include the following CALWATER hydrological units: Tehama, Whitmore, Redding, Eastern Tehama, Sacramento Delta, Valley-Putah-Cache, Marysville, Yuba, Valley-American, Colusa Basin, Butte Creek and Shasta Bally hydrological units. These areas are important for the species' overall conservation by protecting quality growth, reproduction and feeding. The critical habitat designation for this species identifies primary constituent elements that include sites necessary to support one or more Chinook salmon life stages. Specific sites include freshwater spawning sites, freshwater rearing sites, freshwater migration corridors,

nearshore marine habitat and estuarine areas. The physical or biological features that characterize these sites include water quality and quantity, natural cover, forage, adequate passage conditions and floodplain connectivity. The critical habitat designation (70 FR 52488) contains additional details on the sub-areas that are included as part of this designation and the areas that were excluded from designation.

In total, Central Valley spring-run Chinook salmon occupy 37 watersheds (freshwater and estuarine). The total area of habitat designated as critical includes about 1,100 miles of stream habitat and about 250 square miles of estuarine habitat in the San Francisco-San Pablo-Suisun Bay complex. This designation includes the stream channels within the designated stream reaches and includes a lateral extent as defined by the ordinary high water line. In areas where the ordinary high-water line is not defined the lateral extent is defined as the bankfull elevation. In estuarine areas the lateral extent is defined by the extreme high water because extreme high tide areas encompass those areas typically inundated by water and regularly occupied by juvenile salmon during the spring and summer, when they are migrating in the nearshore zone and relying on cover and refuge qualities provided by these habitats and while they are foraging. Of the 37 watersheds reviewed in NMFS' assessment of critical habitat for Central Valley spring-run Chinook salmon, seven watersheds received a low rating of conservation value, three received a medium rating and 27 received a high rating of conservation value for the species.

Factors contributing to the downward trends in this species include: reduced access to spawning/rearing habitat behind impassable dams, climatic variation, water management activities, hybridization with fall-run Chinook salmon, predation and harvest (CDFG, 1998). Several actions have been taken to improve and increase the primary constituent elements of critical habitat for spring-run Chinook salmon. These include improved management of Central Valley water, implementing new and improved screen and ladder designs at major water diversions along the mainstem Sacramento River and tributaries, removal of several small dams on important spring-run Chinook salmon spawning streams and changes in ocean and inland fishing regulations to minimize harvest. Although protective measures and critical habitat restoration likely have contributed to recent increases in spring-run Chinook salmon abundance, the species is still below levels observed from the 1960s through 1990. Many threats still exist.

### **Lower Columbia River Chinook Salmon**

The Lower Columbia River Chinook salmon species includes all naturally spawned populations of Chinook salmon from the Columbia River and its tributaries from its mouth at the Pacific Ocean upstream to a transitional point between Washington and Oregon, east of the Hood River and the White Salmon River and includes the Willamette River to Willamette Falls, Oregon, exclusive of spring-run Chinook salmon in the Clackamas River.

Lower Columbia River Chinook salmon have three life history types, including early fall runs (tules), late fall runs (brights) and spring-runs. Spring and fall runs have been designated as part of a Lower Columbia River Chinook salmon species. The Cowlitz, Kalama, Lewis, White Salmon and Klickitat Rivers are the major river systems on the Washington side and the lower Willamette and Sandy Rivers are foremost on the Oregon side. The eastern boundary for this species occurs at Celilo Falls, which corresponds to the edge of the drier Columbia Basin Ecosystem and historically may have been a barrier to salmon migration at certain times of the year. Fall Chinook salmon typically enter the Columbia River in August through October to spawn in the mainstem of the large rivers (Kostow, 1995). Spring Chinook salmon enter freshwater in March through June to spawn in upstream tributaries and generally emigrate from fresh water as yearlings.

### **Status and Trends**

NMFS originally listed Lower Columbia River Chinook salmon as threatened on March 24, 1999 (64 FR 14308);

NMFS reaffirmed the threatened status of Lower Columbia River Chinook salmon on June 28, 2005 (70 FR 37160). Historical records of Chinook salmon abundance are sparse, but cannery records suggest a peak run of 4.6 million fish (43 million pounds) in 1883 (Lichatowich, 1999). Although fall-run Chinook salmon are still present throughout much of their historical range, they are still subject to large-scale hatchery production, relatively high harvest and extensive habitat degradation. The Lewis River late-fall-run Chinook salmon population is the healthiest and has a reasonable probability of being self-sustaining. Abundances largely declined during 1998 to 2000 and trend indicators for most populations are negative, especially if hatchery fish are assumed to have a reproductive success equivalent to that of natural-origin fish (Good *et al.*, 2005). Most populations for which data are available have a long-term declining population trend (Good *et al.*, 2005).

### **Critical Habitat**

NMFS designated critical habitat for Lower Columbia River Chinook salmon on September 2, 2005 (70 FR 52630). Designated critical habitat includes all Columbia River estuarine areas and river reaches proceeding upstream to the confluence with the Hood Rivers as well as specific stream reaches in a number of tributary subbasins. These areas are important for the species' overall conservation by protecting quality growth, reproduction and feeding. The critical habitat designation for this species identifies primary constituent elements that include sites necessary to support one or more Chinook salmon life stages. Specific sites include freshwater spawning sites, freshwater rearing sites, freshwater migration corridors, nearshore marine habitat and estuarine areas. The physical or biological features that characterize these sites include water quality and quantity, natural cover, forage, adequate passage conditions and floodplain connectivity. Of 52 subbasins reviewed in NMFS' assessment of critical habitat for the Lower Columbia River Chinook salmon species, 13 subbasins were rated as having a medium conservation value, four were rated as low, and the remaining subbasins (35), were rated as having a high conservation value to Lower Columbia River Chinook salmon. Factors contributing to the downward trends in this species are hydromorphological changes resulting from hydropower development, loss of tidal marsh and swamp habitat and degraded freshwater and marine habitat from industrial harbor and port development and urban development. Limiting factors identified for this species include reduced access to spawning/rearing habitat in tributaries, hatchery impacts, loss of habitat diversity and channel stability in tributaries, excessive fine sediment in spawning gravels, elevated water temperature in tributaries and harvest impacts.

### **Upper Columbia River Spring-run Chinook Salmon**

The Upper Columbia River spring-run Chinook salmon species includes all naturally spawned populations of Chinook salmon in all river reaches accessible to Chinook salmon in Columbia River tributaries upstream of Rock Island Dam and downstream of Chief Joseph Dam in Washington, excluding the Okanogan River. Six artificial propagation programs are part of this species. Spring-run Chinook salmon currently spawn in only three river basins above Rock Island Dam: the Wenatchee, Entiat and Methow Rivers (Good *et al.*, 2005).

### **Status and Trends**

NMFS listed Upper Columbia River spring-run Chinook salmon as endangered on March 24, 1999 (64 FR 14308), and reaffirmed their status as endangered on June 28, 2005 (70 FR 37160), because they had been reduced to small populations in three watersheds. Based on redd count data series, spawning escapements for the Wenatchee, Entiat and Methow rivers have declined an average of 5.6%, 4.8% and 6.3% per year, respectively, since 1958. In the most recent 5-year geometric mean (1997 to 2001), spawning escapement for naturally produced fish was 273 for the Wenatchee population, 65 for the Entiat population, and 282 for the Methow population, only 8% to 15% of the minimum abundance thresholds, although escapement increased substantially in 2000 and 2001 in all three river systems. Based on 1980-2004 returns, the average annual growth rate for this species is estimated at 0.93 (meaning

the population is not replacing itself; Fisher and Hinrichsen 2006). Assuming that population growth rates were to continue at 1980 to 2004 levels, Upper Columbia River spring-run Chinook salmon populations are projected to have very high probabilities of decline within 50 years. Population viability analyses for this species (using the Dennis Model) suggest that these Chinook salmon face a significant risk of extinction: a 75 to 100% probability of extinction within 100 years (given return rates for 1980 to present).

Hatchery influence and genetic diversity are significant issues for the continued survival of Upper Columbia River Chinook salmon. This is a result of reduced genetic diversity from homogenization of populations that occurred under the Grand Coulee Fish Maintenance Project from 1939 to 1943. Stray hatchery fish and a high proportion of hatchery fish during spawning have contributed to the high genetic diversity risk.

### **Critical Habitat**

NMFS designated critical habitat for Upper Columbia River spring-run Chinook salmon on September 2, 2005 (70 FR 52630). The designation includes all Columbia River estuaries and river reaches upstream to Chief Joseph Dam and several tributary subbasins. This designation includes the stream channels within the designated stream reaches and includes a lateral extent as defined by the ordinary high water line. In areas where the ordinary high-water line is not defined the lateral extent is defined as the bankfull elevation. These areas are important for the species' overall conservation by protecting quality growth, reproduction and feeding. The critical habitat designation for this species identifies primary constituent elements that include sites necessary to support one or more Chinook salmon life stages. Specific sites include freshwater spawning sites, freshwater rearing sites, freshwater migration corridors, nearshore marine habitat and estuarine areas. The physical or biological features that characterize these sites include water quality and quantity, natural cover, forage, adequate passage conditions and floodplain connectivity. The Upper Columbia River spring-run Chinook salmon species has 31 watersheds within its range. Five watersheds received a medium rating and 26 received a high rating of conservation value to the species. The Columbia River rearing/migration corridor downstream of the spawning range was rated as a high conservation value. Factors contributing to the downward trends in this species include mainstem Columbia River hydropower system mortality, tributary riparian degradation and loss of in-river wood, altered tributary floodplain and channel morphology, reduced tributary stream flow and impaired passage and harvest impacts.

### **Puget Sound Chinook Salmon**

The Puget Sound Chinook salmon species includes all naturally spawned populations of Chinook salmon from rivers and streams flowing into Puget Sound including the Straits of Juan De Fuca from the Elwha River, eastward, including rivers and streams flowing into Hood Canal, South Sound, North Sound and the Strait of Georgia in Washington. Twenty-six artificial propagation programs are part of the species. The Puget Sound species is comprised of 31 historical populations, of which 22 or more are believed to be extant and nine are considered extinct.

Chinook salmon in this area generally have an "ocean-type" life history. Puget Sound populations include both early-returning and late-returning Chinook salmon spawners described by Healey (1991). However, within these generalized behavioral forms, significant variation occurs in residence time in fresh water and estuarine environments. For example, Hayman *et al.*, (1996) described three juvenile Chinook salmon life histories with varying residency times in the Skagit River system in northern Puget Sound. Chinook salmon utilize nearshore Puget Sound habitats year-round, although they can be far from their natal river systems (Brennan *et al.*, 2004).

## Status and Trends

NMFS listed Puget Sound Chinook salmon as threatened in 1999 (64 FR 14308); that status was reaffirmed on June 28, 2005 (70 FR 37160). This species has lost 15 spawning aggregations (nine from the early-run type) that were either independent historical populations or major components of the remaining 22 existing independent historical populations identified (Good *et al.*, 2005). The disproportionate loss of early-run life history diversity represents a significant loss of the evolutionary legacy of the historical species.

Data reported by Good *et al.*, (2005) indicate that long term trends in abundance for this species are split with about half of the populations declining and the other half increasing. In contrast, the short-term trend for four populations is declining. The overall long-term trend in abundance indicates that, on average, populations are just replacing themselves. Estimates of the short-term median population growth rate ( $\lambda$ ) (data years 1990-2002) indicate an even split between populations that are growing and those that are declining, although estimates would be lower for several populations if the fraction of naturally spawning hatchery fish were available for all populations within the species. For available data, when  $\lambda$  is calculated assuming that hatchery fish have the equivalent success of natural spawners then the largest estimated decline occurs in the Green River. Populations with the largest positive short and long-term trends include the White River and the North Fork Nooksack River (Good *et al.*, 2005). Lambda for the Skagit River, which produces the most Chinook salmon in this species, has increased slightly. Overall, the recent analysis by Good *et al.*, (2005) illustrated that there has not be much change in this species since NMFS' first status review (Busby *et al.*, 1996). Individual populations have improved, while others have declined. However, the lack of information on the fraction of naturally spawning, hatchery-origin fish for 10 of the 22 populations that comprise this species limits our understanding of the trends in naturally spawning fish for a large portion of the species.

The estimated total run size of Chinook salmon in Puget Sound in the early 1990s was 240,000 fish, representing a loss of nearly 450,000 fish from historic numbers. During a recent 5-year period, the geometric mean of natural spawners in populations of Puget Sound Chinook salmon ranged from 222 to just over 9,489 fish. Most populations had natural spawners numbering in the hundreds (median recent natural escapement is 766), and of the six populations with greater than 1,000 natural spawners, only two have a low fraction of hatchery fish. The populations with the greatest estimated component of hatchery fish tend to be in mid to southern Puget Sound, Hood Canal and the Strait of Juan de Fuca regions. Estimates of the historical equilibrium abundance, based on pre-European settlement habitat conditions, range from 1,700 to 51,000 potential Puget Sound Chinook salmon spawners per population. The historical estimates of spawner capacity are several orders of magnitude higher than spawner abundances currently observed throughout the species (Good *et al.*, 2005).

## Critical Habitat

NMFS designated critical habitat for Puget Sound Chinook salmon on September 2, 2005 (70 FR 52630). The specific geographic area includes portions of the Nooksack River, Skagit River, Sauk River, Stillaguamish River, Skykomish River, Snoqualmie River, Lake Washington, Green River, Puyallup River, White River, Nisqually River, Hamma Hamma River and other Hood Canal watersheds, the Dungeness/Elwha Watersheds and nearshore marine areas of the Strait of Georgia, Puget Sound, Hood Canal and the Strait of Juan de Fuca. This designation includes the stream channels within the designated stream reaches and includes a lateral extent as defined by the ordinary high water line. In areas where the ordinary high water line is not defined the lateral extent is defined as the bankfull elevation.

The designation for this species includes sites necessary to support one or more Chinook salmon life stages. These areas are important for the species' overall conservation by protecting quality growth, reproduction and feeding.

Specific primary constituent elements include freshwater spawning sites, freshwater rearing sites, freshwater migration corridors, nearshore marine habitat and estuarine areas. The physical or biological features that characterize these sites include water quality and quantity, natural cover, forage, adequate passage conditions and floodplain connectivity. Of 49 subbasins (5th field Hydrological Units) reviewed in NMFS' assessment of critical habitat for the Puget Sound species, nine subbasins were rated as having a medium conservation value, 12 were rated as low, and the remaining subbasins (40), where the bulk of Federal lands occur for this species, were rated as having a high conservation value to Puget Sound Chinook salmon. Factors contributing to the downward trends in this species are hydromorphological changes (such as diking, revetments, loss of secondary channels in floodplains, widespread blockages of streams and changes in peak flows), degraded freshwater and marine habitat affected by agricultural activities and urbanization and upper river tributaries widely affected by poor forest practices. Changes in habitat quantity, availability, diversity, flow, temperature, sediment load and channel stability are common limiting factors in areas of critical habitat.

### **Sacramento River Winter-Run Chinook Salmon**

The Sacramento River winter-run Chinook salmon species includes all naturally spawned populations of winter-run Chinook salmon in the Sacramento River and its tributaries in California. Two artificial propagation programs are included in this species.

This species consists of a single spawning population that enters the Sacramento River and its tributaries in California from November to June and spawns from late April to mid-August, with a peak from May to June (Good *et al.*, 2005). Sacramento River winter-run Chinook salmon historically occupied cold, headwater streams, such as the upper reaches of the Little Sacramento, McCloud and lower Pit Rivers. Young winter-run Chinook salmon venture to sea in November and December, after only four to seven months in fresh water (Groot and Margolis., 1991).

### **Status and Trends**

NMFS listed Sacramento River winter-run Chinook salmon as endangered on January 4, 1994 (59 FR 440), and reaffirmed their status as endangered on June 28, 2005 (70 FR 37160), because dams restrict access to a small fraction of their historic spawning habitat and the habitat remaining to them is degraded. Sacramento River winter-run Chinook salmon consist of a single self-sustaining population which is entirely dependent upon the provision of suitably cool water from Shasta Reservoir during periods of spawning, incubation and rearing.

Construction of Shasta Dams in the 1940s eliminated access to historic spawning habitat for winter-run Chinook salmon in the basin. Winter-run Chinook salmon were not expected to survive this habitat alteration (Moffett, 1949). However, cold water releases from Shasta Dam have created conditions suitable for winter Chinook salmon for roughly 60 miles downstream from the dam. As a result the species has been reduced to a single spawning population confined to the mainstem Sacramento River below Keswick Dam, although some adult winter-run Chinook salmon were recently observed in Battle Creek, a tributary to the upper Sacramento River.

Quantitative estimates of run-size are not available for the period before 1996, the completion of Red Bluff Diversion Dam. However, winter-runs may have been as large as 200,000 fish based upon commercial fishery records from the 1870s (Fisher, 1994). The California Department of Fish and Game estimated spawning escapement of Sacramento River winter-run Chinook salmon at 61,300 (60,000 in the mainstem, 1,000 in Battle Creek and 300 in Mill Creek) in the early 1960s. During the first 3 years of operation of the county facility at the Red Bluff Diversion Dam (1967 to 1969), the spawning run of winter-run Chinook salmon averaged 86,500 fish.

From 1967 through the mid-1990s, the population declined at an average rate of 18% per year, or roughly 50% per generation. The population reached critically low levels during the drought of 1987 to 1992; the 3-year average run size for the period of 1989 to 1991 was 388 fish. Based on the Red Bluff Diversion Dam counts, the population has been growing rapidly since the 1990s. Mean run size from 1995-2000 has been 2,191, but have ranged from 364 to 65,683 (Good *et al.*, 2005). Most recent estimates indicate that the short term trend is 0.26, while the population growth rate is still less than 1 (Good *et al.*, 2005). The draft recovery goal for the species is an average of 10,000 female spawners per year and a population growth rate >1.0, calculated over 13 years of data (Good *et al.*, 2005).

#### Critical Habitat

NMFS designated critical habitat for Sacramento River winter-run Chinook salmon on June 16, 1993 (58 FR 33212). The following areas consisting of the water, waterway bottom and adjacent riparian zones: the Sacramento River from Keswick Dam, Shasta County (river mile 302) to Chipps Island (river mile 0) at the westward margin of the Sacramento-San Joaquin Delta and other specified estuarine waters. These areas are important for the species' overall conservation by protecting quality growth, reproduction and feeding. Factors contributing to the downward trends in this species include reduced access to spawning/rearing habitat, possible loss of genetic integrity through population bottlenecks, inadequately screened diversions, predation at artificial structures and by nonnative species, pollution from Iron Mountain Mine and other sources, adverse flow conditions, high summer water temperatures, unsustainable harvest rates, passage problems at various structures and vulnerability to drought (Good *et al.*, 2005).

#### Snake River Fall-Run Chinook Salmon

The Snake River fall-run Chinook salmon species includes all naturally spawned populations of fall-run Chinook salmon in the mainstem Snake River below Hells Canyon Dam, and in the Tucannon River, Grande Ronde River, Imnaha River, Salmon River and Clearwater River subbasins. Four artificial propagation programs are part of this species.

Historically, the primary fall-run Chinook salmon spawning areas occurred on the upper mainstem Snake River (Connor *et al.*, 2005). A series of Snake River dams blocked access to the upper reaches, which significantly reduced spawning and rearing habitat. Consequently, salmon now reside in waters that are generally cooler than pre-dam habitats. Currently, natural spawning occurs at the upper end of Lower Granite Reservoir to Hells Canyon Dam, the lower reaches of the Imnaha, Grande Ronde, Clearwater and Tucannon rivers and small mainstem sections in the tailraces of the lower Snake River hydroelectric dams.

Adult Snake River fall-run Chinook salmon enter the Columbia River in July and August, and spawning occurs from October through November. Juveniles emerge from the gravels in March and April of the following year, moving downstream from natal spawning and early rearing areas from June through early autumn. Prior to dam construction, fall Chinook salmon were primarily ocean-type (migrated downstream and reared in the mainstem Snake River during their first year). However, today both an ocean-type and reservoir-type occur (Connor *et al.*, 2005). The reservoir-type juveniles overwinter in pools created by dams before migrating to sea; this response is likely due to early development in cooler temperatures which prevents rapid growth. Phenotypic characteristics have shifted in apparent response to environmental changes from hydroelectric dams (Connor *et al.*, 2005). Migration downstream appears to be influenced by flow velocity within both river and reservoir systems (Tiffan *et al.*, 2009).

#### Status and Trends

NMFS originally listed Snake River fall-run Chinook salmon as endangered in 1992 (57 FR 14653) but reclassified their status as threatened on June 28, 2005 (70 FR 37160). Estimated annual returns for the period 1938 to 1949 was

72,000 fish, and by the 1950s, numbers had declined to an annual average of 29,000 fish (Bjornn and Horner 1980). Numbers of Snake River fall-run Chinook salmon continued to decline during the 1960s and 1970s as approximately 80% of their historic habitat was eliminated or severely degraded by the construction of the Hells Canyon complex (1958 to 1967) and the lower Snake River dams (1961 to 1975). Counts of natural-origin adult Snake River fall-run Chinook salmon at Lower Granite Dam were 1,000 fish in 1975, and ranged from 78 to 905 fish (with an average of 489 fish) over the ensuing 25-year period (Good *et al.*, 2005). Numbers of natural-origin Snake River fall-run Chinook salmon have increased over the last few years, with estimates at Lower Granite Dam of 2,652 fish in 2001, 2,095 fish in 2002, and 3,895 fish in 2003.

Snake River fall-run Chinook salmon have exhibited an upward trend in returns over Lower Granite Dam since the mid 1990s. Returns classified as natural-origin spawners exceeded 2,600 fish in 2001, compared to a 1997 to 2001 geometric mean natural-origin count of 871 (35% of the proposed delisting abundance criteria of 2,500 natural spawners averaged over 8 years). Both the long- and short-term trends in natural returns are positive. Harvest impacts on Snake River fall Chinook salmon declined after listing and have remained relatively constant in recent years. Mainstem conditions for sub-yearling Chinook migrants from the Snake River have generally improved since the early 1990s. The hatchery component, derived from outside the basin, has decreased as a percentage of the run at Lower Granite Dam from the 1998/99 status reviews (5-year average of 26.2%) to 2001 (8%). This reflects an increase in the Lyons Ferry component, systematic removal of marked hatchery fish at the Lower Granite trap, and modifications to the Umatilla supplementation program to increase homing of fall Chinook salmon release groups. Hatcheries stocking fish to the Snake River fall run produce genetic effects in the population due to three major components: natural-origin fish (which may be progeny of hatchery fish), returns of Snake River fish from the Lyons Ferry Hatchery program and strays from hatchery programs outside the Snake River.

### **Critical Habitat**

NMFS designated critical habitat for Snake River fall-run Chinook salmon on December 28, 1993 (58 FR 68543). This critical habitat encompasses the waters, waterway bottoms and adjacent riparian zones of specified lakes and river reaches in the Columbia River that are or were accessible to ESA listed Snake River salmon (except reaches above impassable natural falls and Dworshak and Hells Canyon Dams). These areas are important for the species' overall conservation by protecting quality growth, reproduction and feeding. Adjacent riparian zones are defined as those areas within a horizontal distance of 300 feet from the normal line of high water of a stream channel or from the shoreline of a standing body of water. Designated critical habitat includes the Columbia River from a straight line connecting the west end of the Clatsop jetty (Oregon side) and the west end of the Peacock jetty (Washington side) and including all river reaches from the estuary upstream to the confluence of the Snake River and all Snake River reaches upstream to Hells Canyon Dam. Critical habitat also includes several river reaches presently or historically accessible to Snake River fall-run Chinook salmon. Limiting factors identified for Snake River fall-run Chinook salmon include: mainstem lower Snake and Columbia hydrosystem mortality, degraded water quality, reduced spawning and rearing habitat due to mainstem lower Snake River hydropower system, harvest impacts, impaired stream flows, barriers to fish passage in tributaries, excessive sediment and altered floodplain and channel morphology (NMFS, 2005b).

### **Snake River Spring/Summer-Run Chinook Salmon**

The Snake River spring/summer-run Chinook salmon species includes all naturally spawned populations of spring/summer-run Chinook salmon in the mainstem Snake River and the Tucannon River, Grande Ronde River, Imnaha River and Salmon River subbasins. Fifteen artificial propagation programs are part of the species. The Interior Columbia Basin Technical Recovery Team has identified 32 populations in five major population groups

(Upper Salmon River, South Fork Salmon River, Middle Fork Salmon River, Grande Ronde/Imnaha, Lower Snake Mainstem Tributaries) for this species. Historic populations above Hells Canyon Dam are considered extinct (ICBTRT, 2003).

Snake River spring/summer-run Chinook salmon have a stream-type life history. Spawning occurs in late summer and early fall and eggs incubate over the following winter and hatch in late winter and early spring of the following year. Juveniles mature in the river for one year before migrating to the ocean in the spring of their second year. Larger outmigrants have a higher survival rate during outmigration (Zabel and Williams, 2002; Zabel and Achord, 2004). Depending on tributary and the specific habitat conditions, juveniles may migrate widely from natal reaches into alternative summer-rearing or overwintering areas. Spawners return to spawn primarily as 4- and 5-year-olds after 2 to 3 years in the ocean.

### Status and Trends

NMFS originally listed Snake River spring/summer-run Chinook salmon as threatened on April 22, 1992 (57 FR 14653), and reaffirmed their status as threatened on June 28, 2005 (70 FR 37160). Although direct estimates of historical annual Snake River spring/summer Chinook salmon returns are not available, returns may have declined by as much as 97% between the late 1800s and 2000. According to Matthews and Waples (1991), total annual Snake River spring/summer Chinook salmon production may have exceeded 1.5 million adult fish in the late 1800s. Total (natural plus hatchery origin) returns fell to roughly 100,000 spawners by the late 1960s (Fulton, 1968). The 1997 to 2001 geometric mean total return for the summer run component at Lower Granite Dam was slightly more than 6,000 fish, compared to the geometric mean of 3,076 fish for the years 1987 to 1996 (Good *et al.*, 2005). Good *et al.*, (2005) reported that risks to individual populations within the species may be greater than the extinction risk for the entire species due to low levels of annual abundance and the extensive production areas within the Snake River basin. Although the average abundance in the most recent decade is more abundant than the previous decade, there is no obvious long-term trend.

### Critical Habitat

NMFS designated critical habitat for Snake River spring/summer-run Chinook salmon on October 25, 1999 (64 FR 57399). This critical habitat encompasses the waters, waterway bottoms and adjacent riparian zones of specified lakes and river reaches in the Columbia River that are or were accessible to ESA listed Snake River salmon (except reaches above impassable natural falls and Dworshak and Hells Canyon Dams). Adjacent riparian zones are defined as those areas within a horizontal distance of 300 feet from the normal line of high water of a stream channel or from the shoreline of a standing body of water. Designated critical habitat includes the Columbia River from a straight line connecting the west end of the Clatsop jetty (Oregon side) and the west end of the Peacock jetty (Washington side) and including all river reaches from the estuary upstream to the confluence of the Snake River and all Snake River reaches upstream to Hells Canyon Dam; the Palouse River from its confluence with the Snake River upstream to Palouse Falls, the Clearwater River from its confluence with the Snake River upstream to its confluence with Lolo Creek; the North Fork Clearwater River from its confluence with the Clearwater river upstream to Dworshak Dam. Critical habitat also includes several river reaches presently or historically accessible to Snake River spring/summer Chinook salmon. These areas are important for the species' overall conservation by protecting quality growth, reproduction and feeding. Limiting factors identified for this species include hydrosystem mortality, reduced stream flow, altered channel morphology and floodplain, excessive fine sediment and degraded water quality (NMFS, 2006).

## Upper Willamette River Chinook Salmon

The Upper Willamette River Chinook salmon species includes all naturally spawned populations of spring-run Chinook salmon in the Clackamas River and in the Willamette River, and its tributaries, above Willamette Falls, Oregon. Seven artificial propagation programs are part of the species.

Upper Willamette River Chinook salmon occupy the Willamette River and its tributaries. All spring-run Chinook salmon in the species, except those entering the Clackamas River, must pass Willamette Falls. In the past, this species included sizable numbers of spawning salmon in the Santiam River, the middle fork of the Willamette River, and the McKenzie River, as well as smaller numbers in the Molalla River, Calapooia River and Albiqua Creek. Historically, access above Willamette Falls was restricted to the spring when flows were high. In autumn, low flows prevented fish from ascending past the falls. The Upper Willamette spring-run Chinook salmon are one of the most genetically distinct Chinook salmon groups in the Columbia River Basin. Upper Willamette River Chinook salmon enter the Columbia River and estuary earlier than other spring Chinook salmon species (Meyers *et al.*, 1998). Fall-run Chinook salmon spawn in the Upper Willamette but are not considered part of the species because they are not native.

### Status and Trends

NMFS originally listed Upper Willamette River Chinook salmon as threatened on March 24, 1999 (64 FR 14308), and reaffirmed their status as threatened on June 28, 2005 (70 FR 37160). The total abundance of adult spring-run Chinook salmon (hatchery-origin plus natural-origin fish) passing Willamette Falls has remained relatively steady over the past 50 years (ranging from approximately 20,000 to 70,000 fish), but it is an order of magnitude below the peak abundance levels observed in the 1920s (approximately 300,000 adults). Until recent years, interpretation of abundance levels has been confounded by a high but uncertain fraction of hatchery-produced fish. Although the number of adult spring-run Chinook salmon crossing Willamette Falls is in the same range (about 20,000 to 70,000 adults) it has been for the last 50 years, a large fraction of these are hatchery produced. Estimates of the percentage of hatchery fish range according to tributary, several of which exceed 70% (Good *et al.*, 2005). The Calapooia River is estimated to contain 100% hatchery fish. Insufficient information on hatchery production in the past prevents a meaningful analysis of the population trend; therefore no formal trend analysis is available.

Most natural spring Chinook salmon populations of the Upper Willamette River are likely extirpated or nearly so, with only one remaining naturally reproducing population identified in this species: the spring Chinook salmon in the McKenzie River. Unfortunately, recently short-term declines in abundance suggest that this population may not be self-sustaining (Meyers *et al.*, 1998). Abundance in this population has been relatively low (low thousands) with a substantial number of these fish being of hatchery origin. The population increased substantially from 2000 to 2003, probably due to increased survival in the ocean. Future survival rates in the ocean are unpredictable, and the likelihood of long-term sustainability for this population has not been determined. Of concern is that a majority of the spawning habitat and approximately 30 to 40% of total historical habitat are no longer accessible because of dams (Good *et al.*, 2005). Individuals from the species migrate far north and are caught incidentally in ocean fisheries, particularly off southeast Alaska and northern Canada, and in the mainstem Columbia and Willamette rivers during spring.

### Critical Habitat

NMFS designated critical habitat for Upper Willamette River Chinook salmon on September 2, 2005 (70 FR 52630). Critical habitat for upper Willamette River Chinook salmon includes defined areas within subbasins of the middle fork Willamette River, upper Willamette River, McKenzie River, Santiam River, Crabtree Creek, Molalla

River and Clackamas River. This designation includes the stream channels within the designated stream reaches and includes a lateral extent as defined by the ordinary high water line. In areas where the ordinary high-water line is not defined the lateral extent is defined as the bankfull elevation. The critical habitat designation for this species identifies primary constituent elements that include sites necessary to support one or more Chinook salmon life stages. Specific sites include freshwater spawning and rearing sites, freshwater migration corridors. The physical or biological features that characterize these sites include water quality and quantity, natural cover, forage, adequate passage conditions and floodplain connectivity. Of 65 subbasins reviewed in NMFS' assessment of critical habitat for the Upper Willamette River Chinook salmon species, 19 subbasins were rated as having a medium conservation value, 19 were rated as low, and the 27 remaining subbasins were rated as having a high conservation value to Upper Willamette River Chinook salmon. Federal lands were generally rated as having high conservation value to the species' spawning and rearing. Factors contributing to the downward trends in this species include reduced access to spawning/rearing habitat in tributaries, hatchery impacts, altered water quality and temperature in tributaries, altered stream flow in tributaries and lost or degraded floodplain connectivity and lowland stream habitat.

## **Chum Salmon**

Chum salmon are more widely distributed than other salmon and may have at one time made up nearly 50% of the Pacific salmon biomass in the Pacific Ocean (Salo, 1991). Historically, chum salmon were distributed throughout the coastal regions of western Canada and the U.S., as far south as Monterey Bay, California, to the Arctic coast and east to the Mackenzie River, in the Beaufort Sea. They also ranged in Asia from Korea to the Arctic coast of the Soviet Union and west to the Lena River. Presently, major spawning populations on the west coast of the U.S. are found only as far south as Tillamook Bay on the northern Oregon coast. In this section of our Opinion, we discuss the distribution, status and critical habitats of the two listed species of threatened chum salmon separately. However, because chum salmon species share many characteristics, we begin this section describing those characteristics common across species.

There are no known landlocked or naturalized freshwater populations of chum salmon. Like Chinook salmon, chum salmon are semelparous (Randall *et al.*, 1987 as cited in Johnson *et al.*, 1997). Their general life cycle spans fresh and marine waters, although chum salmon are more marine oriented than the other Pacific salmon. Chum salmon spend 2 to 5 years in feeding areas in the northeast Pacific Ocean (Johnson *et al.*, 1997). Chum salmon distribute throughout the North Pacific Ocean and Bering Sea (Neave *et al.*, 1976 as cited in Johnson *et al.*, 1997).

Spawning migrations generally occur in the summer and fall; the precise spawn timing and migration varies across populations. Generally, spawning runs consist of fish between 2 and 5 years of age. Fecundity is highly variable and is correlated with body size and region (Salo, 1991). Once they emerge from their gravel nests, chum salmon fry outmigrate to seawater almost immediately (Salo, 1991). This ocean-type migratory behavior contrasts with the stream-type behavior of other species in its genus. Because of their small size chum salmon will form loosely aggregated schools, presumably to reduce predation by swamping predators (Miller and Brannon 1982; Pitcher 1986).

Generally, chum fry emigrate to estuaries between March through May where they forage on epibenthic and neritic food resources. The timing of juvenile entry into sea water is commonly correlated with nearshore warming and associated plankton blooms (Groot and Margolis., 1991). As food resources decline and the fish grow, they move further out to forage on pelagic and nektonic organisms (Simenstad and Salo, 1982; Salo, 1991). Migratory studies

indicate that chum salmon in their first year of life will typically maintain a coastal migratory pattern although the pattern is variable as they mature at sea. At sea chum salmon feed on pteropods, euphausiids, amphipods, fish and squid larvae (Salo, 1991).

### Threats

*Natural Threats.* Chum salmon are exposed to high rates of natural predation each stage of their life stage and in particular during migration. Mortality at emergence or prior to emergence is significant because eggs develop in the interstitial spaces in the stream gravel and storm surges that redeposit gravels and wash out eggs or introduce silt to the interstitial spaces can reduce egg survival. Other factors that reduce egg survival and larvae development include low dissolved oxygen, poor percolation and extreme cold or warm temperatures.

*Anthropogenic Threats.* Chum salmon, like the other listed salmon, have declined under the combined effects of overharvests in fisheries; competition from fish raised in hatcheries and native and non-native exotic species; dams that block their migrations and alter river hydrology; gravel mining that impedes their migration and alters the dynamics (hydrogeomorphology) of the rivers and streams that support juveniles; water diversions that deplete water levels in rivers and streams; destruction or degradation of riparian habitat that increases water temperatures in rivers and streams sufficient to reduce the survival of juvenile chum salmon; and land use practices (logging, agriculture, urbanization) that destroy wetland and riparian ecosystems while introducing sediment, nutrients, biocides, metals and other pollutants into surface and ground water and degrade water quality in the fresh water, estuarine and coastal ecosystems throughout the Pacific Northwest. These threats are the same as those summarized in detail under the Chinook salmon of this section.

### Columbia River Chum Salmon

The Columbia River chum species includes all naturally spawned populations of chum salmon in the Columbia River and its tributaries in Washington and Oregon. Three artificial propagation programs are part of the species.

Most of the chum salmon that comprise this species return to northern tributaries of the Columbia River (in Washington State), primarily the Grays River, in areas immediately below Bonneville Dam and in smaller numbers under the I-205 bridge near Vancouver. Chum populations that formerly occupied tributaries on the south bank of the Columbia (in Oregon) are considered extirpated or nearly so. Observers have documented spawning over multiple years in the mainstem Columbia River, near McCord Creek and Multnomah Falls in Oregon, although the number of spawners in these areas are generally quite low (McElhany *et al.*, 2007).

### Status and Trends

NMFS listed Columbia River chum salmon as threatened on March 25, 1999, and reaffirmed their threatened status on June 28, 2005 (71 FR 37160). Chum salmon in the Columbia River once numbered in the hundreds of thousands of adults and were reported in almost every river in the Lower Columbia River basin, but by the 1950s most runs disappeared (Rich, 1942; Marr, 1943; Fulton, 1970). The total number of chum salmon returning to the Columbia River in the last 50 years has averaged a few thousand per year, with returns limited to a very restricted portion of the historical range. Significant spawning occurs in only two of the 16 historical populations, meaning that 88% of the historical populations are extirpated, or nearly so (Good *et al.*, 2005). The two remaining populations are the Grays River and the lower Columbia Gorge tributaries (Good *et al.*, 2005). Both long- and short-term trends for Grays River abundance are negative, but the current trend in abundance for the lower Columbia Gorge tributaries is slightly positive. Chum salmon appear to be extirpated from the Oregon portion of this species. In 2000, ODFW conducted surveys to determine the abundance and distribution of chum salmon in the Columbia River, and out of

30 sites surveyed, only one chum salmon was observed.

Few Columbia River chum salmon have been observed in tributaries between The Dalles and Bonneville dams. Surveys of the White Salmon River in 2002 found one male and one female carcass, with no evidence of spawning (Ehlke and Keller, 2003). Chum salmon were not observed in any upper Columbia Gorge tributaries during the 2003 and 2004 spawning ground surveys. Finally, most Columbia River chum populations have been functionally extirpated or are presently at very low abundance levels.

Historically, the Columbia River chum salmon supported a large commercial fishery in the first half of this century which landed more than 500,000 fish per year as recently as 1942. Commercial catches declined beginning in the mid-1950s, and in later years rarely exceeded 2,000 per year (Good *et al.*, 2005). During the 1980s and 1990s, the combined abundance of natural spawners for the lower Columbia Gorge, Washougal and Grays River populations was below 4,000 adults. In 2002, however, the abundance of natural spawners exhibited a substantial increase at several locations (estimate of natural spawners is approximately 20,000 adults) (Good *et al.*, 2005). The cause of this dramatic increase in abundance is unknown. However, long- and short-term productivity trends for populations are at or below replacement. The loss of off-channel habitat and the extirpation of approximately 17 historical populations increase this species' vulnerability to environmental variability and catastrophic events. Overall, the populations that remain have low abundance, limited distribution and poor connectivity (Good *et al.*, 2005).

#### **Critical Habitat**

NMFS designated critical habitat for Columbia River chum salmon on September 2, 2005 (70 FR 52630). The designated includes defined areas in the following subbasins: Middle Columbia/Hood, Lower Columbia/Sandy, Lewis, Lower Columbia/Clatskanie, Lower Cowlitz, Lower Columbia subbasin and river corridor. This designation includes the stream channels within the designated stream reaches and includes a lateral extent as defined by the ordinary high water line. In areas where the ordinary high-water line is not defined the lateral extent is defined as the bankfull elevation.

The critical habitat designation for this species identifies primary constituent elements that include sites necessary to support one or more chum salmon life stages. These areas are important for the species' overall conservation by protecting quality growth, reproduction and feeding and are rated as having high conservation value to the species. Columbia River chum salmon have primary constituent elements of freshwater spawning, freshwater rearing, freshwater migration, estuarine areas free of obstruction, nearshore marine areas free of obstructions and offshore marine areas with good water quality. The physical or biological features that characterize these sites include water quality and quantity, natural cover, forage, adequate passage conditions and floodplain connectivity. Of 21 subbasins reviewed in NMFS' assessment of critical habitat for the Columbia River chum salmon species, three subbasins were rated as having a medium conservation value, no subbasins were rated as low, and the majority of subbasins (18), were rated as having a high conservation value to Columbia River chum salmon. The major factors limiting recovery for Columbia River chum salmon are altered channel form and stability in tributaries, excessive sediment in tributary spawning gravels, altered stream flow in tributaries and the mainstem Columbia River, loss of some tributary habitat types and harassment of spawners in the tributaries and mainstem.

#### **Hood Canal Summer-Run Chum Salmon**

The Hood Canal summer-run chum salmon species includes all naturally spawned populations of summer-run chum salmon in Hood Canal and its tributaries as well as populations in Olympic Peninsula rivers between Hood Canal and Dungeness Bay, Washington (64 FR 14508) from mid-September to mid-October (WDF, 1993), but may enter

natal rivers in late August. Eight artificial propagation programs are considered to be part of the species.

On average Hood Canal chum salmon reside in estuaries for 23 days; daily tidal migrations have not been observed, but prey availability does influence movement patterns (Bax, 1983). Upon leaving their natal estuaries summer-run chum salmon generally migrate through Hood Canal and into the main body of Puget Sound.

### Status and Trends

NMFS listed Hood Canal summer-run chum salmon as threatened on March 25, 1999 (64 FR 14508), and reaffirmed as threatened on June 28, 2005 (70 FR 37160). Historically, Hood Canal summer-run chum salmon comprised an estimated 16 populations. Only eight extant populations remain within this species (Good *et al.*, 2005). Most of the extirpated populations historically occurred on the eastern side of Hood Canal, which is cause for concern over the current spatial structure of this species. The widespread loss of estuary and lower floodplain habitat is a continuing threat to species spatial structure and connectivity.

Although adult returns for some populations showed modest improvements in 2000, with upward trends continuing in 2001 and 2002 (Good *et al.*, 2005), the recent 5-year mean abundance is variable among populations in the species, ranging from one fish to nearly 4,500 fish in the Big/Little Quilcene rivers. Hood Canal summer-run chum are the focus of an extensive rebuilding program developed and implemented since 1992 by the State and Tribal comanagers. Two populations (the combined Quilcene and Union River populations) are above the conservation thresholds established by the rebuilding plan. However, most populations remain depressed. Estimates of the fraction of naturally spawning hatchery fish exceed 60% for some populations, indicating that reintroduction programs are supplementing the numbers of total fish spawning naturally in streams (Good *et al.*, 2005). Long-term trends in productivity are above replacement for only the Quilcene and Union River populations (Good *et al.*, 2005). Buoyed by recent increases, seven populations are exhibiting short-term productivity trends above replacement.

Of the eight programs releasing summer-run chum salmon that are considered to be part of the Hood Canal summer chum species, six of the programs are supplementation programs implemented to preserve and increase the abundance of native populations in their natal watersheds. NMFS' assessment of the effects of artificial propagation on species extinction risk concluded that these hatchery programs collectively do not substantially reduce the extinction risk of the species. The hatchery programs are reducing risks to species abundance by increasing total species abundance as well as the number of naturally spawning summer-run chum salmon.

### Critical Habitat

NMFS designated critical habitat for Hood Canal summer-run chum salmon on September 2, 2005 (70 FR 52630). The specific geographic area includes the Skokomish River, Hood Canal subbasin, which includes the Hamma Hamma and Dosewallips rivers and others, the Puget Sound subbasin, Dungeness/Elwha subbasin and nearshore marine areas of Hood Canal and the Strait of Juan de Fuca from the line of extreme high tide to a depth of 30 meters. This includes a narrow nearshore zone from the extreme high-tide to mean lower low tide within several Navy security/restricted zones. This also includes about 8 miles of habitat that was unoccupied at the time of the designation Finch, Anderson and Chimacum creeks (69 FR 74572; 70 FR 52630), but has recently been re-seeded. The designation for Hood Canal summer-run chum, like others made at this time, includes the stream channels within the designated stream reaches and includes a lateral extent as defined by the ordinary high water line. In areas where the ordinary high-water line is not defined the lateral extent is defined as the bankfull elevation.

The specific primary constituent elements identified for Hood Canal summer-run chum salmon are areas for spawning, freshwater rearing and migration, estuarine areas free of obstruction, nearshore marine areas free of

obstructions and offshore marine areas with good water quality. The physical or biological features that characterize these sites include water quality and quantity, natural cover, forage, adequate passage conditions and floodplain connectivity. Of 17 subbasins reviewed in NMFS' assessment of critical habitat for the Hood Canal chum salmon species, 14 subbasins were rated as having a high conservation value, while only three were rated as having a medium value to conservation. These areas are important for the species' overall conservation by protecting quality growth, reproduction, and feeding. Limiting factors identified for this species include degraded floodplain and mainstem river channel structure, degraded estuarine conditions and loss of estuarine habitat, riparian area degradation and loss of in-river wood in mainstem, excessive sediment in spawning gravels and reduced stream flow in migration areas.

## **Coho Salmon**

Coho salmon occur naturally in most major river basins around the North Pacific Ocean from central California to northern Japan (Laufle *et al.*, 1986). They spawn in the fall and winter and the young emerge in the spring. Adult coho salmon may remain in fresh water three or more months before spawning, with early migrants often moving farther upstream than later migrants (Sandercock, 1991). Spawning occurs in a few third-order streams, but most spawning activity occurs in fourth- and fifth-order streams. As with other Pacific salmon, coho salmon fecundity varies with the size of the fish and latitudinally with coho salmon in northern climes generally exhibiting higher rates of fecundity (Sandercock, 1991). Most coho salmon mature and spawn at age 3, although there are exceptions (Sandercock, 1991).

The outmigration of coho smolts begins as early as February and may continue through the summer and fall, with peak outmigration often between March and June, although this varies among basins and environmental conditions (Sandercock, 1991). While at sea, coho salmon tend to eat fish including herring, sand lance, sticklebacks, sardines, shrimp and surf smelt. While in estuaries and in fresh water coho salmon are significant predators of Chinook, pink and chum salmon, as well as aquatic and terrestrial insects. Smaller fish, such as fry, eat chironomids, plecoptera and other larval insects and typically use visual cues to find their prey.

## **Threats**

*Natural Threats.* Coho salmon, like other salmon, are exposed to high rates of natural predation at each life stage. Most mortality, however, occurs in the freshwater life stages. Winter mortality may be significant for coho salmon because they overwinter in fresh water, where they can be swept downstream from freshets or eaten by raccoon, cutthroat trout or other small animals. Once coho reach the ocean, survival is high (Sandercock, 1991).

*Anthropogenic Threats.* Coho salmon have declined under the combined effects of overharvests in fisheries; competition from fish raised in hatcheries and native and non-native exotic species; dams that block their migrations and alter river hydrology; gravel mining that impedes their migration and alters the dynamics (hydrogeomorphology) of the rivers and streams that support juveniles; water diversions that deplete water levels in rivers and streams; destruction or degradation of riparian habitat that increase water temperatures in rivers and streams sufficient to reduce the survival of juvenile coho salmon; and land use practices (logging, agriculture, urbanization) that destroy wetland and riparian ecosystems while introducing sediment, nutrients, biocides, metals and other pollutants into surface and ground water and degrade water quality in the fresh water, estuarine and coastal ecosystems throughout the species' range. These threats are the same as those summarized in detail under the Chinook salmon of this section.

## Central California Coast Coho Salmon

The Central California Coast coho salmon species extends from Punta Gorda in northern California south to and including the San Lorenzo River in central California (Sandercock, 1991). The species includes all naturally spawned populations of coho salmon from Punta Gorda in northern California south to and including the San Lorenzo River in central California, as well as populations in tributaries to San Francisco Bay, excluding the Sacramento-San Joaquin River system. Four artificial propagation programs are part of the Central California Coast coho salmon species.

Coho salmon in this species enter rivers to spawn very late (peaking in January), with little time spent in fresh water between river entry and spawning. This compressed adult freshwater residency appears to coincide with the single, brief peak of river flow characteristic of this region.

### Status and Trends

NMFS originally listed the central California coast coho salmon species as threatened on October 31, 1996 (61 FR 56138) and later reclassified their status to endangered June 28, 2005 (70 FR 37160). Information on the abundance and productivity trends for the naturally spawning component of the central California coast coho species is extremely limited. There are no long-term time series of spawner abundance for individual river systems. Historical estimated escapement for this species is 56,100 for 1963 and more recent estimates suggest the species dropped to about one-fourth that size by the late 1980s and early 1990s (Good *et al.*, 2005).

Where data are available, analyses of juvenile coho presence-absence information, juvenile density surveys and irregular adult counts for the South Fork Noyo River indicate low abundance and long-term downward trends for the naturally spawning populations throughout the species (Good *et al.*, 2005). Improved ocean conditions coupled with favorable stream flows and harvest restrictions have contributed to increased returns in 2001 in streams in the northern portion of the species, as indicated by an increase in the observed presence of fish in historically occupied streams (Good *et al.*, 2005). Data are particularly lacking for many river basins in the southern two-thirds of the species where naturally spawning populations are considered to be at the greatest risk. The extirpation or near extirpation of natural coho salmon populations in several major river basins, and across most of the southern historical range of the species, represents a significant risk to species spatial structure and diversity (Good *et al.*, 2005).

Artificial propagation of coho salmon within the Central California Coast species has declined since the species was listed in 1996 though it continues at the Noyo River and Scott Creek facilities. Two captive broodstock populations have recently been established. Genetic diversity risk associated with out-of-basin transfers appears to be minimal, but diversity risk from domestication selection and low effective population sizes in the remaining hatchery programs remains a concern. An artificial propagation program for coho was operated at the Don Clausen hatchery on the Russian River through the mid 1990s, but was terminated in 1996.

For the naturally spawning component of the species, the biological review team found very high risk of extinction for the abundance, productivity and spatial structure of the Viable Salmon Population (VSP) parameters and comparatively moderate risk with respect to the diversity VSP parameter. The lack of direct estimates of the performance of the naturally spawned populations in this species, and the associated uncertainty this generates, was of specific concern to the biological review team. Informed by the VSP risk assessment and the associated uncertainty, the strong majority opinion of the biological review team was that the naturally spawned component of the Central California Coast coho species was “in danger of extinction.” Accordingly, NMFS upgraded the status of central California coast coho species to endangered on June 28, 2005 (70 FR 37160).

Central California Coast coho salmon populations continue to be depressed relative to historical numbers. Strong indications show that breeding groups have been lost from a significant percentage of historical stream range. A number of coho populations in the southern portion of the range appear to be either extinct or nearly so, including those in Gualala, Garcia, and Russian rivers, as well as smaller coastal streams in and south of San Francisco Bay (Good *et al.*, 2005).

#### **Critical Habitat**

NMFS designated critical habitat for central California coast coho salmon on May 5, 1999 (64 FR 24049). The designation encompasses accessible reaches of all rivers (including estuarine areas and riverine reaches) between Punta Gorda and the San Lorenzo River (inclusive) in California, including two streams entering San Francisco Bay: Arroyo Corte Madera Del Presidio and Corte Madera Creek. This critical habitat designation includes all waterways, substrate and adjacent riparian zones of estuarine and riverine reaches (including off-channel habitats) below longstanding naturally impassable barriers (i.e. natural waterfalls in existence for at least several hundred years). These areas are important for the species' overall conservation by protecting growth, reproduction and feeding.

#### **Lower Columbia River Coho Salmon**

The lower Columbia River coho salmon species includes all naturally spawned populations of coho salmon in the Columbia River and its tributaries in Washington and Oregon, from the mouth of the Columbia up to and including the Big White Salmon and Hood Rivers, and includes the Willamette River to Willamette Falls, Oregon. Twenty-five artificial propagation programs are part of this species.

Two distinct runs distinguished by the timing of adult returns to fresh water (early returners and later returners) occur within the species. Early returning adults generally migrate south of the Columbia River once they reach the ocean, returning to fresh water in mid-August and to spawning tributaries in early September. Peak spawning of early returning adults occurs from mid-October to early November. Late returning adult coho salmon exhibit a northern oceanic distribution, return to the Columbia River from late September through December and enter tributaries from October through January. Most late return adults spawn between November through January, although some spawn in February and as late as March (Sandercock, 1991). Almost all Lower Columbia River species coho salmon females and most males spawn at 3 years of age.

#### **Status and Trends**

NMFS listed Lower Columbia River coho salmon as threatened on June 28, 2005 (70 FR 37160). The vast majority (over 90%) of the historic population in the Lower Columbia River coho salmon species appear to be either extirpated or nearly so.

Only two populations of coho salmon that comprise this species produce a sizeable number of naturally spawned fish, the upper Sandy River population above Marmot Dam and the Clackamas River population above the North Fork Dam. Most of the other populations are believed to have very little, if any, natural production. The long-term and short-term trends for Marmot Dam counts are both negative. The long-term median growth rate is slightly positive for both the Sandy and Clackamas rivers, but the confidence intervals for each are very wide indicating there is a large amount of uncertainty. Both populations within the Sandy and Clackamas rivers have suffered from recruitment failure a number of times over the past 15 years, despite the reductions in harvest. The most serious threat facing this species is the scarcity of naturally-produced spawners, with attendant risks associated with small populations, loss of diversity and fragmentation and isolation of the remaining naturally-produced fish. Spatial structure has been substantially reduced by the loss of access to upper basins from tributary hydro development (i.e.,

Condit Dam on the Big White Salmon River and Powerdale Dam on the Hood River). The diversity of populations in all three areas has been eroded by large hatchery influences and periodically, low effective population sizes.

#### Critical Habitat

NMFS has not designated critical habitat for Lower Columbia River coho salmon.

#### **Southern Oregon/Northern California Coast Coho Salmon**

Southern Oregon/Northern California coast coho salmon consists of all naturally spawning populations of coho salmon that reside below long-term, naturally impassible barriers in streams between Punta Gorda, California and Cape Blanco, Oregon, as well as three artificial propagation programs: the Cole Rivers Hatchery, Trinity River Hatchery and Iron Gate Hatchery coho hatchery programs. The three major river systems supporting Southern Oregon – Northern Coastal California coast coho are the Rogue, Klamath (including the Trinity) and Eel rivers.

Southern Oregon and Northern California coast coho immigrate to natal rivers in September or October. River entry is much later south of the Klamath River Basin, occurring in November and December, as well as in basins south of the Klamath River to the Mattole River, California. River entry occurs from mid-December to mid-February in rivers farther south. Because individuals enter rivers late, they spend much less time in the river. Coho salmon adults spawn at age 3, spending just over 1 year in fresh water and a year and a half in the ocean.

#### Status and Trends

Southern Oregon/Northern California coast coho salmon were listed as threatened on May 7, 1997 (62 FR 24588); they retained that classification when their status was reviewed on June 28, 2005 (70 FR 37160). Southern Oregon/Northern California Coast coho salmon extend from Cape Blanco in southern Oregon to Punta Gorda in northern California (Sandercock, 1991). The status of coho salmon coast-wide, including the Southern Oregon/Northern California Coast coho salmon species, was formally assessed in 1995 (Sandercock, 1991). Two subsequent status review updates have been published by NMFS, one addressing all West Coast coho salmon species and a second specifically addressing the Oregon Coast Southern Oregon/Northern California Coast coho salmon species (NMFS, 1996, 1997a). In the 1997 status update, estimates of natural population abundance were based on very limited information. New data on presence/absence in northern California streams that historically supported coho salmon were even more disturbing than earlier results, indicating that a smaller percentage of streams contained coho salmon compared to the percentage presence in an earlier study (Good *et al.*, 2005). However, it was unclear whether these new data represented actual trends in local extinctions or were biased by sampling effort.

Data on population abundance and trends are limited for the California portion of this species. No regular estimates of natural spawner escapement are available. Historical point estimates of coho salmon abundance for the early 1960s and mid-1980s suggest that coho spawning escapement in the 1940s ranged between 200,000 and 500,000 fish. Numbers declined to about 100,000 fish by the mid-1960s with about 43% originating from this species. Brown *et al.*, (1994) estimated that the California portion of this species was represented by about 7,000 wild and naturalized coho salmon (Good *et al.*, 2005). In the Klamath River, the estimated escapement has dropped from approximately 15,400 in the mid-1960s to about 3,000 in the mid 1980s, and more recently to about 2,000 (Good *et al.*, 2005). The second largest producing river in this species, the Eel River, dropped from 14,000, to 4,000 to about 2,000 during the same period. Historical estimates are considered “best guesses” made using a combination of limited catch statistics, hatchery records and the personal observations of biologists and managers.

Most recently, Williams *et al.*, (2006) described the structure of historic populations of Southern Oregon/Northern California Coast coho salmon. They described three categories of populations: functionally independent populations, potentially independent populations and dependent populations. Functionally independent populations are populations capable of existing in isolation with a minimal risk of extinction. Potentially independent populations are similar but rely on some interchange with adjacent populations to maintain a low probability of extinction. Dependent populations have a high risk of extinction in isolation over a 100-year timeframe and rely on exchange of individuals from adjacent populations to maintain themselves.

### **Critical Habitat**

NMFS designated critical habitat for Southern Oregon/Northern California Coast coho salmon on May 5, 1999 (64 FR 24049). Critical habitat for this species encompasses all accessible river reaches between Cape Blanco, Oregon and Punta Gorda, California. Critical habitat consists of the water, substrate and river reaches (including off-channel habitats) in specified areas. Accessible reaches are those within the historical range of the species that can still be occupied by any life stage of coho salmon. Of 155 historical streams for which data are available, 63% likely still support coho salmon. These river habitats are important for a variety of reasons, such as supporting the feeding and growth of juveniles and serving as spawning habitat for adults. Limiting factors identified for this species include: loss of channel complexity, connectivity and sinuosity, loss of floodplain and estuarine habitats, loss of riparian habitats and large in-river wood, reduced stream flow, poor water quality, temperature and excessive sedimentation and unscreened diversions and fish passage structures.

### **Oregon Coast Coho Salmon**

The Oregon Coast coho salmon species includes all naturally spawned populations of coho salmon in Oregon coastal streams south of the Columbia River and north of Cape Blanco (63 FR 42587; August 1998). One hatchery population, the Cow Creek hatchery coho salmon, is considered part of the species.

### **Status and Trends**

The Oregon coast coho salmon species was listed as a threatened species under the ESA on February 11, 2008 (73 FR 7816), the conclusion to a 13-year history of court cases. The most recent NMFS status review for the Oregon Coast coho species was conducted by the biological review team in 2003, which assessed data through 2002. The abundance and productivity of Oregon Coast coho since the previous status review represented some of the best and worst years on record (Sandercock, 1991). Yearly adult returns for the Oregon Coast coho species were over 160,000 natural spawners in 2001 and over 260,000 in 2002, far exceeding the abundance observed for the past several decades (Good *et al.*, 2005). These increases in spawner abundance in 2000 to 2002 followed three consecutive brood years (the 1994 to 1996 brood years returning in 1997 to 1999, respectively) exhibiting recruitment failure (recruitment failure is when a given year class of natural spawners fails to replace itself when its offspring return to the spawning grounds 3 years later). These 3 years of recruitment failure were the only such instances observed thus far in the entire 55-year abundance time series for Oregon Coast coho salmon (although comprehensive population-level survey data have only been available since 1980). The 2000 to 2002 increases in natural spawner abundance occurred in many populations in the northern portion of the species, which were the most depressed at the time of the last review (Sandercock, 1991). Although encouraged by the increase in spawner abundance in 2000 to 2002, the biological review team noted that the long-term trends in species productivity were still negative due to the low abundances observed during the 1990s.

Since the biological review team convened, the total abundance of natural spawners in the Oregon Coast coho species has declined each year (i.e., 2003 to 2006). The abundance of total natural spawners in 2006 (111,025

spawners) was approximately 43% of the recent peak abundance in 2002 (255,372 spawners). In 2003, species-level productivity (evaluated in terms of the number of spawning recruits resulting from spawners 3 years earlier) was above replacement, and in 2004, productivity was approximately at replacement level. However, productivity was below replacement in 2005 and 2006 and dropped to the lowest level since 1991 in 2006 (73 FR 7816).

Preliminary spawner survey data for 2007 (the average peak number of spawners per mile observed during random coho spawning surveys in 41 streams) suggest that the 2007 to 2008 return of Oregon Coast coho is either (1) much reduced from abundance levels in 2006, or (2) exhibiting delayed run timing from previous years. As of December 13, 2007, the average peak number of spawners per mile was below 2006 levels in 38 of 41 surveyed streams (see ODFW 2007 *in* 73 FR 7816). It is possible that the timing of peak spawner abundance is delayed relative to previous years, and that increased spawner abundance in late December and January 2008 will compensate for the low levels observed thus far.

The recent 5-year geometric mean abundance (2002 to 2006) of approximately 152,960 total natural spawners remains well above that of a decade ago (approximately 52,845 from 1992 to 1996). However, the decline in productivity from 2003 to 2006, despite generally favorable marine survival conditions and low harvest rates, is of concern (73 FR 7816).

#### **Critical Habitat**

NMFS designated critical habitat for Oregon Coast coho on February 11, 2008 (73 FR 7816). The designation includes 72 of 80 watersheds occupied by Oregon Coast coho salmon, and totals about 6,600 stream miles including all or portions of the Nehalem, Nestucca/Trask, Yaguina, Alsea, Umpqua and Coquille basins. These areas are essential for feeding, migration, spawning and rearing. The specific primary constituent elements include: spawning sites with water and substrate quantity to support spawning, incubation and larval development; freshwater rearing sites with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth, foraging, behavioral development (e.g., predator avoidance, competition) and mobility; freshwater migratory corridors free of obstruction with adequate water quantity and quality conditions; and estuarine, nearshore and offshore areas free of obstruction with adequate water quantity, quality and salinity conditions that support physiological transitions between fresh- and saltwater, predator avoidance, foraging and other life history behaviors.

#### **Sockeye Salmon**

Sockeye salmon are the second most abundant of the seven Pacific salmon species and occur in the North Pacific and Arctic oceans and associated freshwater systems. This species ranges south as far as the Sacramento River in California and northern Hokkaido in Japan, to as far north as Bathurst Inlet in the Canadian Arctic and the Anadyr River in Siberia (Burgner, 1991). The largest populations, and hence the most important commercial populations, occur north of the Columbia River.

The majority of sockeye salmon are anadromous fish that make use of lacustrine habitat for juvenile rearing. Sockeye salmon also have a wholly freshwater life history form, called kokanee (Burgner, 1991). In some cases a single population will give rise to both the anadromous and freshwater life history form. While in fresh water juveniles of both life history types prey primarily upon insects. In coastal lakes, where the migration to sea is relatively short and energetic costs are minimal, kokanee populations are rare.

Once smolts enter the Pacific Ocean, they distribute widely across the North Pacific, generally above 40°N where a current boundary is located. Season, temperature, salinity, life stage, age, size, availability of prey and population-

of-origin are all factors that influence offshore movements (Burgner, 1991). They may migrate several thousand miles in search of prey and are considered to travel continuously (Royce *et al.*, 1968). While at sea, sockeye prey upon a variety of organisms, including small fish (capelin, lantern fish, cod, sand lance, herring and pollock), squid, crustacean larvae, krill and other invertebrates (Foerster, 1968; French *et al.*, 1976; Wing, 1977).

Spawning generally occurs in late summer and autumn, but the precise time can vary greatly among populations. Age at maturity varies by region from 2 to 5 years, but is generally 2 to 4 years in Washington State (Burgner, 1991). Males often arrive earlier than females on the spawning grounds and will persist longer during the spawning period.

Incubation is a function of water temperatures, but generally lasts between 100 and roughly 200 days (Burgner, 1991). After emergence, fry move rapidly downstream or upstream along the banks to the lake rearing area. Fry emerging from lakeshore or island spawning grounds may simply move along the shoreline of the lake (Burgner, 1991).

### Threats

Sockeye salmon have declined under the combined effects of overharvesting; competition from fish raised in hatcheries of native and non-native exotic species; dams that block migration patterns and alter river hydrology; water diversions that deplete water levels in rivers and streams; destruction or adverse modification of riparian habitat; and land use practices that destroy wetland and riparian ecosystems while introducing sediment, nutrients, biocides, metals and other pollutants into surface and ground water and degrade water quality in the fresh water, estuarine and coastal ecosystems throughout the species' range. These threats are the same as those summarized in detail under the Chinook salmon of this section.

### Ozette Lake Sockeye Salmon

This species includes all naturally spawned sockeye salmon in Ozette Lake, Ozette River, Coal Creek and other tributaries flowing into Ozette Lake, Washington. Composed of only one population, the Ozette Lake sockeye salmon species consists of five spawning aggregations or subpopulations which are grouped according to their spawning locations. The five spawning locations are Umbrella and Crooked creeks, Big River and Olsen's and Allen's beaches (NMFS, 2009b).

Adult Ozette Lake sockeye salmon enter Ozette Lake through the Ozette River from mid-April to mid-August, holding three to nine months in Ozette Lake prior to spawning in late October through January. Sockeye salmon spawn primarily in lakeshore upwelling areas in Ozette Lake (particularly at Allen's Bay and Olsen's Beach) and in two tributaries Umbrella Creek and Big River. Minor spawning may occur below Ozette Lake in the Ozette River or in Coal Creek, a tributary of the Ozette River. Beach spawners are almost all age four adults, while tributary spawners are ages three and five (Haggerty *et al.*, 2009). Spawning occurs in the fall through early winter, with peak spawning in tributaries in November and December. Eggs and alevins remain in the gravel until the fish emerge as fry in spring. Fry then migrate immediately to the limnetic zone in Ozette Lake, where the fish rear. After one year of rearing, in late spring, Ozette Lake sockeye salmon emigrate seaward as age-1+ smolts, where they spend between 1 and 3 years in ocean before returning to fresh water.

### Status and Trends

NMFS originally listed Ozette Lake sockeye salmon species as a threatened species in 1999 (64 FR 14528). This classification was retained on June 28, 2005 (70 FR 37160). This species includes all naturally spawned populations of sockeye salmon in Ozette Lake, Ozette River, Coal Creek and other tributaries flowing into Ozette Lake,

Washington. Two artificial propagation programs are considered part of this species: The Umbrella Creek and Big River sockeye salmon hatchery programs. NMFS considers these artificially propagated populations no more divergent relative to the local natural population than would be expected between closely related natural populations (70 FR 37160).

The historical abundance of Ozette Lake sockeye salmon is poorly documented, but may have been as high as 50,000 individuals (Blum, 1988). The overall abundance of naturally-produced Ozette Lake sockeye salmon is believed to have declined substantially from historical levels. In the first study of lake escapement of Ozette Lake sockeye salmon (Kemmerich, 1945), the run size entering the lake was estimated at a level of several thousand fish. These counts appear to be roughly double the current mean lake abundance, considering that they were likely conducted upstream from fisheries in or near to the Ozette River. Makah Fisheries Management (as cited in Good *et al.*, 2005) concluded that there appears to be a substantial decline in the Tribal catch of Ozette Lake sockeye salmon beginning in the 1950s and a similar decline in the run size since the 1920s weir counts reported by Kemmerich (1945).

An analysis of total annual Ozette Lake sockeye salmon abundance (based on adult run size data presented in Jacobs *et al.*, 1996) indicates a trend in abundance averaging -2% per year over the period 1977 through 1998 (NMFS, 1998d). The current tributary-based hatchery program was planned and initiated in response to the declining population trend identified for the Ozette Lake sockeye salmon population. The most recent (1996 to 2003) run-size estimates range from a low of 1,609 in 1997 to a high of 5,075 in 2003, averaging approximately 3,600 sockeye per year (NMFS, 2009b). For return years 2000 to 2003, the 4-year average abundance estimate was slightly over 4,600 sockeye. Because run-size estimates before 1998 are likely to be even more unreliable than recent counts, and new counting technology has resulted in an increase in estimated run sizes, no statistical estimation of trends is reported. The current trends in abundance are unknown for the beach spawning aggregations. Although overall abundance appears to have declined from historical levels, whether this resulted in fewer spawning aggregations, lower abundances at each aggregation, or both, is not known (Good *et al.*, 2005). Based on estimates of habitat carrying capacity, a viable sockeye salmon population in Lake Ozette watershed would range between 35,500 to 121,000 spawners (Rawson *et al.*, 2009).

There has been no harvest of Ozette Lake sockeye salmon for the past four brood-cycle years (since 1982). Prior to that time, ceremonial and subsistence harvests by the Makah Tribe were low, ranging from zero to 84 fish per year. Harvest has not been an important mortality factor for the population in over 35 years. In addition, due to the early river entry timing of returning Ozette Lake sockeye salmon (beginning in late April, with the peak returns prior to late-May to mid-June), the fish are not intercepted in Canadian and U.S. marine area fisheries directed at Fraser River sockeye salmon. There are currently no known marine area harvest impacts on Ozette Lake sockeye salmon.

Overall abundance is substantially below historical levels (Good *et al.*, 2005). Declines in abundance have been attributed to a combination of introduced species, predation, loss of tributary populations, a loss of quality of beach spawning habitat, temporarily unfavorable ocean conditions, habitat degradation and excessive historical harvests (Jacobs *et al.*, 1996). In the last few years the number of returning adults has increased, although some of these individuals are of hatchery origin. This produces uncertainty regarding natural growth rate and productivity of the species' natural component. In addition, genetic integrity has perhaps been compromised due to the artificial supplementation that has occurred in this population, since approximately one million sockeye have been released into the Ozette watershed from the late 1930s to present (Kemmerich, 1945).

### Critical Habitat

On September 2, 2005, NMFS designated critical habitat for the Ozette Lake sockeye salmon species (70 FR 52630). The specific geographic areas designated as critical are the Hoh/Quillayute Subbasin, Ozette Lake and the Ozette Lake watershed, and include: the Ozette River upstream to endpoints in Big River, Coal Creek, East Branch Umbrella Creek, the North and South Fork of Crooked Creek and several other tributaries. The specific primary constituent elements identified for Lake Ozette sockeye salmon are areas for spawning, freshwater rearing and migration, estuarine areas free of obstruction, nearshore marine areas free of obstructions and offshore marine areas with good water quality. The physical or biological features that characterize these sites include water quality and quantity, natural cover, forage and adequate passage conditions. Only one watershed supports this species and it is rated as having a high conservation value. This watershed is essential to the species' overall conservation by protecting quality growth, reproduction and feeding.

### Snake River Sockeye Salmon

Snake River sockeye salmon are unique compared to other sockeye salmon populations: it spawns at a higher elevation (6,500 feet) and a longer freshwater migration (approximately 900 miles) than any other sockeye salmon population in the world. Sockeye salmon in this species spawn in Redfish Lake in Idaho's Stanley Basin (Bjornn *et al.*, 1968; Foerster, 1968). Stanley Basin sockeye salmon are separated by 700 or more river miles from two other extant upper Columbia River populations in the Wenatchee River and Okanogan River drainages. These latter populations return to lakes at substantially lower elevations (Wenatchee at 1,870 feet and Okanogan at 912 feet) and occupy different ecoregions. The Snake River sockeye salmon species includes all anadromous and residual sockeye salmon from the Snake River basin of Idaho, as well as hatchery individuals from the Redfish Lake Captive Broodstock Program.

### Status and Trends

Snake River sockeye salmon were originally listed as endangered in 1991 and retained that classification when their status was reviewed on June 28, 2005 (70 FR 37160). The only extant sockeye salmon population in the Snake River basin at the time of listing was that in Redfish Lake, in the Stanley Basin (upper Salmon River drainage) of Idaho. Other lakes in the Snake River basin historically supported sockeye salmon populations, including Wallowa Lake (Grande Ronde River drainage, Oregon), Payette Lake (Payette River drainage, Idaho) and Warm Lake (South Fork Salmon River drainage, Idaho; (Waples *et al.*, 1997). These populations are now considered extinct. Although kokanee, a resident form of *O. nerka*, occur in numerous lakes in the Snake River basin, other lakes in the Stanley Basin, and sympatrically with sockeye in Redfish Lake, resident *O. nerka* were not considered part of the species at the time of listing (1991). Subsequent to the 1991 listing, a residual form of sockeye residing in Redfish Lake was identified. The residuals are non-anadromous, completing their entire life cycle in fresh water, but spawn at the same time and in the same location as anadromous sockeye salmon. In 1993, NMFS determined that residual sockeye salmon in Redfish Lake were part of the Snake River sockeye salmon. Also, artificially propagated sockeye salmon from the Redfish Lake Captive Propagation program are considered part of this species (70 FR 37160; June 28, 2005).

Five lakes in the Stanley Basin historically contained sockeye salmon: Alturas, Pettit, Redfish, Stanley and Yellowbelly (Bjornn *et al.*, 1968). It is generally believed that adults were prevented from returning to the Sawtooth Valley from 1910 to 1934 by Sunbeam Dam. Sunbeam Dam was constructed on the Salmon River approximately 20 miles downstream of Redfish Lake. Whether Sunbeam Dam was a complete barrier to adult migration remains unknown. It has been hypothesized that some passage occurred while the dam was in place, allowing the Stanley Basin population or populations to persist (Bjornn *et al.*, 1968; Waples *et al.*, 1991).

Adult returns to Redfish Lake during the period 1954 through 1966 ranged from 11 to 4,361 fish (Bjornn *et al.*, 1968). Sockeye salmon in Alturas Lake were extirpated in the early 1900s as a result of irrigation diversions, although residual sockeye may still exist in the lake (Chapman and Witty, 1993). From 1955 to 1965, the Idaho Department of Fish and Game eradicated sockeye salmon from Pettit, Stanley and Yellowbelly lakes, and built permanent structures on each of the lake outlets that prevented re-entry of anadromous sockeye salmon (Chapman and Witty, 1993). In 1985, 1986, and 1987, 11, 29, and 16 sockeye, respectively, were counted at the Redfish Lake weir (Good *et al.*, 2005). Only 18 natural origin sockeye salmon have returned to the Stanley Basin since 1987. During the fall of 1990, during the course of NMFS' first status review on the species, no fish were observed at Lower Granite Dam or entering the lake and only one fish was observed in each of the two previous years. The first adult returns from the captive broodstock program returned to the Stanley Basin in 1999. From 1999 through 2005, a total of 345 captive brood program adults that had migrated to the ocean returned to the Stanley Basin.

Recent annual abundances of natural origin sockeye salmon in the Stanley Basin have been extremely low. No natural origin anadromous adults have returned since 1998 and the abundance of residual sockeye salmon in Redfish Lake is unknown. This species is entirely supported by adults produced through the captive propagation program at the present time. Current smolt-to-adult survival of sockeye originating from the Stanley Basin lakes is rarely greater than 0.3% (Hebdon *et al.*, 2004). The status of this species is extremely precarious, such that there was unanimous consent among the biological review team members that the species remains in danger of extinction (Good *et al.*, 2005).

#### **Critical Habitat**

Critical habitat for these salmon was designated on December 28, 1993 (58 FR 68543) and encompasses the waters, waterway bottoms and adjacent riparian zones of specified lakes and river reaches in the Columbia River that are or were accessible to ESA listed Snake River salmon (except reaches above impassable natural falls and Dworshak and Hells Canyon Dams). Adjacent riparian zones are defined as those areas within a horizontal distance of 300 feet from the normal line of high water of a stream channel or from the shoreline of a standing body of water. Designated critical habitat includes the Columbia River from a straight line connecting the west end of the Clatsop jetty (Oregon side) and the west end of the Peacock jetty (Washington side) and including all river reaches from the estuary upstream to the confluence of the Snake River and all Snake River reaches upstream to the confluence of the Salmon River; all Salmon River reaches to Alturas Lake Creek; Stanley, Redfish, Yellow Belly, Pettit and Alturas Lakes (including their inlet and outlet creeks); Alturas Lake Creek and that portion of Valley Creek between Stanley Lake Creek and the Salmon River. Critical habitat also includes all river lakes and reaches presently or historically accessible to Snake River sockeye salmon. These habitats are critical for the conservation of the species because it provides spawning and juvenile rearing habitat, areas for juvenile growth and development and migration corridors for smolts to the ocean and adults to spawning habitat from the Pacific Ocean. Limiting factors identified for Snake River sockeye include: reduced tributary stream flow, impaired tributary passage and blocks to migration and mainstem Columbia River hydropower system mortality

#### **Steelhead**

Steelhead, the common name of the anadromous form of *O. mykiss*, are native to Pacific Coast streams extending from Alaska south to northwestern Mexico (Moyle, 1976a; NMFS, 1997b). The life history of this species varies considerably throughout its range. Generally, steelhead fall into two races: the stream-maturing type; and the ocean-maturing type.

Summer steelhead enter fresh water between May and October in the Pacific Northwest (Nickelson *et al.*, 1992; Busby *et al.*, 1996). They require cool, deep holding pools during summer and fall, prior to spawning (Nickelson *et al.*, 1992). Summer steelhead migrate inland toward spawning areas, overwinter in the larger rivers, resume migration in early spring to natal streams, and then spawn in January and February (Barnhart, 1986; Meehan and Bjornn, 1991; Nickelson *et al.*, 1992). Winter steelhead enter fresh water between November and April in the Pacific Northwest (Nickelson *et al.*, 1992), migrate to spawning areas and spawn generally between April and May (Barnhart, 1986). Some adults, however, do not enter some coastal streams until spring, just before spawning (Meehan and Bjornn, 1991).

In late spring, after emerging from the gravel, fry usually inhabit shallow water along banks of perennial streams (Nickelson *et al.*, 1992). Summer rearing takes place primarily in the faster parts of pools, while winter rearing occurs more uniformly at lower densities across a wide range of fast and slow habitat types. Some older juveniles move downstream to rear in larger tributaries and mainstem rivers (Nickelson *et al.*, 1992).

There is a high degree of overlap in spawn timing between populations regardless of run type (Busby *et al.*, 1996). Difficult field conditions at that time of year and the remoteness of spawning grounds contribute to the relative lack of specific information on steelhead spawning. Unlike Pacific salmon, steelhead are capable of spawning more than once before death, although steelhead rarely spawn more than twice before dying; most that do spawn more than twice tend to be female (Nickelson *et al.*, 1992; Busby *et al.*, 1996).

Juvenile steelhead migrate little during their first summer and occupy a range of habitats featuring moderate to high water velocity and variable depths (Bisson *et al.*, 1988). Steelhead hold territories close to the substratum where flows are lower and sometimes counter to the main stream; from these, they can make forays up into surface currents to take drifting food (Kalleberg 1958). Juveniles rear in fresh water from 1 to 4 years, then smolt and migrate to the ocean in March and April (Barnhart, 1986). Winter steelhead juveniles generally smolt after 2 years in fresh water (Busby *et al.*, 1996). Juveniles feed primarily on insects (chironomids, baetid mayflies and hydropsychid caddisflies (Merz, 1994) while adults feed on aquatic and terrestrial insects, mollusks, crustaceans, fish eggs, minnows and other small fishes (Chapman and Bjornn, 1969) .

### Threats

*Natural Threats.* Steelhead, like other salmon, are exposed to high rates of natural predation each stage of their life stage. Mortality is high early in life and decreases with age. For example, Puget Sound steelhead leaving freshwater and estuarine habitats experience 55-86% survival to the point of reaching Hood Canal and 0-49% from Hood Canal to the Strait of Juan de Fuca, with survival increasing greatly upon entering the Pacific Ocean (Moore *et al.*, 2010). In fresh water, fry fall prey to older steelhead and other trout, as well as birds, sculpin and various mammals. In the ocean, marine mammals and other fish prey on steelhead but the extent of such predation is not well known.

*Anthropogenic Threats.* Steelhead have declined under the combined effects of overharvests in fisheries, competition from hatchery fish and exotic species, dams that block their migrations and alter river hydrology, hydrogeomorphological changes, destruction or degradation of riparian habitat and land use practices that destroy or degrade fresh water, estuarine and coastal ecosystems throughout the species' range. These threats are the same as those summarized in detail under the Chinook salmon of this section.

### Central California Coast Steelhead

The Central California Coast steelhead species includes all naturally spawned anadromous steelhead populations below natural and manmade impassable barriers in California streams from the Russian River (inclusive) to Aptos

Creek (inclusive), and the drainages of San Francisco, San Pablo, and Suisun Bays eastward to Chipps Island at the confluence of the Sacramento and San Joaquin Rivers. Tributary streams to Suisun Marsh including Suisun Creek, Green Valley Creek, and an unnamed tributary to Cordelia Slough (commonly referred to as Red Top Creek), excluding the Sacramento-San Joaquin River Basin, as well as two artificial propagation programs: the Don Clausen Fish Hatchery, and Kingfisher Flat Hatchery/ Scott Creek (Monterey Bay Salmon and Trout Project) steelhead hatchery programs.

The species is entirely composed of winter run fish, as are those species to the south. As winter-run fish adults migrating upstream from December-April, and smolts emigrating between March-May (Shapovalov and Taft, 1954; Hayes *et al.*, 2008). At the time of the 1996 status review and 1997 listing, little information was available on the specific demographics and life history characteristics of steelhead in this species. While age at smoltification typically ranges from one to four years, recent studies by Sogard and Williams (2009) that growth rates in Soquel Creek likely prevent juveniles from undergoing smoltification until age 2. Survival in freshwater reaches tends to be higher in summer and lower from winter through spring for year classes zero and one (Sogard *et al.*, 2009). Larger individuals also survive more readily than do smaller fish within year classes (Sogard *et al.*, 2009). Greater movement of juveniles in fresh water has been observed in winter and spring versus summer and fall time periods, with smaller individuals more likely to move between stream areas (Sogard *et al.*, 2009). Growth rates during this time have rarely been observed to exceed 0.3 mm per day and are highest in winter through spring, potentially due to higher water flow rates and greater food availability (Boughton *et al.*, 2007; Hayes *et al.*, 2008; Sogard *et al.*, 2009).

#### Status and Trends

The Central California Coast steelhead species was listed as a threatened species on August 18, 1997 (62 FR 43937); threatened status was reaffirmed on January 5, 2006 (71 FR 834). Estimates of historical abundance are provided here only for background, as the accuracy of the estimates is unclear. An estimate of historical abundance for the species is provided by CDFG at 94,000 fish. This estimate is based on a partial data set and “best professional judgment” (see Good *et al.*, 2005). Other estimates of historical abundance are on a per river basis: Shapovalov and Taft (1954) (as cited in Busby *et al.*, 1996) described an average of about 500 adults in Waddell Creek (Santa Cruz County) for the 1930s and early 1940s.

No current estimates of total population size are available for this species, and consequently there is no time series data available to evaluate the central California coast steelhead population trends. Rather, a general lack of data on adult steelhead within the species, led the biological review team to examine data collected on juvenile steelhead (see Good *et al.*, 2005). In general, juvenile data is considered a poor indicator of the reproductive portion of the population as juvenile age classes exhibit greater mortality rates, which are closely tied to stochastic events, and may move widely within a basin (which may include intermixing with other populations). There is no simple relationship between juvenile and adult numbers (Shea and Mangel, 2001). Nonetheless, there was not enough adult data upon which the biological review team could base an assessment of the population trends within the species. Therefore, the biological review team log transformed and normalized juvenile survey data from a number of watersheds (presumed populations). As a result, the team derived trend estimates for five populations: the San Lorenzo River, Scott Creek, Waddell Creek, Gazos Creek and Redwood Creek in Marin County (see Good *et al.*, 2005). All populations exhibited downward trends in abundance. Accordingly, provided the juvenile data is representative of the true trend, this data suggests that there is an overall downward trend in abundance in the species.

In the most recent review of the status of this species, most members of the biological review team (69%)

considered this species “likely to become endangered” thus supporting the renewal of the threatened status for central California coast steelhead. Notably, 25% of the team voted that the species be upgraded to endangered status (see Good *et al.*, 2005). Abundance and productivity were of relatively high concern (as a contributing factor to risk of extinction) and spatial structure was also of concern.

Since the original status review, fishing regulations have changed in a way that probably reduces extinction risk for Central California Coast steelhead. Ocean sport harvest is prohibited and ocean harvest is considered rare. Although freshwater streams are closed to fishing year round, CDFG has identified certain streams as exceptions where they allow catch-and-release angling or summer trout fishing. In catch-and-release streams, all wild steelhead must be released unharmed.

### **Critical Habitat**

Critical habitat was designated for the Central California Coast steelhead species on September 2, 2005 (70 FR 52488) and includes areas within the following hydrologic units: Russian River, Bodega, Marin Coastal, San Mateo, Bay Bridge, Santa Clara, San Pablo and Big Basin. These areas are important for the species’ overall conservation by protecting quality growth, reproduction and feeding. The critical habitat designation for this species identifies primary constituent elements that include sites necessary to support one or more steelhead life stages. Specific sites include freshwater spawning sites, freshwater rearing sites, freshwater migration corridors, nearshore marine habitat and estuarine areas. The physical or biological features that characterize these sites include water quality and quantity, natural cover, forage, adequate passage conditions and floodplain connectivity. The critical habitat designation (70 FR 52488) contains additional details on the sub-areas that are included as part of this designation and the areas that were excluded from designation.

In total, Central California Coast steelhead occupy 46 watersheds (fresh water and estuarine). The total area of habitat designated as critical includes about 1,500 miles of stream habitat and about 400 square miles of estuarine habitat (principally Humboldt Bay). This designation includes the stream channels within the designated stream reaches and includes a lateral extent as defined by the ordinary high water line. In areas where the ordinary high-water line is not defined the lateral extent is defined as the bankfull elevation. In estuarine areas the lateral extent is defined by the extreme high water because extreme high tide areas encompass those areas typically inundated by water and regularly occupied by juvenile salmon during the spring and summer, when they are migrating in the nearshore zone and relying on cover and refuge qualities provided by these habitats and while they are foraging. Of the 46 occupied watersheds reviewed in NMFS’ assessment of critical habitat for Central California Coast steelhead, 14 watersheds received a low rating of conservation value, 13 received a medium rating and 19 received a high rating of conservation value for the species.

### **California Central Valley Steelhead**

California Central Valley steelhead salmon occupy the Sacramento and San Joaquin Rivers and their tributaries, although they were once widespread throughout the Central Valley (Busby *et al.*, 1996; Zimmerman *et al.*, 2009). Steelhead were found from the upper Sacramento and Pit River systems (now inaccessible due to Shasta and Keswick Dams), south to the Kings and possibly the Kern River systems (now inaccessible due to extensive alteration from water diversion projects) and in both east- and west-side Sacramento River tributaries (Yoshiyama *et al.*, 1996). The present distribution has been greatly reduced (McEwan and Jackson, 1996). The CACSS (1988) reported a reduction of steelhead habitat from 6,000 miles historically to 300 miles today. Historically, steelhead probably ascended Clear Creek past the French Gulch area, but access to the upper basin was blocked by Whiskeytown Dam in 1964 (Yoshiyama *et al.*, 1996). Steelhead also occurred in the upper drainages of the Feather,

American, Yuba and Stanislaus Rivers which are now inaccessible (McEwan and Jackson, 1996; Yoshiyama *et al.*, 1996).

Existing wild steelhead populations in the Central Valley are mostly confined to the upper Sacramento River and its tributaries, including Antelope, Deer, and Mill Creeks and the Yuba River. Populations may exist in Big Chico and Butte Creeks and a few wild steelhead are produced in the American and Feather Rivers (McEwan and Jackson, 1996). Recent snorkel surveys (1999 to 2002) indicate that steelhead are present in Clear Creek (Good *et al.*, 2005). Because of the large resident *O. mykiss* population in Clear Creek, steelhead spawner abundance has not been estimated. Until recently, steelhead were thought to be extirpated from the San Joaquin River system. Recent monitoring has detected small self-sustaining populations of steelhead in the Stanislaus, Mokelumne, Calaveras and other streams previously thought to be void of steelhead (McEwan, 2001). On the Stanislaus River, steelhead smolts have been captured in rotary screw traps at Caswell State Park and Oakdale each year since 1995 (Demko and Cramer, 2000). It is possible that naturally spawning populations exist in many other streams but are undetected due to lack of monitoring programs.

The Sacramento and San Joaquin Rivers offer the only migration route to the drainages of the Sierra Nevada and southern Cascade mountain ranges for anadromous fish. The CDFG considers all steelhead in the Central Valley as winter steelhead, although “three distinct runs,” including summer steelhead, may have occurred there as recently as 1947 (McEwan and Jackson, 1996). Steelhead in these basins travel extensive distances in fresh water (some exceed 300 km to their natal streams), making these the longest freshwater migrations of any population of winter steelhead. The upper Sacramento River essentially receives a single continuous run of steelhead in from July through May, with peaks in September and February. Spawning begins in late December and can extend into April (McEwan and Jackson, 1996).

#### Status and Trends

NMFS originally listed California Central Valley steelhead as threatened in 1998; this status was reviewed and retained on January 5, 2006 (71 FR 834). Historic Central Valley steelhead run size is difficult to estimate given the paucity of data, but may have approached one to two million adults annually (McEwan, 2001). By the early 1960s, the steelhead run size had declined to about 40,000 adults (McEwan, 2001). Over the past 30 years, the naturally spawned steelhead populations in the upper Sacramento River have declined substantially. Hallock *et al.*, (1961) estimated an average of 20,540 adult steelhead occurred in the Sacramento River (upstream of the Feather River). Steelhead counts at Red Bluff Diversion Dam declined from an average of 11,187 for the period of 1967 to 1977, to an average of approximately 2,000 through the early 1990s, with an estimated total annual run size for the entire Sacramento-San Joaquin system at no more than 10,000 adults (McEwan and Jackson, 1996; McEwan, 2001). The five-year geometric mean is approximately 2,000 steelhead and the long-term trend suggests that the population is declining (Good *et al.*, 2005).

The only consistent data available on steelhead numbers in the San Joaquin River basin come from CDFG mid-water trawling samples collected on the lower San Joaquin River at Mossdale. These data indicate a decline in steelhead numbers in the early 1990s, which have remained low through 2002 (Good *et al.*, 2005). In 2004, a total of 12 steelhead smolts were collected at Mossdale (Good *et al.*, 2005).

Reynolds *et al.*, (1993) reported that 95% of salmonid habitat in California’s Central Valley has been lost, largely due to mining and water development activities. They also noted that declines in Central Valley steelhead populations are “due mostly to water development, inadequate instream flows, rapid flow fluctuations, high summer water temperatures in streams immediately below reservoirs, diversion dams which block access and entrainment of

juveniles into unscreened or poorly screened diversions.” Thus, overall habitat problems in this species relate primarily to water development resulting in inadequate flows, flow fluctuations, blockages and entrainment into diversions (McEwan and Jackson, 1996). Other problems related to land use practices (agriculture and forestry) and urbanization have also contributed to population declines. It is unclear how harvest has affected California’s Central Valley steelhead, although it is likely a continuing threat. A CDFG creel census in 2000 indicated that most fish are caught and released, but due to the size of the catch and release fishery (more than 14,000 steelhead were caught and released according to the survey) even a small amount of mortality in this fishery could cause declines in the populations.

### **Critical Habitat**

NMFS designated critical habitat for California Central Valley steelhead on September 2, 2005 (70 FR 52488). Specific geographic areas designated include the following CALWATER hydrological units: Tehama, Whitmore, Redding, Eastern Tehama, Sacramento Delta, Valley-Putach-Cache, American River, Marysville, Yuba, Valley American, Colusa Basin, Butte Creek, Ball Mountain, Shasta Bally, North Valley Floor, Upper Calaveras, Stanislaus River, San Joaquin Valley, Delta-Mendota Canal, North Diablo Range and the San Joaquin Delta. These areas are important for the species’ overall conservation by protecting quality growth, reproduction and feeding. The critical habitat designation for this species identifies primary constituent elements that include sites necessary to support one or more steelhead life stages. Specific sites include freshwater spawning sites, freshwater rearing sites, freshwater migration corridors, nearshore marine habitat and estuarine areas. The physical or biological features that characterize these sites include water quality and quantity, natural cover, forage, adequate passage conditions and floodplain connectivity. The critical habitat designation (70 FR 52488) contains additional details on the sub-areas that are included as part of this designation and the areas that were excluded from designation.

In total, California Central Valley steelhead occupy 67 watersheds (freshwater and estuarine). The total area of habitat designated as critical includes about 2,300 miles of stream habitat and about 250 square miles of estuarine habitat in the San Francisco-San Pablo-Suisan Bay estuarine complex. This designation includes the stream channels within the designated stream reaches and includes a lateral extent as defined by the ordinary high water line. In areas where the ordinary high-water line is not defined the lateral extent is defined as the bankfull elevation. In estuarine areas the lateral extent is defined by the extreme high water because extreme high tide areas encompass those areas typically inundated by water and regularly occupied by juvenile salmon during the spring and summer, when they are migrating in the nearshore zone and relying on cover and refuge qualities provided by these habitats and while they are foraging. Of the 67 watersheds reviewed in NMFS’ assessment of critical habitat for California Central Valley steelhead, seven watersheds received a low rating of conservation value, three received a medium rating and 27 received a high rating of conservation value for the species.

### **Lower Columbia River Steelhead**

Lower Columbia River steelhead include naturally produced steelhead returning to Columbia River tributaries on the Washington side between the Cowlitz and Wind rivers in Washington and on the Oregon side between the Willamette and Hood rivers, inclusive. In the Willamette River, the upstream boundary of this species is at Willamette Falls. This species includes both winter and summer steelhead. Two hatchery populations are included in this species, the Cowlitz Trout Hatchery winter-run population and the Clackamas River population but neither was listed as threatened

Summer steelhead return sexually immature to the Columbia River from May to November and spend several months in fresh water prior to spawning. When winter steelhead enter fresh water from November to April, they are

close to sexual maturity and spawn shortly after arrival in their natal streams. Where both races spawn in the same stream, summer steelhead tend to spawn at higher elevations than the winter forms (see Good *et al.*, 2005).

### Status and Trends

NMFS listed Lower Columbia River steelhead as threatened on March 19, 1998 (63 FR 13347), and reaffirmed their status as threatened on January 5, 2006 (71 FR 834). The 1998 status review noted that this species is characterized by populations at low abundance relative to historical levels, significant population declines since the mid-1980s, and widespread occurrence of hatchery fish in naturally spawning steelhead populations. During this review NMFS was unable to identify any natural populations that would be considered at low risk.

All populations declined between 1980 and 2000, with sharp declines beginning in 1995. Those with adequate data for modeling are estimated to have a high extinction risk (Good *et al.*, 2005). Abundance trends are generally negative, showing that most populations are in decline, although some populations, particularly summer run, have shown higher return in the last 2 to 3 years (Good *et al.*, 2005). Historical counts in some of the larger tributaries (Cowlitz, Kalama and Sandy Rivers) suggest the population probably exceeded 20,000 fish while in the 1990s fish abundance dropped to 1,000 to 2,000. Recent abundance estimates of natural-origin spawners range from completely extirpated for some populations above impassable barriers to over 700 for the Kalama and Sandy winter-run populations (Good *et al.*, 2005). A number of the populations have a substantial fraction of hatchery-origin spawners in spawning areas and are hypothesized to be sustained largely by hatchery production. Exceptions are the Kalama, the Toutle and East Fork Lewis winter-run populations (Good *et al.*, 2005).

### Critical Habitat

NMFS designated critical habitat for Lower Columbia River steelhead on September 2, 2005 (70 FR 52630). Designated critical habitat includes the following subbasins: Middle Columbia/Hood subbasin, Lower Columbia/Sandy subbasin, Lewis subbasin, Lower Columbia/Clatskanie subbasin, Upper Cowlitz subbasin, Cowlitz subbasin, Clackamas subbasin, Lower Willamette subbasin and the Lower Columbia River corridor. These areas are important for the species' overall conservation by protecting quality growth, reproduction and feeding. The critical habitat designation for this species identifies primary constituent elements that include sites necessary to support one or more steelhead life stages. Specific sites include freshwater spawning sites, freshwater rearing sites, freshwater migration corridors, nearshore marine habitat and estuarine areas. The physical or biological features that characterize these sites include water quality and quantity, natural cover, forage, adequate passage conditions and floodplain connectivity. The critical habitat designation (70 FR 52630) contains additional description of the watersheds that are included as part of this designation and any areas specifically excluded from the designation.

In total, Lower Columbia River steelhead occupy 32 watersheds. The total area of habitat designated as critical includes about 2,340 miles of stream habitat. This designation includes the stream channels within the designated stream reaches and includes a lateral extent as defined by the ordinary high water line. In areas where the ordinary high-water line is not defined the lateral extent is defined as the bankfull elevation. Of the 32 watersheds reviewed in NMFS' assessment of critical habitat for Lower Columbia River steelhead, two watersheds received a low rating of conservation value, 11 received a medium rating and 26 received a high rating of conservation value for the species. Limiting factors identified for Lower Columbia River steelhead include: degraded floodplain and stream channel structure and function, reduced access to spawning/rearing habitat, altered stream flow in tributaries, excessive sediment and elevated water temperatures in tributaries and hatchery impacts.

### Middle Columbia River Steelhead

The Middle Columbia River steelhead species includes all naturally spawned anadromous steelhead populations

below natural and manmade impassible barriers in Oregon and Washington drainages upstream of the Hood and Wind River systems, up to and including the Yakima River (61 FR 41541). Steelhead from the Snake River Basin are excluded from this species. Seven artificial propagation programs are part of this species.

Middle Columbia River steelhead occupy the intermountain region of the Pacific Northwest, which includes some of the driest areas in the region generally receiving less than 15.7 inches of rainfall annually. The major drainages that support this species are the Deschutes, John Day, Umatilla, Walla Walla, Yakima and Klickitat river systems. The area is generally characterized by its dry climate and harsh temperature extremes. Almost all steelhead populations within this species are summer-run fish; the only exceptions are the only populations of inland winter steelhead, which occur in the Klickitat River and Fifteen-mile Creek (Busby *et al.*, 1996). According to Interior Columbia Basin Technical Recovery Team (ICTRT, 2003) this species is comprised of 16 putative populations in four major population groups (Cascades Eastern Slopes Tributaries, John Day River, Walla Walla and Umatilla Rivers, and Yakima River) and one unaffiliated independent population (Rock Creek).

There are two extinct populations in the Cascades Eastern Slope major population group, the White Salmon River and Deschutes Crooked River above the Pelton/Round Butte Dam complex. Present population structure is delineated largely based on geographical proximity, topography, distance, ecological similarities or differences. Additional genetic studies are needed to describe the species substructure, as well as the fine-scale genetic structure of the populations within a particular basin (e.g., John Day River).

Most Middle Columbia River steelhead smolt at 2 years of age and spend 1 to 2 years at sea prior to re-entering natal river systems. They may remain in such rivers for up to a year prior to spawning (Howell *et al.*, 1985b). Factors contributing to the decline of Middle Columbia river steelhead include hydropower development and agriculture; these land uses impede or prevent migrations, alter water availability and alter water chemistry and temperatures.

### Status and Trends

Middle Columbia River steelhead were listed as threatened in 1999 (64 FR 14517), and their status was reaffirmed on January 5, 2006 (71 FR 834). The precise pre-1960 abundance of this species is unknown. Based upon the Washington Department of Fish and Wildlife's estimates of the historic run size for the Yakima River at 100,000 steelhead, Busby *et al.*, (1996) surmised that total species abundance likely exceeded 300,000 returning adults. By 1993, the estimated 5-year average size (ending in 1993) of the Middle Columbia steelhead species was 142,000 fish (Busby *et al.*, 1996). Survey data collected between 1997 and 2001 indicates that several populations within the species have increased since the last status review (Good *et al.*, 2005). However, long-term annual population growth rate ( $\lambda$ ) is negative for most populations.

In contrast, short term trends in major areas were positive for seven of the 12 areas with available data (see Good *et al.*, 2005). Spawner numbers in the Yakima River, the Deschutes River and sections of the John Day River system were substantially higher compared to numbers surveyed between 1992 and 1997 (Good *et al.*, 2005). Similarly, spawner numbers substantially increased in the Umatilla River and Fifteen-mile Creek relative to annual levels in the early 1990s. Nonetheless, most populations remain below interim target levels. For instance, the Yakima River returns are still substantially below interim target levels of 8,900 (the current 5-year average is 1,747 fish) and estimated historical return levels. In fact, the majority of spawning occurs in only one tributary, Satus Creek (Berg, 2001 as cited in Good *et al.*, 2005). Based on recent 5-year geometric means, only the Deschutes River exceeded interim target levels (Good *et al.*, 2005). While increases in short-term trends could suggest improvements within the species, given that the average population growth rate across all streams is negative (0.98 assuming hatchery

spawners do not contribute to production, and 0.97 assuming that both hatchery and natural-origin fish contribute equally) and evidence of large fluctuation in marine survival for the species, recent increases in population sizes must be viewed cautiously (Good *et al.*, 2005).

### **Critical Habitat**

NMFS designated critical habitat for Middle Columbia River steelhead on September 2, 2005 (70 FR 52630). Designated critical habitat includes the following subbasins: Upper Yakima, Naches, Lower Yakima, Middle Columbia/Lake Wallula, Walla Walla, Umatilla, Middle Columbia/Hood, Klickitat, Upper John Day, North Fork John Day, Middle Fork John Day, Lower John Day, Lower Deschutes, Trout, and the Upper Columbia/Priest Rapids subbasins and the Columbia River corridor. These areas are important for the species' overall conservation by protecting quality growth, reproduction and feeding. The critical habitat designation for this species identifies primary constituent elements that include sites necessary to support one or more steelhead life stages. Specific sites include freshwater spawning sites, freshwater rearing sites, freshwater migration corridors, nearshore marine habitat and estuarine areas. The physical or biological features that characterize these sites include water quality and quantity, natural cover, forage, adequate passage conditions and floodplain connectivity. The final rule (70 FR 52630) lists the watersheds that comprise the designated subbasins and any areas that are specifically excluded from the designation.

In total, there are 114 watersheds within the range of Middle Columbia River steelhead. The total area of habitat designated as critical includes about 5,800 miles of stream habitat. This designation includes the stream channels within the designated stream reaches and includes a lateral extent as defined by the ordinary high water line. In areas where the ordinary high-water line is not defined the lateral extent is defined as the bankfull elevation. Of the 114 watersheds reviewed in NMFS' assessment of critical habitat for Middle Columbia River steelhead, nine watersheds received a low rating of conservation value, 24 received a medium rating and 81 received a high rating of conservation value for the species. Although pristine habitat conditions are still present in some wilderness, roadless and undeveloped areas, habitat complexity has been greatly reduced in many areas of designated critical habitat for Middle Columbia River steelhead. Limiting factors identified for Middle Columbia River steelhead include: hydropower system mortality, reduced stream flow, impaired passage, excessive sediment, degraded water quality and altered channel morphology and floodplain.

### **Northern California Steelhead**

The Northern California species of steelhead includes all naturally spawned steelhead populations below natural and manmade impassible barriers in California coastal river basins from Redwood Creek south to, but not including the Russian river and two artificial propagation programs (Yager Creek Hatchery and North Fork Gualala River Hatchery). In the recent update on the status of this species, the southern boundary of the species was redefined to include the small coastal streams south of the Gualala River (between the Gualala River and the Russian River) that support steelhead. This species consists of winter and summer-run fish, as well as "half-pounders" – a steelhead that returns from the sea after spending less than a year in the ocean.

### **Status and Trends**

NMFS listed Northern California steelhead as threatened on June 7, 2000 (65 FR 36074), and reaffirmed their status as threatened on January 5, 2006 (71 FR 834). Long-term data sets are limited for Northern California steelhead. Before 1960, estimates of abundance specific to this species were available from dam counts in the upper Eel River (Cape Horn Dam; annual average number of adults was 4,400 in the 1940s), the South Fork Eel River (Benbow Dam; annual average number of adults was 18,000 in the 1940s) and the Mad River (Sweasey Dam; annual average

number of adults was 3,800 in the 1940s). According to California Department of Fish & Game nearly 200,000 spawning steelhead may have comprised this species in the early 1960s (Good *et al.*, 2005). At the time of the first status review on this population, adult escapement trends could be calculated for seven populations. Five of the seven populations exhibited declines, while two exhibited increases with a range of almost 6% annual decline to a 3.5% increase. At the time, little information was available on the actual contribution of hatchery fish to natural spawning, there was and continues to be insufficient information to calculate an overall abundance estimate for Northern California steelhead (Busby *et al.*, 1996).

Recent time series data is also limited for this species, with recent abundance estimates available for only four populations, three summer-run and one winter-run. Similarly, Good *et al.*, (2005) could only calculate the population growth rate for three populations. Population growth rates are negative for two of the three populations, the South Fork Eel River winter-run and the Middle Fork Eel River summer-run. Based on time series data for the Middle Fork Eel River, both the long-term and short-term trends are downward. Due to the lack of adult data on which to base their risk assessment, Good *et al.*, (2005) also examined data on juvenile steelhead and found both upward and downward trends. The lack of data for the populations within this species, particular winter-run fish is of continuing concern.

#### **Critical Habitat**

NMFS designated critical habitat for Northern California steelhead on September 2, 2005 (70 FR 52488). Specific geographic areas designated include the following CALWATER hydrological units: Redwood Creek, Trinidad, Mad River, Eureka Plain, Eel River, Cape Mendocino and the Mendocino Coast. These areas are important for the species' overall conservation by protecting quality growth, reproduction and feeding. The critical habitat designation for this species identifies primary constituent elements that include sites necessary to support one or more steelhead life stages. Specific sites include freshwater spawning sites, freshwater rearing sites, freshwater migration corridors, nearshore marine habitat and estuarine areas. The physical or biological features that characterize these sites include water quality and quantity, natural cover, forage, adequate passage conditions and floodplain connectivity. The critical habitat designation (70 FR 52488) contains additional details on the sub-areas that are included as part of this designation and the areas that were excluded from designation.

In total, Northern California steelhead occupy 50 watersheds (fresh water and estuarine). The total area of habitat designated as critical includes about 3,000 miles of stream habitat and about 25 square miles of estuarine habitat, mostly within Humboldt Bay. This designation includes the stream channels within the designated stream reaches and includes a lateral extent as defined by the ordinary high water line. In areas where the ordinary high-water line is not defined the lateral extent is defined as the bankfull elevation. In estuarine areas the lateral extent is defined by the extreme high water because extreme high tide areas encompass those areas typically inundated by water and regularly occupied by juvenile salmon during the spring and summer, when they are migrating in the nearshore zone and relying on cover and refuge qualities provided by these habitats and while they are foraging. Of the 50 watersheds reviewed in NMFS' assessment of critical habitat for Northern California steelhead, nine watersheds received a low rating of conservation value, 14 received a medium rating and 27 received a high rating of conservation value for the species. Two estuarine areas used for rearing and migration (Humboldt Bay and the Eel River estuary) also received a rating of high conservation value.

#### **Puget Sound Steelhead**

The Puget Sound species for steelhead includes all naturally spawned anadromous winter-run and summer-run steelhead populations in watersheds of the Strait of Juan de Fuca, Puget Sound and Hood Canal, Washington.

Boundaries of this species extend to and include the Elwha River to the west and the Nooksack River and Dakota Creek to the north. Hatchery production of steelhead is widespread throughout this species, but only two artificial propagation programs are part of this species: the Green River natural and Hamma Hamma winter-run steelhead hatchery populations. The remaining hatchery programs are not considered part of the Puget Sound steelhead species because they are more than moderately diverged from the local native populations (Hard *et al.*, 2007).

The oceanic distribution of Puget Sound steelhead is not well understood. Winter and summer runs from multiple steelhead species comingle in the North Pacific Ocean and some may undergo extensive migrations as a result of the location of their natal streams and oceanic “centers of abundance” (Light *et al.*, 1989). Tagging and genetic studies indicate that Puget Sound steelhead migrate to the central North Pacific ocean (see French *et al.* 1975, Hartt and Dell 1986, and Burgner *et al.* 1992 in Hard *et al.*, 2007). Oceanic residence times varies among populations within the species, with some populations spending only one season in the ocean and others spending three years in marine waters before returning to their natal stream for spawning. Generally, winter-run steelhead enter their natal freshwater systems later (November to April) in the year than summer-run steelhead (May to October). Winter-run steelhead have a lower pre-spawn mortality rate than summer-run steelhead (Hard *et al.*, 2007). Winter-run steelhead are also more prevalent than summer-run fish, comprising 37 of the 53 populations within this species.

#### Status and Trends

NMFS listed Puget Sound steelhead as a threatened species on May 11, 2007 (72 FR 26722). At the time of the listing, the biological review team concluded that: the viability of Puget Sound steelhead is at a high risk due to declining productivity and abundance; Puget Sound steelhead are at moderate risk due to reduced spatial complexity and connectivity among populations within the species and reduction in life-history diversity within populations and from the threats posed by artificial propagation and harvest. The Puget Sound steelhead species includes 53 putative populations; most of which are composed of winter-run fish. Summer-run populations within Puget Sound are small, with most averaging less than 200 spawners and most lack sufficient data to estimate population abundance (Hard *et al.*, 2007).

In general, steelhead are most abundant in the northern Puget Sound streams (Hard *et al.*, 2007). The largest populations in this species are in the Skagit River and Snohomish River winter-run steelhead populations. The recent geometric mean escapement is 5,608 winter-run steelhead in the Skagit, and 3,230 winter-run steelhead in the Snohomish River (Hard *et al.*, 2007). The Green River and Puyallup River populations, in central Puget Sound, are the next largest populations and average approximately 1,500 (Green) and 1,000 (Puyallup) winter-run steelhead spawners annually (Hard *et al.*, 2007).

Estimates of historical abundance for this species are largely based on catch data. The earliest catch records from commercial fisheries in the late 1880s indicate that the catch peaked at 163,796 steelhead in Puget Sound in 1895 (Hard *et al.*, 2007). Based on this catch data, estimates for the peak run size for Puget Sound steelhead ranges between 300,000 and 550,000 fish (Hard *et al.*, 2007). Given that most fish were harvested in terminal fisheries (nets set at the mouth of rivers) NMFS expects that this estimate is a fair estimate of the Puget Sound species as it is unlikely to include fish from neighboring rivers outside of the Puget Sound species. As early as 1898, Washington officials expressed concerns that the run had declined by half of its size in only three years (Hard *et al.*, 2007). Since 1925, Washington has managed steelhead as a game fish, and in 1932 the State prohibited the commercial catch, possession or sale of steelhead.

Run size for this species was calculated in the early 1980s at about 100,000 winter-run fish and 20,000 summer-run fish. It is not clear what portion were hatchery fish, but a combined estimate with coastal steelhead suggested that

roughly 70% of steelhead in ocean runs were of hatchery origin. Escapement of wild fish to spawning grounds would be much lower without the influx of hatchery fish (Busby *et al.*, 1996).

NMFS' first status review for Puget Sound steelhead demonstrated that 80% of the runs for which there was data had declining trends in abundance. Busby *et al.*, (1996) noted that the largest decline, an 18% annual decline, occurred in the Lake Washington population. On the contrary, the largest increase in abundance occurred in the Skykomish River winter-run steelhead (the Skykomish River is a tributary to the Snohomish River) at a 7% annual increase. Estimates of spawner abundance in the Skagit and Snohomish rivers, the two largest steelhead producing basins in the species, were about 8,000 naturally spawning adult steelhead each. These two basins exhibited modest overall upward trends at the time of the first status review. Recent data demonstrates significant declines in the natural escapement of steelhead throughout the species, especially in the southern Puget Sound populations. Significant positive trends have occurred in the Samish and the Hamma Hamma winter-run populations. The increasing trend in the Hamma Hamma River appears to be the result of a captive rearing program, rather than due to natural escapement. The predominant downward trends in escapement and run size of natural steelhead in the Puget Sound species, both over the long-term and short-term, is of concern particularly given that despite widespread reductions in direct harvest since the mid 1990s (Hard *et al.*, 2007).

#### Critical Habitat

NMFS has not designated critical habitat for Puget Sound steelhead.

#### Snake River Steelhead

The Snake River Basin steelhead species includes all naturally spawned populations of steelhead in streams in the Snake River basins of southeast Washington, northeast Oregon and Idaho. Six artificial propagation programs are considered part of this species: The Tucannon River, Dworshak National Fish Hatchery, Lolo Creek, North Fork Clearwater, East Fork Salmon River and the Little Sheep Creek/Imnaha river hatchery programs.

Snake River Basin steelhead are distributed throughout the Snake River drainage basin, migrating a considerable distance from the ocean to use high-elevation tributaries (typically 1,000-2,000 m above sea level) (Good *et al.*, 2005). Generally classified as summer-run fish, Snake River steelhead enter the Columbia River from late June to October. (Good *et al.*, 2005) After remaining in the river through the winter, Snake River steelhead spawn the following spring (March to May) (Good *et al.*, 2005). Managers recognize two life history patterns within Snake River steelhead primarily based on ocean age and adult size upon return: A-run steelhead are typically smaller, have a shorter fresh water and ocean residence (generally 1 year in the ocean) , and begin their up-river migration earlier in the year; whereas B-run steelhead are larger, spend more time in fresh water and the ocean (generally 2-years in ocean) and appear to start their upstream migration later in the year (Good *et al.*, 2005).

#### Status and Trends

NMFS listed Snake River steelhead as threatened in 1997 (62 FR 43937), and reaffirmed their status as threatened on January 5, 2006 (71 FR 834). NMFS 1997 status review identified sharp declines in the returns of naturally produced steelhead, beginning in the mid-1980s. At the time nine of 13 trend indicators were in decline and the average abundance (geometric mean, 1992-1996) for the species was 75,000 adult steelhead (8,900 naturally produced). Of this, about 7,000 were A-run adults, and about 1,400 were B-run adults (Busby *et al.*, 1996).

The lack of data on adult spawning escapement for specific tributaries of the Snake River Basin species continues to make a quantitative assessment of viability difficult. Available data indicate that the overall long-term estimates of population trends have remained negative (Good *et al.*, 2005). Annual return estimates are limited to counts of the

aggregate return over Lower Granite Dam, and spawner estimates for the Tucannon, Asotin, Grande Ronde and Imnaha Rivers. The 2001 return over Lower Granite Dam was substantially higher relative to the low levels seen in the 1990s; the recent geometric 5-year mean abundance (Total escapement 106,175 with 14,768 natural returns) was approximately 28% of the interim recovery target level (52,000 natural spawners) (Good *et al.*, 2005). The 10-year average for natural-origin steelhead passing Lower Granite Dam between 1996 and 2005 is 28,303 adults. Long-term trend estimates of the population growth rate ( $\lambda$ ) across the available data set was 0.998 assuming that natural returns are produced only from natural-origin spawners, and 0.733 if both hatchery and wild spawners are contributing to production equally (Good *et al.*, 2005). The Snake River supports approximately 63% of the total natural-origin production of steelhead in the Columbia River Basin (Good *et al.*, 2005).

### **Critical Habitat**

NMFS designated critical habitat for Snake River steelhead on September 2, 2005 (70 FR 52630). Designated critical habitat includes the following subbasins: Hells Canyon, Imnaha River, Lower Snake/Asotin, Upper Grand Ronde River, Wallowa River, Lower Grand Ronde, Lower Snake/Tucannon, Upper Salmon, Pahsimeroi, Middle Salmon-Panther, Lemhi, Upper Middle Fork Salmon, Lower Middle Fork Salmon, Middle Salmon, South Fork Salmon, Lower Salmon, Little Salmon, Upper and Lower Selway, Lochsa, Middle and South Fork Clearwater, and the Clearwater subbasins and the Lower Snake/Columbia River corridor. These areas are important for the species' overall conservation by protecting quality growth, reproduction, and feeding. The critical habitat designation for this species identifies primary constituent elements that include sites necessary to support one or more steelhead life stages. Specific sites include freshwater spawning sites, freshwater rearing sites, freshwater migration corridors, nearshore marine habitat and estuarine areas. The physical or biological features that characterize these sites include water quality and quantity, natural cover, forage, adequate passage conditions, and floodplain connectivity. The final rule (70 FR 52630) lists the watersheds that comprise the designated subbasins and any areas that are specifically excluded from the designation.

There are 289 watersheds within the range of Snake River steelhead. The total area of habitat designated as critical includes about 8,000 miles of stream habitat. This designation includes the stream channels within the designated stream reaches, and includes a lateral extent as defined by the ordinary high water line. In areas where the ordinary high-water line is not defined the lateral extent is defined as the bankfull elevation. Of the 289 fifth order streams reviewed in this species, 231 received a high conservation value rating, 44 received a medium rating and 14 received a rating of low conservation value for the species. The lower Snake/Columbia rearing/migration corridor downstream of the spawning range has a high conservation value. Limiting factors identified for Snake River Basin steelhead include: hydrosystem mortality, reduced stream flow, altered channel morphology and floodplain, excessive sediment, degraded water quality, harvest impacts, and hatchery impacts.

### **South-Central California Coast Steelhead**

The South-Central California Coast steelhead species includes all naturally spawned populations of steelhead (and their progeny) in streams from the Pajaro River (inclusive) to, but not including the Santa Maria River, California. No artificially propagated steelhead populations that reside within the historical geographic range of this species are included in this designation. The two largest basins within this species' range are the inland basins of the Pajaro River and the Salinas River. Both of these watersheds drain intercoastal mountain ranges and have long alluvial lower stretches. Principle sub-basins in the Pajaro River that support steelhead include: Corralitos Creek, Pescadero Creek, Uvas Creek and Pacheco Creek. Principle sub-basins in the Salinas River that support steelhead include the Arroyo Seco River, Gabilan Creek, Paso Robles Creek, Atascadero Creek and Santa Margarita Creek. Other important watersheds include the smaller coastal basins of the Carmel River, and St. Rosa and San Luis Obispo

creeks.

### Status and Trends

NMFS listed South-Central California Coast steelhead as threatened in 1997, and reaffirmed their status as threatened on January 5, 2006 (71 FR 834). Historical data on the South-Central California Coast steelhead species are sparse and no credible historic or recent estimates of total species size are available. Steelhead are present in a large portion of the historically occupied basins within this species' range (estimated 86-95%) but observed and inferred abundance suggest many of these basins support a small fragment of their historic run size. Present population trends within individual watersheds continuing to support runs is generally unknown, but may vary widely between watersheds. No data are available to estimate the steelhead abundance or trends in the two largest watersheds in the species, the Pajaro and Salinas basins. These basins are highly degraded and expected to support runs much reduced in size from historical levels.

Steelhead in the Carmel Basin have been monitored at San Clemente Dam since 1964, representing one of the longest data sets available for steelhead in this species. However, this data is also limited because a nine year gap exists in the series, a large portion of the run spawns below the dam and the older dam counts may be incomplete. Between NMFS' 1997 status review and 2005 status update, continuous data from San Clemente dam suggests that the abundance of adult spawners in the Carmel River has increased. Carmel River time series data indicate that the population declined by about 22% per year between 1963 and 1993, and between 1991 and 1997 the population increased from one adult to 775 adults at San Clemente Dam. Good *et al.*, (2005) deemed this increase too great to attribute simply to improved reproduction and survival of the local steelhead population. Other possibilities were considered, including that the substantial immigration or translocation occurred or that resident trout production increased as a result of improved environmental conditions within the basin. The five-year geometric mean calculated by Good *et al.*, (2005) for the Carmel River population (1998-2002) was 611.

### Critical Habitat

NMFS designated critical habitat for South-Central California Coast steelhead on September 2, 2005 (70 FR 52488). Specific geographic areas designated include the following CALWATER hydrological units: Pajaro River, Carmel River, Santa Lucia, Salinas River and Estero Bay. These areas are important for the species' overall conservation by protecting quality growth, reproduction and feeding. The critical habitat designation for this species identifies primary constituent elements that include sites necessary to support one or more steelhead life stages. Specific sites include freshwater spawning sites, freshwater rearing sites, freshwater migration corridors, nearshore marine habitat and estuarine areas. The physical or biological features that characterize these sites include water quality and quantity, natural cover, forage, adequate passage conditions and floodplain connectivity. The critical habitat designation (70 FR 52488) contains additional details on the sub-areas that are included as part of this designation and the areas that were excluded from designation.

In total, South-Central California Coast steelhead occupy 30 watersheds (fresh water and estuarine). The total area of habitat designated as critical includes about 1,250 miles of stream habitat and about 3 square miles of estuarine habitat (e.g., Morro Bay). This designation includes the stream channels within the designated stream reaches and includes a lateral extent as defined by the ordinary high water line. In areas where the ordinary high-water line is not defined the lateral extent is defined as the bankfull elevation. In estuarine areas the lateral extent is defined by the extreme high water because extreme high tide areas encompass those areas typically inundated by water and regularly occupied by juvenile salmon during the spring and summer, when they are migrating in the nearshore zone and relying on cover and refuge qualities provided by these habitats and while they are foraging. Of the 30

watersheds reviewed in NMFS' assessment of critical habitat for South-Central California Coast steelhead, six watersheds received a low rating of conservation value, 11 received a medium rating and 13 received a high rating of conservation value for the species.

### **Southern California Steelhead**

The Southern California steelhead species includes all naturally spawned populations of steelhead in streams from the Santa Maria River, San Luis Obispo County, California (inclusive) to the U.S.-Mexico border. Artificially propagated steelhead that reside within the historical geographic range of this species are not included in the listing.

A comprehensive assessment of the distribution of steelhead within the Southern California species indicates that steelhead occur in most of the coastal basins (Boughton and Fish 2003 in Good *et al.*, 2005). Major watersheds occupied by steelhead in this species include the Santa Maria, Santa Ynez, Ventura, Santa Clara rivers. Smaller watersheds that support steelhead include the Los Angeles, San Gabriel, San Luis Rey and Sweetwater rivers, and San Juan and San Mateo creeks. Significant portions of several upper watersheds are contained within four national forests (Los Padres, Angeles, Cleveland and San Bernardino National Forests), whereas coastal and inland valleys are dominated by urban development, with the Los Angeles basin being the most expansive and densest urban area in the species. Populations within the southernmost portion of the species (San Juan Creek, San Luis Rey River and San Mateo Creek) are separated from the northernmost populations by about 80 miles.

### **Status and Trends**

NMFS listed Southern California steelhead as endangered in 1997 (62 FR 43937), and reaffirmed their status as endangered on January 5, 2006 (71 FR 834). Historical and recent data is generally lacking for Southern California steelhead, making a general assessment of their status difficult. The historical run size estimate for the entire species was between 32,000-46,000 steelhead, but this estimate omits the Santa Maria system and basins south of Malibu Creek (Busby *et al.*, 1996). Estimates for the Santa Ynez River Basin, probably the largest run historically, range from 13,000 to 30,000 spawners, although this number may underestimate the steelhead abundance in the basin prior to the construction of Juncal and Gibraltar dams (Busby *et al.*, 1996; Good *et al.*, 2005). No recent data are available for steelhead in the Santa Ynez basin and most of the historical spawning habitat was blocked by Bradbury and Gibraltar dams.

Steelhead and rainbow trout are known to occur in streams downstream of Bradbury Dam, but no estimates of abundance or trends are available. Similarly, Twitchell Dam in the Santa Maria River, and Casitas Dam on Coyote Creek and Matilija Dam on Matilija Creek block access to significant portions of historical spawning and rearing habitat and alter the hydrology of the basins. A fish ladder and counting trap at the Vern Freeman Diversion Dam on the Santa Clara River is thought to be dysfunctional (Good *et al.*, 2005). In general run sizes in river systems within the species are believed to range between less than five anadromous adults per year, to less than 100 anadromous adults per year. An estimated 26-52% of historically occupied basins are believed to contain some steelhead and about 30% are believed vacant, extirpated or nearly extirpated due to dewatering or barriers that block spawning habitat.

### **Critical Habitat**

NMFS designated critical habitat for Southern California steelhead on September 2, 2005 (70 FR 52488). Specific geographic areas designated include the following CALWATER hydrological units: Santa Maria River, Santa Ynez, South Coast, Ventura River, Santa Clara Calleguas, Santa Monica Bay, Calleguas and San Juan hydrological units. These areas are important for the species' overall conservation by protecting quality growth, reproduction and feeding. The critical habitat designation for this species identifies primary constituent elements that include sites

necessary to support one or more steelhead life stages. Specific sites include freshwater spawning sites, freshwater rearing sites, freshwater migration corridors, nearshore marine habitat and estuarine areas. The physical or biological features that characterize these sites include water quality and quantity, natural cover, forage, adequate passage conditions and floodplain connectivity. The critical habitat designation (70 FR 52488) contains additional details on the sub-areas that are included as part of this designation and the areas that were excluded from designation.

In total, Southern California steelhead occupy 32 watersheds (fresh water and estuarine). The total area of habitat designated as critical includes about 700 miles of stream habitat and about 22 square miles of estuarine habitat, mostly within Humboldt Bay. This designation includes the stream channels within the designated stream reaches and includes a lateral extent as defined by the ordinary high water line. In areas where the ordinary high-water line is not defined the lateral extent is defined as the bankfull elevation. In estuarine areas the lateral extent is defined by the extreme high water because extreme high tide areas encompass those areas typically inundated by water and regularly occupied by juvenile salmon during the spring and summer, when they are migrating in the nearshore zone and relying on cover and refuge qualities provided by these habitats and while they are foraging. Of the 32 watersheds reviewed in NMFS' assessment of critical habitat for Southern California steelhead, five watersheds received a low rating of conservation value, six received a medium rating and 21 received a high rating of conservation value for the species.

#### Upper Columbia River Steelhead

The Upper Columbia River steelhead species includes all naturally spawned populations of steelhead in streams in the Columbia River Basin upstream from the Yakima River, Washington, to the U.S.-Canada border. Six artificial propagation programs are part of this species.

Rivers in this species primarily drain the east slope of the northern Cascade Mountains and include the Wenatchee, Entiat, Methow and Okanogan River Basins. Some of these upper Columbia River subbasins, including the Okanogan River and the upper Columbia River proper, extend into British Columbia although steelhead do not occur in significant numbers in British Columbia and thus were not included in the species. Identified largely based on spawning distributions, this species is composed of four putative populations defined by the Wenatchee, Entiat, Methow and Okanogan rivers. Historically (before the construction of Grand Coulee Dam blocked 50% of the river to Upper Columbia steelhead) major watershed that may have supported steelhead that comprise this species were the Sanpoil, Spokane, Colville, Kettle, Pend Oreille and Kootenai rivers (ICBTRT, 2003).

All upper Columbia River steelhead are summer-run steelhead. Adults return in the late summer and early fall, with most migrating relatively quickly to their natal tributaries. A portion of the returning adult steelhead overwinters in mainstem reservoirs, passing over upper-mid-Columbia dams in April and May of the following year. Spawning occurs in the late spring of the year following river entry. Juvenile steelhead spend one to seven years rearing in fresh water before migrating to sea. Smolt outmigrations are predominantly year class two and three (juveniles), although some of the oldest smolts are reported from this species (7 years). Most adult steelhead return to fresh water after one or two years.

#### Status and Trends

NMFS originally listed Upper Columbia River steelhead as endangered in 1997 (62 FR 43937). On January 5, 2006, after reviewing the status of Upper Columbia River steelhead and noting an increase in abundance and more widespread spawning, NMFS reclassified the status of Upper Columbia River threatened (71 FR 834). In accordance with a U.S. District Court decision, NMFS reinstated the endangered status of Upper Columbia River steelhead in June 2007 (62 FR 43937). NMFS appealed the Court's decision, and on June 18, 2009, the District Court revised its

ruling, effectively reinstating threatened status for Upper Columbia River steelhead (74 FR 42605). Thus, consistent with the court's rulings and the NMFS' listing determination of January 5, 2006, Upper Columbia River steelhead are listed as threatened under the ESA.

Since the 1940s, artificially propagated steelhead have seeded this species to supplement the numbers lost with the construction of the Grand Coulee Dam. Abundance estimates of returning naturally produced Upper Columbia River steelhead have been based on extrapolations from mainstem dam counts and associated sampling information (e.g., hatchery/wild fraction, age composition). Early estimates of steelhead in this species may be based on runs that were already depressed due to dams and steelhead fisheries. Nevertheless, these early dam counts are the best source of available data on the former size of the populations within this species. From 1933-1959 counts at Rock Island Dam averaged between 2,600 and 3,700 steelhead adults, which suggested the pre-fishery run size likely exceeded 5,000 adults destined for tributaries above Rock Island Dam (Chapman *et al.*, 1994 as cited in Busby *et al.* 1996). Using counts at Priest Rapids Dam (located below the production areas for this species) as an indicator of species size and trends suggests that the total number of spawners has increased since NMFS' 1996 status review. The 1992-1996 average annual total returns (hatchery plus natural) of steelhead spawners was 7,800, and the 1997-2001 average is 12,900 steelhead (hatchery plus natural). The natural component increased in these same periods from 1,040 to 2,200, respectively (Good *et al.*, 2005).

While the total number of naturally produced fish in this species increased between status reviews, the proportion of naturally produced steelhead to hatchery-origin fish has declined. Total escapement increased in the combined estimate for the Wenatchee and Entiat rivers to a geometric mean of 3,279 spawners (900 natural spawners) over NMFS' previous estimate of 2,500 hatchery and natural steelhead spawners (1989 to 1993, natural component 800 steelhead) (Good *et al.*, 2005). Estimates of the hatchery contribution to this population increased from 65% to 71% of total escapement. (Good *et al.*, 2005) A comparison of estimates for the Methow and Okanogan rivers during the same periods indicate that the total escapement increased from 2,400 to 3,714 while naturally produced steelhead declined from 450 to 358. Thus, the contribution of naturally produced steelhead declined from 19% to only 9% of total escapement between the 1993 and 2001 estimates (Good *et al.*, 2005).

The assumptions of the role that hatchery fish play in the overall productivity and health of the species strongly influence estimates of population growth rates. Estimates based on the assumption that hatchery fish contribute to natural production at the same rate as natural-origin spawners consistently result in long-term population growth rates (expressed as  $\lambda$ ) that are consistently below 1 (Good *et al.*, 2005). Under the assumption that hatchery fish do not contribute to natural production, estimates of long term population growth rate suggest the population is growing. Determining the actual contribution of hatchery fish to natural production is important for understanding the true status of this species, particularly given that the proportion of naturally produced steelhead to hatchery-origin steelhead continues to decline. The extremely low replacement rate of naturally produced steelhead in this species is of concern.

The majority of the biological review team (54%) felt that this species warranted an "endangered" listing due to the growth rate and productivity and uncertainty over the contribution of hatchery fish to natural production. NMFS, after convening a review of the artificial propagation programs of the six hatcheries concluded that the programs collectively mitigate the immediacy of extinction risk of the species. Thus, NMFS listed the species as threatened rather than threatened (71 FR 834). NMFS concluded that the hatchery programs have increased total escapement and the distribution of spawning areas and minimize the potential risks associated with artificial propagation. However, the abundance and productivity of naturally spawned steelhead remains a concern.

## Critical Habitat

NMFS designated critical habitat for Upper Columbia River steelhead on September 2, 2005 (70 FR 52630). Designated critical habitat includes the following subbasins: Chief Joseph, Okanogan, Similkameen, Methow, Upper Columbia/Entiat, Wenatchee, Lower Crab, and the Upper Columbia/Priest Rapids subbasins and the Columbia River corridor. These areas are important for the species' overall conservation by protecting quality growth, reproduction and feeding. The critical habitat designation for this species identifies primary constituent elements that include sites necessary to support one or more steelhead life stages. Specific sites include freshwater spawning sites, freshwater rearing sites, freshwater migration corridors, nearshore marine habitat and estuarine areas. The physical or biological features that characterize these sites include water quality and quantity, natural cover, forage, adequate passage conditions and floodplain connectivity. The final rule (70 FR 52630) lists the watersheds that comprise the designated subbasins and any areas that are specifically excluded from the designation.

There are 42 watersheds within the range of Upper Columbia River steelhead. The total area of habitat designated as critical includes about 1,250 miles of stream habitat. This designation includes the stream channels within the designated stream reaches and includes a lateral extent as defined by the ordinary high water line. In areas where the ordinary high-water line is not defined the lateral extent is defined as the bankfull elevation. Of the 42 watersheds reviewed in NMFS' assessment of critical habitat for Upper Columbia River steelhead, three watersheds received a low rating of conservation value, eight received a medium rating and 31 received a high rating of conservation value for the species. In addition, the Columbia River rearing/migration corridor downstream of the spawning range was rated as a high conservation value. Limiting factors identified for the Upper Columbia River steelhead include: mainstem Columbia River hydropower system mortality, reduced tributary stream flow, tributary riparian degradation and loss of in-river wood, altered tributary floodplain and channel morphology and excessive fine sediment and degraded tributary water quality.

## Upper Willamette River Steelhead

The Upper Willamette River steelhead species includes all naturally spawned populations of winter-run steelhead in the Willamette River, Oregon and its tributaries upstream from Willamette Falls to the Calapooia River (inclusive). No artificially propagated populations that reside within the historical geographic range of this species are included in this listing. Hatchery summer-run steelhead occur in the Willamette Basin but are an out-of-basin population that is not included in this species.

The native (late) winter-run steelhead, with spring Chinook salmon, are the only two populations of salmon believed to historically occur above Willamette Falls. The construction of a fish ladder at the falls in the late 1880s, allowed for the passage of summer steelhead from Skamania Creek and winter-run steelhead from Big Creek (i.e., Gnat Creek). The two groups of winter-run steelhead exhibit different return times. The later run exhibits the historical phenotype adapted to passing the seasonal barrier that existed at Willamette Falls prior to construction of the fish ladder. The early run of winter-run steelhead are considered non-native and were derived from Columbia River steelhead outside the Willamette River (Good *et al.*, 2005). While the release of these hatchery winter-run fish was recently discontinued, some fish from earlier releases now reproduce naturally within the upper Willamette River Basin. Nonnative summer-run hatchery steelhead continue to be released within the upper basin (Good *et al.*, 2005).

Native steelhead in the Upper Willamette are a late-migrating winter group that enters fresh water in January and February (Howell *et al.*, 1985a). They do not ascend to their spawning areas until late March or April (Dimick and Merryfield, 1945) and spawning occurs from April to June 1. The smolt migration past Willamette Falls also begins in early April and proceeds into early June, peaking in early- to mid-May (Howell *et al.*, 1985). Smolts generally

migrate through the Columbia via Multnomah Channel rather than the mouth of the Willamette River. Most spend 2 years in the ocean before re-entering natal rivers to spawn (Busby *et al.*, 1996). Steelhead of the Upper Willamette River species generally spawn once or twice, although some may spawn three times. Repeat spawners are predominantly female and generally account for less than 10% of the total run size (Busby *et al.*, 1996).

### Status and Trends

NMFS originally listed Upper Willamette River steelhead as threatened in 1999 (64 FR 14517), and reaffirmed their status as threatened on January 5, 2006 (71 FR 834). The Upper Willamette steelhead species consists of four demographically independent populations, each of which remains extant although depressed from historical levels. Available data for this species comes from a combination of dam counts, redd count index surveys and hatchery trap counts. Estimates of abundance from NMFS 1996 status review on this species, demonstrate a mix of trends with the largest populations, Molalla and North Santiam Rivers, declining over the period of analysis. The 2005 review of the status of the Upper Willamette steelhead species indicated that each population showed a declining trend over the data series that extended to 2000 and 2001, while one population, the Calapooia River, increased over the short-term (Good *et al.*, 2005).

More recently, data reported in McElhany *et al.*, (2007) indicate that currently the two largest populations within this species are the Santiam River populations. Mean spawner abundance in both the North Santiam River and the South Santiam River is about 2,100. Long-term growth is negative for three of the populations within the species, with Calapooia River demonstrating a lambda of >1 indicating long-term growth in this population (McElhany *et al.*, 2007). Spatial structure for the North and South Santiam populations has been substantially reduced by the loss of access to the upper North Santiam basin and the Quartzville Creek watershed in the South Santiam subbasin due dam construction lacking passage facilities (McElhany *et al.*, 2007). Additionally, habitat in the Molalla subbasin has been reduced significantly by habitat degradation and in the Calapooia by habitat degradation as well as passage barriers. Finally, the diversity of some populations has been eroded by small population size, the loss of access to historical habitat, legacy effects of past winter-run hatchery releases and the ongoing release of summer steelhead (McElhany *et al.*, 2007).

### Critical Habitat

NMFS designated critical habitat for Upper Willamette River steelhead on September 2, 2005 (70 FR 52488). Designated critical habitat includes the following subbasins: Upper Willamette, North Santiam, South Santiam, Middle Willamette, Molalla/Pudding, Yamhill, Tualatin, and the Lower Willamette subbasins and the lower Willamette/Columbia River corridor. These areas are important for the species' overall conservation by protecting quality growth, reproduction and feeding. The critical habitat designation for this species identifies primary constituent elements that include sites necessary to support one or more steelhead life stages. Specific sites include freshwater spawning sites, freshwater rearing sites, freshwater migration corridors, nearshore marine habitat and estuarine areas. The physical or biological features that characterize these sites include water quality and quantity, natural cover, forage, adequate passage conditions and floodplain connectivity. The final rule (70 FR 52630) lists the watersheds that comprise the designated subbasins and any areas that are specifically excluded from the designation.

There are 38 watersheds within the range of Upper Willamette River steelhead. The total area of habitat designated as critical includes about 1,250 miles of stream habitat. This designation includes the stream channels within the designated stream reaches and includes a lateral extent as defined by the ordinary high water line. In areas where the ordinary high-water line is not defined the lateral extent is defined as the bankfull elevation. Of the 38 watersheds reviewed in NMFS' assessment of critical habitat for Upper Willamette River steelhead, 17 watersheds received a

low rating of conservation value, six received a medium rating and 15 received a high rating of conservation value for the species. In addition, the lower Willamette/Columbia River rearing/migration corridor downstream of the spawning range was rated as a high conservation value.

## **Marine Mammals**

### **Cook Inlet Beluga Whale**

Beluga whales are widely distributed in Arctic and subarctic waters and in Alaska five putative populations exist (Beaufort Sea, eastern Chukchi Sea, Bristol Bay, eastern Bering Sea and Cook Inlet) (Angliss *et al.*, 2001). Cook Inlet beluga whales are the only population that is listed under the ESA. Mitochondrial and nuclear DNA distinguish Alaskan beluga whales from those that occur in Hudson Strait, Baffin Bay and the St. Lawrence River, with the Cook Inlet population demonstrating the strong evidence of genetic isolation from the other Alaskan populations and other populations demonstrating weak to moderate evidence of genetic isolation (O'Corry-Crowe *et al.*, 2007; O'Corry-Crowe, 2008).

Based on past studies of the summer distribution of beluga whales in Cook Inlet, it appears that the population has experienced a contraction in its overall distribution (Speckman and Piatt., 2000; Hobbs *et al.*, 2008; Rugh *et al.*, 2010). According to Hobbs *et al.*, (2008) 90% of the whales in the 1970s were observed within 70 nmi of the western tip of Anchorage (Point Woronzof), whereas more recently (1998-2007) 90% were detected within 20 nmi. Although the precise reason for the range contraction is not known, the shrinking summer distribution likely reflects the reduction in the population size over the same intervals and the beluga whale's preference for dense aggregations of preferred prey species.

Analyses of beluga whale stomach contents indicate that beluga whales are opportunistic feeders, but specific species form the bulk of the prey when they are seasonally abundant (Hobbs *et al.*, 2008). For instance, eulachon (*Thaleichthys pacificus*) also known as smelt or candlefish, are a small anadromous fish return that their natal rivers in spring for spawning. The high fat content of this species confers a significant source of energy for beluga whales, including calving whales that occur in the upper inlet during the same period (Calkins, 1989). Based on stomach sample analyses from 2002-2007 fish compose the majority of the prey species, with gadids (cod and walleye pollock) and salmonids composing the majority of the fish eaten (Hobbs *et al.*, 2008). Anadromous salmonids begin concentrating at the river mouths and intertidal flats in upper Cook Inlet in late spring and early summer as emigrating smolts and immigrating adult spawners. Like eulachon, salmon are another source of lipid-rich prey for the beluga whale and represent the greatest percent frequency of occurrence of the prey species found in Cook Inlet beluga whale stomachs (Hobbs *et al.*, 2008). As salmonid numbers dwindle in the fall and winter, beluga whales return to feed on nearshore or deeper water species including cod, sculpin, flounder, sole, shrimp, crab and others (Hobbs *et al.*, 2008).

Beluga whale calving is not well documented but the presence of cow/calf pairs in large river estuaries in the upper inlet, and accounts of Alaskan Natives, suggests that calving and nursery areas are located near the mouths of the Beluga and Susitna Rivers, Chickaloon Bay and Turnagain Arm (see NMFS, 2008b). Recent surveys suggest that cow/calf pairs also make extensive use of Knik Arm in the summer and fall (Funk *et al.* 2005 as cited in NMFS, 2008b). Neonates are often not seen until June in Cook Inlet (Burns and Seaman, 1986). Some researchers have suggested that the shallow waters of Cook Inlet may be important for reproduction and calving, as the shallower water is warmer which may confer an important thermal advantage for calf survival as they have relatively limited

fat deposits at birth (see NMFS, 2008b). A beluga female's first parturition is at age five or six. Breeding is presumed to occur shortly after calving, in the late summer after about 14-15 months of gestation (Calkins, 1989). Lactation lasts about two years, with breeding occurring during lactation (Calkins, 1989).

### Status and Trends

On October 22, 2008, NMFS listed the Cook Inlet beluga whale as endangered (73 FR 62919). Historic numbers of beluga whales in Cook Inlet are unknown. Dedicated surveys began in earnest in the 1990s when NMFS began conducting aerial surveys for beluga whales in Cook Inlet. Prior to then, survey efforts were inconsistent, part of larger sea bird and marine mammal surveys, made by vessel, or estimated following interviews with fishermen (Klinkhart, 1966). In many cases the survey methodology or confidence intervals were not described. For instance, Klinkhart (1966) conducted aerial surveys in 1964 and 1965, where he describes having estimated the populations at 300-400 whales, but the methodology was not described nor did he report the variance around these estimates. Other estimates were incomplete due to the small area the survey focused upon (e.g. river mouth estimates; e.g., Hazard 1988). The most comprehensive survey effort prior to the 1990s occurred in 1979 and included transects from Anchorage to Homer, and covered the upper, middle and lower portions of Cook Inlet. From this effort, and using a correction factor of 2.7 to account for submerged whales Calkins (1989) estimated the 1979 abundance at about 1,293 whales.

In 1993, NMFS began systematic aerial surveys of beluga whales in Cook Inlet and like the 1979 survey cover the upper, middle and lower portions of Cook Inlet. The survey protocol involves using paired observers who make independent counts at the same time a video of the whale grouping is recorded. Each group size estimate is corrected for subsurface and missed animals, or if video counts are not available then additional corrections are made (Allen and Angliss, 2010).

Between 1979 and 1994, according to above noted population estimates, Cook Inlet beluga whales declined by 50%, with another 50% decline observed between 1994 and 1998. Using a growth fitted model Hobbs *et al.*, (2008) observed an average annual rate of decline of -2.91% (SE = 0.010) from 1994 to 2008, and a -15.1% (SE = 0.047) between 1994 and 1998. A comparison with the 1999-2008 data suggests the rate of decline at -1.45% (SE=0.014) per year (Hobbs *et al.*, 2008). Given that harvest was curtailed significantly between 1999 and 2008, NMFS had expected the population would begin to recover at a rate of 2-6% per year. However, abundance estimates demonstrate that this is not the case (Hobbs and Shelden, 2008).

In conducting its status review, NMFS ran a number of population viability analyses (PVA) to estimate the time to extinction for Cook Inlet beluga whales. The models were sensitive to a variety of parameters such as killer whale predation, allee effects and unusual mortality events. The best approximation of the current population incorporated killer whale predation at only one beluga whale per year and allowed for an unusual mortality event occurring on average every 20 years. According to this model, there is an 80% probability that the population is declining, a 26% probability that the population will be extinct in 100 years (by 2108) and a 70% probability that the population will be extinct within 300 years (by 2308).

### Threats

*Natural Threats.* Natural threats to Cook Inlet beluga whales include stranding, predation, parasitism and disease, environmental change and genetic risks associated with small populations (e.g., inbreeding, loss of genetic variability). As noted in NMFS' Cook Inlet beluga whale conservation plan (NMFS, 2008b), beluga whales may strand accidentally as they occupy shallow water areas or escape predators, or as a result of diseases, illness or injury. Given the extreme tidal fluctuations in Cook Inlet, beluga whale strandings are not uncommon. According to

NMFS (2008b) killer whales have been observed in Cook Inlet concurrent to beluga whale strandings and evidence of killer whale attacks is apparent in some beluga whale strandings.

Over 700 beluga whales have stranded in Cook Inlet since 1988, many of which occurred in Turnagain Arm and often coincided with extreme tidal fluctuations (NMFS, 2008b). Where stranding occurs from extreme tidal fluctuations and animals are out of the water for extended periods the risk of mortality increases from cardiovascular collapse. Ten hours may be the upper limit for out of the water for beluga whales before serious injury or death occurs (NMFS, 2008b). Strandings may represent a significant threat to the conservation and recovery of the Cook Inlet beluga whale population.

Gaydos *et al.*, (2004) identified 16 infectious agents in free-ranging and captive southern resident killer whales, but concluded that none of these pathogens were known to have high potential to cause epizootics. Many of these same infectious agents could pose a problem for Cook Inlet beluga whales. At this time little information is available to date to suggest bacterial or viral agents are actively contributing to the decline in the Cook Inlet population. About 80% of Cook Inlet beluga whales examined, however, have evidence of the parasite *Crassicauda giliakiana* in the kidneys, although it is presently unclear whether the parasite is affecting the status of the population (NMFS, 2008b). Necropsies have also revealed infestations of the common nematode anasakids, or whaleworm in the stomach of adult Cook Inlet beluga whales. While the parasite tends to favor the stomach and can cause gastritis or ulcerations, the infestations in beluga whales has not been considered severe enough to have caused clinical responses (NMFS, 2008b). Liver trematodes have also been identified in at least one beluga whale. At present, NMFS has no information to suggest that parasites are having a measureable impact on the survival and health of the Cook Inlet whale population (NMFS, 2008b).

*Anthropogenic Threats.* Human induced threats to Cook Inlet beluga whales include subsistence harvest, poaching and illegal harvest, incidental take during commercial fishing and reduction of prey through fishing harvests, pollution, oil and gas development, urban development, vessel traffic including from tourism and whale watching, noise, as well as research activities directed at beluga whales. During the early 1900s there was a short-lived commercial whaling company, The Beluga Whaling Company, which operated at the Beluga River in upper Cook Inlet. The Company during its 5 years of operation harvest 151 belugas from 1917-1921 (Mahoney and Shelden, 2000). Another commercial hunt of beluga whales in 1930s is recollected by residents, but no record of the hunt exists in Alaska fishery and fur seal documents (as cited in Mahoney and Shelden, 2000). In 1999 and 2000 there was a voluntary moratorium on subsistence harvest. Thereafter, subsistence harvests have been conducted under co-management agreements. Since 2000, no more than 2 beluga whales have been taken in subsistence harvests in any one year (NMFS, 2008b).

Commercial fisheries likely have varying levels of interactions with Cook Inlet beluga whales, according to the timing, gear types, targeted species and location of activities (NMFS, 2008b). Reports of fatal interactions with commercial fisheries have been noted in the literature (Hobbs *et al.*, 2008). Direct interactions with fishing vessels and nets are considered unusual, based on observer data and unlikely to inhibit the recovery of Cook Inlet beluga whales. The reduction of prey species, however, is of more concern for the species. In 2000 NMFS recommended the closing of the eulachon fishery due to a lack of understanding of how this fishery interfered with beluga whale feeding, but in 2005 this fishery was reopened with a harvest limited at 100 tons of eulachon. Currently, it is unclear if fishery harvest of prey species is having a significant impact on the beluga whale population. Impacts from recreational fisheries, which are very popular in the region, likely include the reduction of fish prey species particularly salmonid species and also the harassment from noise and risk of injury from vessel strikes from the

operation of small watercraft in the estuarine/river mouths (NMFS, 2008b).

Contaminants in beluga whales are of concern for both whale health and the health of subsistence users. Tissue samples are regularly collected from subsistence harvested and stranded beluga whales and archived. Tissues and organs commonly collected include blubber, liver and kidneys, as well as muscle, heart, bone, skin and brain. Blubber is the most commonly collected; due to the lipid content it typically contains the most lipophilic substances (Becker, 2000). The kidney and liver are used to analyze heavy metal compounds. Relatively high levels of PCBs, chlorinated pesticides and mercury are evident in beluga whales, although the more contaminated belugas are from the St. Lawrence River, Canada (Becker 2000). Concentrations of chlorinated hydrocarbons in Cook Inlet beluga whales range from 0.1-2.4 µg/g, w.w. DDT, 0.6-4.7 µg/g, w.w. PCB, 0.1-0.6 µg/g, w.w. chlordane, <0.1-4.3 µg/g, w.w. toxaphene. Studies indicate that PCBs and chlorinated pesticide concentrations are higher in male beluga whales than females, reflecting the transference of body loads to the offspring that occurs during gestation and lactation (Becker *et al.*, 2000). Other contaminants detected in Cook Inlet beluga whales include heavy metals such as cadmium, mercury, selenium, copper and zinc. Comparative studies suggest that Cook Inlet beluga whales generally carry less contaminant body burdens than beluga whales from other areas. An exception is copper, which is two to three times higher in Cook Inlet beluga whales than beluga whales from the eastern Beaufort Sea and the eastern Chukchi Sea, but is similar concentrations found in Hudson Bay beluga whales (Becker *et al.*, 2000).

#### Critical Habitat

On April 11, 2011 NMFS designated critical habitat for the Cook Inlet beluga whale 76 FR 20180. Two specific areas are designated comprising 7,800 square kilometers of marine habitat. Area one encompasses all marine waters of Cook Inlet north of a line from the mouth of Threemile Creek (61°08.5' N., 151°04.4' W.) connecting to Point Possession (61°02.1' N., 150°24.3' W.), including waters of the Susitna River south of 61°20.0' N., the Little Susitna River south of 61°18.0' N. and the Chickaloon River north of 60°53.0' N. (2) Area two encompasses all marine waters of Cook Inlet south of a line from the mouth of Threemile Creek (61°08.5' N., 151°04.4' W.) to Point Possession (61°02.1' N., 150°24.3' W.) and north of 60°15.0' N., including waters within two nautical miles seaward of the mean high water boundary along the western shoreline of Cook Inlet between 60°15.0' N. and the mouth of the Douglas River (59°04.0' N., 153°46.0' W.); all waters of Kachemak Bay east of 151°40.0' W.; and waters of the Kenai River below the Warren Ames bridge at Kenai, Alaska.

Area 1 has the highest concentration of beluga whales in the spring through fall as well as the greatest potential for adverse impact from anthropogenic threats. It contains many rivers with large eulachon and salmon runs, including two rivers in Turnagain Arm (Twenty-mile River and Placer River) which are visited by beluga whales in the early spring. Use declines in the summer and increases again in August through the fall, coinciding with coho salmon returns. Also included in Area 1 are Knik Arm and the Susitna delta. Area 2 is located south of Area 1 and is used by Cook Inlet beluga whales for fall and winter feeding and as transit waters.

The primary constituent elements essential to the conservation of Cook Inlet beluga whales are: (1) Intertidal and subtidal waters of Cook Inlet with depths <30 ft. (MLLW) and within 5 miles of high and medium flow accumulation anadromous fish streams; (2) Primary prey species consisting of four species of Pacific salmon (Chinook, coho, sockeye and chum salmon), Pacific eulachon, Pacific cod, walleye pollock, saffron cod and yellowfin sole; (3) Waters free of toxins or other harmful agents; (4) Unrestricted passage within or between the critical habitat areas; and (5) An absence of in-water noise levels that result in the abandonment of habitat by Cook Inlet beluga whales.

## **Killer Whale (Southern Resident Species)**

The SRKW has been listed as endangered under the ESA since November 18, 2005 (70 FR 69903); critical habitat for this species was designated on November 29, 2006 (71 FR 69054). In April 2004, the Washington Department of Fish and Wildlife (WDFW) designated killer whales in Washington State as a “State endangered species” (WAC 232-12-297). SRKWs are also protected by the MMPA and Canada’s Species at Risk Act (SARA).

The Southern Resident killer whale (*Orcinus orca*) is a toothed whale and is the largest member of the dolphin family. Based on genetic research, it is believed that multiple subspecies of killer whales exist worldwide (Krahn *et al.*, 2004; Reeves *et al.*, 2004; Waples and Clapham, 2004; Jefferson *et al.*, 2008). Resident killer whales in the Northeast Pacific are distributed from Alaska to California, with four distinct communities recognized: southern, northern, southern and western Alaska (Krahn *et al.*, 2002; Krahn *et al.*, 2004). The SRKW occurs in the northeastern Pacific Ocean along the west coasts of the U.S. and Canada. Resident whales exhibit advanced vocal communication and live in highly stable social matriarchal groupings called pods. They frequent a variety of marine habitats and their range does not appear to be limited by depth, temperature or salinity (Baird, 2000).

The SRKW species consists of three pods, designated J, K and L, that reside for part of the year in the inland waterways of Washington State and British Columbia (Strait of Georgia, Strait of Juan de Fuca and Puget Sound), principally during the late spring, summer and fall (Bigg, 1982; Ford *et al.*, 2000; Krahn *et al.*, 2002). Pods have visited coastal sites off Washington and Vancouver Island (Ford *et al.*, 2000) and are known to travel as far south as central California and as far north as the Queen Charlotte Islands off British Columbia. The locations of SRKWs in the late fall, winter and early spring are less well known.

Parsons (2009) noted that members of different pods interact, but members generally remain within their matrilinear group. Interaction between pods has increased over the past two decades and may be the result of a common response among pods to the stress of a declining population (Parsons *et al.*, 2009). The rate of intrapod interaction was lowest within L pod, which is the largest of the SRKW pods (Parsons *et al.*, 2009).

Male SRKWs become sexually mature at a mean age of approximately 15 years and are thought to remain sexually active throughout their adult lives (Christensen *et al.*, 1984; Perrin and Reilly, 1984; Duffield and Miller, 1988; Olesiuk *et al.*, 1990). Females first give birth at a mean age of approximately 14.9 years and produce an average of approximately 5.4 surviving calves over a reproductive life span of about 25 years (Olesiuk *et al.*, 1990; Matkin *et al.*, 2003). Gestation periods, as observed in captive killer whales, average around 17 months (Asper *et al.*, 1988; Walker *et al.*, 1988; Duffield *et al.*, 1995). The mean interval between viable calve births is four years (Bain, 1990). Older mothers tend to have greater calving success and they appear to be assisted in calf rearing by grandmothers (Ward *et al.*, 2009b). Some females may reach 90 years of age (Olesiuk *et al.*, 1990). Mothers and offspring maintain highly-stable, lifelong social bonds and this relationship appears to be the basis for their matrilinear social structure (Bigg *et al.*, 1990; Baird, 2000; Ford *et al.*, 2000).

Although mating can occur year-round, most killer whale reproduction in the North Pacific has been observed to occur primarily from April to October (Olesiuk *et al.*, 1990; Matkin *et al.*, 1997), with a peak in calving occurring between September and March (Olesiuk *et al.*, 2005; Jefferson *et al.*, 2008). Killer whales are polygamous (Dahlheim and Heyning, 1999) and genetic data indicate that resident males mate with females outside of their own pods almost exclusively. This reduces the chances of inbreeding (Barrett-Lennard, 2000; Barrett-Lennard and Ellis, 2001).

Killer whales are apex predators and consume a varied diet but fish are their preferred prey (Scheffer and Slipp,

1948; Ford *et al.*, 1998; Ford *et al.*, 2000; Saulitis *et al.*, 2000). Although the record is incomplete, data suggest that SRKWs have a strong preference for Chinook salmon during late spring to fall (Hanson *et al.*, 2005; Ford and Ellis, 2006). Their winter and early spring diet is largely unknown. SRKWs spend about half of their time hunting prey. Approximately 95% of their time spent underwater is at depths of less than 30 m (Baird, 2000; Baird *et al.*, 2003; Baird *et al.*, 2005). They detect prey via echolocation and passive listening and likely hunt through a combination of vision and echolocation (Barrett-Lennard *et al.*, 1996; Baird, 2000). Maximum observed dive depths average 141 m (Baird *et al.*, 2003). Baird *et al.*, (2005) reported that although the deepest recorded dive for a SRKW is 264 m, they are probably capable of diving to at least 330 m. No significant differences in the diving behavior of the three Southern Resident pods has been observed (Baird *et al.*, 2005).

### Status and Trends

The only pre-1974 account of Southern Resident abundance is from Sheffer and Slipp (1948) and merely notes that the species was “frequently seen” during the 1940s in the Strait of Juan de Fuca, northern Puget Sound, and off the coast of the Olympic Peninsula, with smaller numbers along Washington’s outer coast. Little information exists on the historic abundance of SRKWs. Until the mid- to late-1800s, the SRKW community may have numbered more than 200 animals (Krahn *et al.*, 2002). Using the estimated abundance of SRKWs in 1971 of 67 whales and factoring in various sources of mortality, NMFS estimated a minimum historical abundance of about 140 SRKWs (Olesiuk *et al.*, 1990). The SRKW population had grown to 90 whales by September 2006, but declined in 2007 with the loss of five individuals and the gain of two new calves leaving the total number at 87, with 25 whales in J pod, 19 whales in K pod and 43 whales in L pod (Center for Whale Research, unpublished data cited in NMFS, 2008d). At present, the Southern Resident population has declined to essentially the same size that was estimated during the early 1960s, when it was considered to be depleted (Olesiuk *et al.*, 1990).

Photo-identification catalogs for SRKWs provide information on recent abundance and trends of these pods (see Dahlheim, 1997; Dahlheim *et al.*, 1997; Ford and Ellis, 1999; Matkin *et al.*, 1999). From 1974–2007, the SRKWs as a whole have gone through several periods of growth and decline. For example, the species appeared to experience a period of recovery by increasing to 99 whales in 1995, but then declined by 20% to 79 whales in 2001 before another slight increase to 83 whales in 2003 (Ford *et al.*, 2000; Carretta *et al.*, 2005). This abrupt decline and unstable population status continue to be cause for concern, particularly given the small size of the species which makes it potentially vulnerable to Allee effects (e.g., inbreeding depression) that could cause further population decline or preclude a substantial increase in abundance (see NMFS, 2008d). The intensity of factors affecting the species is increased by stochastic events such as the small number of reproductive age males and high mortality rates for this group and is a major reason that the SRKW was listed as endangered rather than threatened (NMFS, 2008d).

Using data from 1974–2003, Krahn *et al.*, (2002; 2004) further analyzed the population dynamics of the species to identify demographic factors contributing to the latest decline in abundance. Changes in survival were not related to stochastic variation caused by the SRKW community’s small size, such as random patterns in births or deaths or to annual fluctuations in survival. Rather, the survival patterns were more likely influenced by external causes, such as changes in prey availability etc.

### Threats

*Natural Threats.* The population of SRKWs has declined recently. The recent decline and unstable population structure make it difficult for SRKWs to recover from natural spikes in mortality (NMFS, 2008d). Although disease outbreaks have not been identified in this population, increased contaminant loading may increase the susceptibility

of individuals to disease.

*Anthropogenic Threats.* Salmon is the primary prey of killer whales and has been severely reduced due to habitat loss (NRC, 1996; Slaney *et al.*, 1996; Gregory and Bisson, 1997; Lichatowich, 1999; Lackey, 2003; Pess *et al.*, 2003; Schoonmaker *et al.*, 2003). A 50% reduction in killer whale calving has been correlated with years of low Chinook salmon abundance (Ward *et al.*, 2009b).

Contaminants entering SRKW habitat in Puget Sound and its surrounding waters accumulate in water, benthic sediments and in prey organisms (Krahn *et al.*, 2009). SRKWs bioaccumulate these toxins in their tissues which may lead to numerous adverse physiological changes (Krahn *et al.*, 2009). The greatest contaminant threats are from organochlorines (e.g. PCBs, pesticides, dioxins, furans and DDT) (Ross *et al.*, 2000; CBD, 2001; Krahn *et al.*, 2002; Cullon *et al.*, 2009; Krahn *et al.*, 2009). These chemicals bioaccumulate in fatty tissues, persist and can be transmitted from mother to offspring (Haraguchi *et al.*, 2009; Krahn *et al.*, 2009).

Vessel activity has also been identified as a threat to SRKWs. In 2005, a U.S. vessel participating in sonar exercises apparently caused significant behavior changes in killer whale activity, such that the whales vacated the area (NMFS, 2005a). Additionally, the increase in “background noise” resulting from vessel traffic has the potential to influence or disrupt the ability of SRKWs to navigate, communicate and forage (Bain and Dahlheim, 1994; Gordon and Moscrop, 1996; Erbe, 2002; Williams *et al.*, 2002a; Williams *et al.*, 2002b; Holt *et al.*, 2009).

#### Critical Habitat

NMFS designated critical habitat for Southern Resident killer whales on November 29, 2006 (71 FR 69054). Three specific areas were designated; (1) the Summer Core Area in Haro Strait and waters around the San Juan Islands; (2) Puget Sound; and (3) the Strait of Juan de Fuca, which comprise approximately 6,630 square kilometers of marine habitat. Three primary constituent elements exist in these areas: water quality to support growth and development, prey species of sufficient quantity, quality and availability to support individual growth, reproduction and development, as well as overall population growth, and passage conditions to allow for migration, resting and foraging. Water quality has declined in recent years due to agricultural run-off, urban development resulting in additional treated water discharge, industrial development and oil spills. The primary prey of southern residents, salmon, has also declined due to overfishing and reproductive impairment associated with loss of spawning habitat. The constant presence of whale-watching vessels and growing anthropogenic noise background has raised concerns about the health of areas of growth and reproduction as well.

---

### Environmental Baseline

---

By regulation, environmental baselines for Biological Opinions include the past and present impacts of all state, Federal or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process (50 CFR 402.02). The environmental baseline for this Biological Opinion includes the effects of several activities that affect the survival and recovery of endangered and threatened in the Action Area.

A number of human activities have contributed to the current status of populations of endangered and threatened

species in the action area. Some of those activities, most notably commercial whaling, occurred extensively in the past, ended, and no longer appear to affect populations of these species, although the effects of these reductions likely persist today. Other human activities are ongoing and appear to continue to affect populations of endangered and threatened species in the Action Area. The following discussion summarizes the principal phenomena in the Action Area that are known to affect the likelihood that these endangered and threatened species will survive and recover in the wild.

Because this is a programmatic consultation, however, on what is primarily a continuing action with a geographic scope that encompasses all lands and waters of the United States, its territories and possessions, this *Environmental Baseline* serves a slightly different purpose. First, because this is both a programmatic and national consultation that does not assess the consequences of the Corps proposed action for specific sites or listed resources that occur at those sites, this *Environmental Baseline* focuses primarily on the status and trends of the aquatic ecosystems in the United States and the consequences of that status for listed resources. As such, this *Environmental Baseline* elaborates on some of the narratives we have already presented in our treatments of the *Status of Listed* resources by focusing on the status and trends of waters of the United States at a national scale. However, this Opinion is limited to discharges that occur in the District of Columbia, Idaho, Massachusetts and New Hampshire, all Indian lands and Federal lands in Delaware, Vermont and Washington State.

We begin this *Environmental Baseline* with a discussion of the status and trends of waters of the United States. Because the status and trends of those waters, and the endangered and threatened species that depend on them, has been strongly influenced by wetland ecosystems in the United States, we summarize the status and trends of wetlands in the United States as a second step. Then we summarize the effect of Federal programs designed to protect and restore waters of the United States. We conclude by integrating and synthesizing this information to assess the effect of these programs on endangered species, threatened species, and designated critical habitat.

### ***The Changing Landscapes of the United States***

The continental United States has a land area of about 2.3 billion acres. In 2002, about 20 percent of this area (442 million acres) was cropland in 2002, 26 percent (587 million acres) was permanent grassland pasture and range, 29 percent (651 million acres) was forest-use land, and urban areas represented about 3 percent (60 million acres) of this land area, while a variety of other land uses -parks and recreational areas, wildlife areas, rural highways, roads, railroads, airport rights-of-way- represented about 13 percent of the land area (Lubowski *et al.*, 2006).

Since the 1940s, the acreage of land dedicated to forest-uses has declined since, although this acreage has increased by about 2 percent between 1997 and 2002. Between 1945 and 2002, the acreage of land dedicated to cropland uses declined by about 2 percent; between 1997 and 2002, total cropland decreased by 14 million acres (3 percent) to its lowest level since 1945 (Lubowski *et al.*, 2006). The acreage of land dedicated to grassland pasture and range increased by almost 7 million acres (1 percent) from 1997 to 2002; however, the area dedicated to grazing has declined from the 1940s to 2002 (Lubowski *et al.*, 2006). Between 1945 and 2002, the land area dedicated to special-uses and urban areas has increased continuously. Between 1990 and 2002, the acres in urban areas increased by about 13 percent to 60 million acres (Lubowski *et al.*, 2006).

Since colonial times, the landscapes of the United States reflect the abundance, distribution and economics of the human population. In 1790, the United States had a resident population that was slightly less than 4 million and a population density of 4.5 people per square mile. By 2000, that population had grown to slightly more than 281 million people and the population density had increased to 79.6 per square mile. In 2007, the population of the United States increased to more than 300 million people for the first time in its history.

Most of the population growth in the United States occurred in urban areas, first in central cities and later suburbs. Population sizes of cities in the eastern United States increased from the early 1800s until the 1950s; since then, the population size of western cities like Los Angeles and Phoenix increased while large eastern and Midwestern cities started to decline (Gibson, 1998). At the same time, an increasing percentage of our nation's population was located in suburban areas. In 1910, three times more Americans lived in central cities than in suburban areas; by 1970, slightly more Americans lived in suburban areas than in either cities or rural areas. From 1950 to 1996, the urban population increased by 63 percent, the rural population decreased by 19 percent, and the greatest relative change occurred in the suburban population, an increase of 274 percent.

By 2000, half of the population in the United States lived in the suburbs (Hobbs *et al.*, 2002). About 75 percent of all Americans now live in areas that are urban or suburban in character; that is, about 75 percent of the people in the lower 48 States live in less than 2 percent of the land area of the lower 48 states. Most of the urban or suburban areas occur in the South and Midwest, but cities and suburbs account for less than 2 percent of the land area in those regions. In comparison, urban and suburban lands in the Northeast made up over 5 percent of the landscape. The percentage of "undeveloped" land or natural areas in the South, Northeast and West was almost the same as the percentage of urban and suburban area in those regions (about 22 percent). The Midwest had the lowest percentage of these lands (17 percent). In the Northeast and South, these lands are represented by forest cover; in the Midwest, these lands are represented by farmland, and in the West the lands are represented by grassland and shrub cover.

About half of all natural lands in urban and suburban areas consist of patches that are smaller than 10 acres. Nationally, less than 5 percent of all natural areas consist of patches at least 1,000 acres in size. The northeast States have a higher percentage of natural areas between 100 and 1,000 acres and 1,000 to 10,000 acres in size than the other regions. Only western States have natural areas greater than 10,000 acres; these natural areas, however, account for 0.3 percent of all natural lands in urban and suburban areas.

In some cases suburbs developed along major highways and transportation systems to connect pre-existing, rural communities with nearby urban areas. In other cases, suburbs developed in areas that had previously been agricultural or had been dominated by natural communities because of favorable environmental conditions, zoning ordinances or land costs (Abler, 1976; Matlack, 1997). As a result, most modern metropolitan areas encompass a mosaic of different land covers and uses (Hart, 1991). The mosaic or land uses associated with urban and suburban centers has been cited as the primary cause of declining environmental conditions in the United States (Flather *et al.*, 1998) and other areas of the world (Houghton, 1994).

Other human activities that have altered the landscapes of the United States include agricultural practices that include land conversion, sod busting, and applications of pesticides; forest practices that include timber harvests, silviculture, and the construction of logging roads; mining practices that include open-pit mining, mountain-top mining, placer mining, heap-leach mining, and removal of overburden materials; road construction practices that include alteration of land in the right of way, spraying herbicides to maintain the right of way, and construction of quarries for source materials; civil works projects that include canals, drainage ditches, projects to deliver water to arid lands in the western States, projects to drain wetlands in southeastern States, projects to control flooding in mid-western and eastern States, port construction, projects to maintain shipping channels, and the construction of more than 8,100 major dams on rivers and streams in the United States, Puerto Rico, and the U.S. Virgin Islands.

The direct and indirect effects of these changes in land-use and land-cover change have had a lasting effect on the quantity, quality and distribution of every major terrestrial, aquatic, and coastal ecosystem in the United States, its territories and possessions. By the mid-1990s, at least 27 types of ecosystems had declined by more than 98 percent

(Noss and Murphy, 1995). These include old growth and virgin forests in the eastern United States, pine barrens across Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island (Cryan, 1985); more than 95 percent of the natural barrier island beaches in Maryland had been destroyed along with more than 50 percent of barrier island dunes. By 1986, more than 98 percent of the pre-settlement longleaf pine (*Pinus palustris*) forests in the southeastern coastal plain had been destroyed (Noss and Murphy, 1995). Many other native ecosystems have experienced substantial reductions in area. About 90 percent of the original 58 million hectares of tallgrass prairie had been destroyed; 99 percent of the tallgrass prairie east of the Missouri River and 85 percent of the tallgrass prairie west of the Missouri River has been destroyed (Klopatek *et al.*, 1979).

Aquatic and semi-aquatic ecosystems have not fared much better than these terrestrial ecosystems. Between the 1780s and 1980s, 30 percent of the nation's wetlands had been destroyed, including 74 percent of the wetlands in Connecticut, 73 percent of the wetlands in Maryland, 52 percent of the wetlands in Texas, 91 percent of all wetlands in California, including 94 percent of all inland wetlands (Dahl, 1990). From 1982 to 1987, the wetland area throughout the conterminous United States declined by 1.1 percent and the expansion of urban – suburban metropolitan areas accounted for 48 percent of this decline (Brady and Flather, 1994).

Because of these changes in land use, many of the native plant and animal species that inhabited those native ecosystems over the past have become extinct or extinct in the wild over the past 200 years. The last passenger pigeon, a species that once numbered in the billions and covered most of the eastern and mid-western United States, became extinct in 1912. In the same year, the Louisiana parakeet (*Conuropsis carolinensis ludoviciana*) became extinct followed two years later by the extinction of its relative, the Carolina parakeet (*C. c. carolinensis*). The heath hen became extinct in the mid-1920s, the June sucker (*Chasmistes liorus liorus*) in the mid-1930s, Tecopa pupfish (*Cyprinodon nevadensis calidae*) in the early 1940s, and Ash Meadows killifish (*Empetrichthys merriami*) and Thicktail chub (*Gila crassicauda*) in the 1950s. Over the past 200 years, a substantial portion of the bird fauna of the Hawaiian islands -including the Oahu akepa, Kona finch, Lanai creeper, black mamo, and Hawai'i o'o- became extinct combined with the extinction of substantial portions of the freshwater mussel fauna of the Mississippi, Ohio, and Tennessee Rivers and regional extirpations of the flora and fauna of California, Florida, Oregon, Puerto Rico, and the desert states.

### **Status and Trends of Waters of the United States**

All of the endangered and threatened species and designated critical habitat under the jurisdiction of NMFS depend on the health of aquatic ecosystems for their survival. All of these species were listed as endangered or threatened, at least in part, because of the consequences of human activities on the aquatic ecosystems -the estuaries, rivers, lakes, streams, and associated wetlands, floodplains, and riparian ecosystems- of the United States, its Territories and possessions. The status and trends of those aquatic ecosystems determines the status and trends of these species and the critical habitat that has been designated for them.

Over the past 30 to 40 years, the nation's aquatic ecosystems have improved substantially. In particular, pollution from point sources has been significantly reduced over the past 35 years. Sewage and industrial discharges into aquatic ecosystems have been controlled and some agricultural pesticides have been restricted or banned. Programs like the Conservation Reserve Program have taken highly erodible lands out of production. Despite this progress, however, many aquatic ecosystems remain highly polluted. Of the waters bodies they assessed -39 percent of the river and stream miles, 46 percent of the lake area and 51 percent of the estuarine area- one or more designated uses are impaired. Non-point pollution from urban and agricultural land (e.g. siltation, nutrients, bacteria, metals and oxygen depleting substances) that is transported by precipitation and runoff was the primary cause of the

impairment.

These water quality problems, particularly the problem of non-point sources of pollution, have resulted from the changes humans have imposed on the landscapes of the United States over the past 100 – 200 years. One way of relating these changes in water quality to land uses relies on the surface area of a watershed that is covered by porous versus impervious surfaces. Most land areas that are covered by natural vegetation are highly porous and have very little sheet flow; precipitation falling on these landscapes infiltrates the soil, is transpired by the vegetative cover or evaporates. The increased transformation of the landscapes of the United States into a mosaic of urban and suburban land uses has increased the area of impervious surfaces -roads, rooftops, parking lots, driveways and sidewalks- in those landscapes.

The amount of impervious surface in a watershed is a reliable indicator of a suite of phenomena that influence a watershed's hydrology (Center for Watershed Protection, 2003). Above certain thresholds, landscapes with impervious surfaces respond to precipitation differently than other land-uses: rain that would normally infiltrate in forest, grassland and wetland soils falls on and flows over impervious surfaces. That runoff is then channeled into storm sewers and released directly into surface waters (rivers and streams), which changes the magnitude and variability of water velocity and volume in those receiving waters.

### **Clean Water Act**

The Federal Water Pollution Control Act, or Clean Water Act, is the principal law concerned with polluting activity in streams, lakes and estuaries in the United States. This 1948 statute was totally re-written in 1972 (P. L. 92-500) to produce its current purpose: “to restore and maintain the chemical, physical, and biological integrity of the Nation's waters” (Federal Water Pollution Control Act, Public Law 92 –500). Congress made substantial amendment to the Clean Water Act in the Water Quality Act of 1987 (P. L. 100-4) in response to the significant and persistent water quality problems.

The Clean Water Act uses two primary approaches to achieve its goal. The first approach uses regulations to achieve a goal of zero discharge of pollutants into waters of the United States. The second approach provides Federal technical assistance for municipal wastewater treatment construction. Both approaches are supported by research activities, permits and provisions for enforcement.

To achieve its objectives, the Clean Water Act prohibits all discharges into the nation's waters, unless they are specifically authorized by a permit. For example, the National Pollutant Discharge Elimination System or NPDES program regulates discharges of pollutants like bacteria, oxygen-consuming materials, and toxic pollutants like heavy metals, pesticides, and other organic chemicals. On the other hand, Section 404 of the Clean Water Act prohibits discharges of dredged or fill material into waters of the United States without a permit.

Most of these Federal programs are administered by the EPA, while state and local governments have the principal day-to-day responsibility for implementing the law. However, other section of the Clean Water Act, such as the regulation of discharges of dredged or fill material into waters of the United States pursuant to section 404 (33 U.S.C section 1344) are administered by the U.S. Army Corps of Engineers, or a state with a program approved by the EPA. Nonpoint sources of water pollution, which are believed to be responsible for the majority of modern water quality problems in the United States, are not subject to Clean Water Act permits or the regulatory requirements. Instead, non-point sources of pollution are regulated by State programs.

### **Puget Sound as an Example of the Impact**

Puget Sound provides an illustrative example of the impacts of the environmental baseline on endangered and threatened species under NMFS' jurisdiction. Between 2000 and 2006, counties in Puget Sound increased by 315,965 people or by more than 50,000 people per year, with associated increases in the area of impervious surface and population density per square mile of impervious surface in the Puget Sound region (Puget Sound Action Team 2007). Between 1991 and 2001, the area of impervious surface in the Puget Sound basin increased 10.4 percent (Puget Sound Action Team, 2007). By 2001, impervious surface covered 7.3 percent of the Puget Sound region below 1,000 feet elevation; in some counties and watersheds in the region, this area was substantially higher.

Over the same time interval, about 190 square miles of forest (about 2.3 percent of the total forested area of the Puget Sound basin) was converted to other uses. In areas below 1,000 feet elevation, the change was more dramatic: 3.9 percent of total forest area was converted to other uses. By 2004, about 1,474 fresh and marine waters in Puget Sound were listed as "impaired waters" in Puget Sound. Fifty-nine percent of these waters tested were impaired because of toxic contamination, pathogens, low dissolved oxygen or high temperatures. Less than one-third of these impaired waters have cleanup plans in place. Chinook salmon from Puget Sound have 2-to-6 times the concentrations of PCBs in their bodies as Chinook salmon from other populations on the Pacific Coast. Because of this contamination, the Washington State Department of Health issued consumption advisories for Puget Sound chinook (Puget Sound Action Team, 2007).

The quality of water in the Puget Sound Basin and aquatic biota those water support have been affected by a range of forestry, agricultural, and urban development practices. The chemical quality of surface water in the foothills and mountains is generally suitable for most uses. However, the physical hydrology, water temperature and biologic integrity of streams have been influenced to varying degrees by logging (Black and Silkey, 1998).

Because of development, many streams in the Puget Lowlands have undergone changes in structure and function with a trend toward simplification of stream channels and loss of habitat (Black and Silkey, 1998). Sources of contaminants to lowland streams and lower reaches of large rivers are largely nonpoint because most major point sources discharge directly to Puget Sound. Compared with that in small streams in the Puget Lowlands, the quality of water in the lower reaches of large rivers is better because much of the flow is derived from the forested headwaters.

More than half of the agricultural acreage in the basin is located in Whatcom, Skagit and Snohomish Counties. Agricultural land use consists of about 60 percent cropland and 40 percent pasture. Livestock produce a large amount of manure that is applied as fertilizer to cropland, some- times in excess amounts, resulting in runoff of nitrogen and phosphorus to surface water and leaching of nitrate to ground water. Runoff from agricultural areas also carries sediment, pesticides, and bacteria to streams (Staubitz *et al.*, 1997). Pesticides and fumigant-related compounds are present, usually at low concentrations, in shallow ground water in agricultural areas.

Heavy industry is generally located on the shores of the urban bays and along the lower reaches of their influent tributaries, such as Commencement Bay and the Puyallup River in Tacoma and Elliott Bay and the Duwamish Waterway in Seattle. High-density commercial and residential development occurs primarily within and adjacent to the major cities. Development in recent years has continued around the periphery of these urban areas but has trended toward lower density. This trend has resulted in increasing urban sprawl in the central Puget Sound Basin.

Urban land-use activities have significantly reduced the quality of streams in the Puget Sound Basin (Staubitz and others, 1997). Water-quality concerns related to urban development include providing adequate sewage treatment

and disposal, transport of contaminants to streams by storm runoff, and preservation of stream corridors. Water availability has been and will continue to be a major, long-term issue in the Puget Sound Basin. It is now widely recognized that ground-water withdrawals can deplete streamflows (Morgan and Jones, 1999), and one of the increasing demands for surface water is the need to maintain instream flows for fish and other aquatic biota.

Chinook salmon from Puget Sound have 2-to-6 times the concentrations of PCBs in their bodies as other Chinook salmon populations on the Pacific Coast. Because of this contamination, the Washington State Department of Health has issued consumption advisories for Puget Sound Chinook (Puget Sound Action Team, 2007). Nevertheless, between 2000 and 2006, counties in Puget Sound increased by 315,965 people or by more than 50,000 people per year, with associated increases in impervious surfaces and population density per square mile of impervious surface (Puget Sound Action Team, 2007).

Pollutants found in Puget Sound Chinook salmon have found their way into the food chain of the Sound. Harbor seals in southern Puget Sound, which feed on Chinook salmon, have PCB levels that are seven times greater than those found in harbor seals from the Georgia Basin. Concentrations of polybrominated diphenyl ether (also known as PBDE, a product of flame retardants that are used in household products like fabrics, furniture, and electronics) in seals have increased from less than 50 parts per billion in fatty tissue to more than 1,000 ppb over the past 20 years (Puget Sound Action Team, 2007).

Water quality appears poised to have larger-scale effects on the marine ecosystem of the Puget Sound Georgia Basin as evidenced by the intensity and persistence of water stratification in the basin. Historically, Puget Sound was thought to have an unlimited ability to assimilate waste from cities, farms and industries in the region and decisions about human occupation of the landscape were based on that belief. More recent data suggests that the marine ecosystems of the basin have a much more limited ability to assimilate pollution, particularly in areas such as Hood Canal, south Puget Sound, inner Whidbey basin and the central Georgia Basin. In these areas, as strong stratification has developed and persisted, the respective water quality has steadily decreased. As waters become more stratified, through weather, climate or circulation changes, they become even more limited in their ability to assimilate pollution.

The presence of high levels of persistent organic pollutants, such as PCB, DDT, and flame-retardants have also been documented in southern resident killer whales (Herman *et al.*, 2005; Ross, 2006; Ylitalo *et al.*, 2008). Although the consequences of these pollutants on the fitness of individual killer whales and the population itself remain unknown, in other species these pollutants have been reported to suppress immune responses (Kakuschke and Prange, 2007), impair reproduction and exacerbate the energetic consequences of physiological stress responses when they interact with other compounds in an animal's tissues (Martineau, 2007). Because of their long life span, position at the top of the food chain, and their blubber stores, killer whales would be capable of accumulating high concentrations of contaminants.

#### Ambient Noise in the Puget Sound Region

Ambient noise is background noise in the environment. When one considers the distance from its source that a signal can be detected, the intensity and frequency characteristics of ambient noise are important factors to consider in combination with the rate at which sound is lost as it is transmitted from its source to a receiver (Richardson *et al.*, 1995). Generally, a signal would be detectable or salient only if it is stronger than the ambient noise at similar frequencies. The lower the intensity of ambient noise, the farther signals would travel and remain salient.

There are many sources of ambient noise in the ocean, including wind and waves, rain and hail, human activities

such as shipping, fishing boats, and seismic surveys; sounds produced by living organisms, seismic noise from volcanic and tectonic activity, and thermal noise that results from molecular agitation (which is important at frequencies greater than 30 kHz).

Several authors have reported that ambient noise levels in the northeast Pacific Ocean increased between the mid-1960s, the mid-1990s and the early 2000s. Andrew *et al.* (2002) reported that ambient sound levels increased by about 10 dB in the frequency ranges between 20 and 80 Hz and 200 and 300 Hz between the period from 1963 to 1965 and 1994 to 2001. In the frequency range between 200 and 300 Hz, ambient sound levels increased by about 3 dB. Since the 1960s, ambient noise in the 30–50 Hz band has increased by 10–12 dB, with most of this increase resulting from changes in commercial shipping (McDonald *et al.*, 2006) and increases in whale song (Andrew *et al.* 2002).

Measurements taken at San Nicholas Island, which were considered representative of patterns that would occur across the Pacific Coast of California, Oregon, and Washington, identified seasonal differences in ocean ambient levels due to seasonal changes in wind driven waves, biological sound production, and shipping route changes (McDonald *et al.*, 2006). The strongest seasonal signal at the San Nicolas South site was attributed to blue whale singing (Burtenshaw *et al.*, 2004) which had a broad peak near 20 Hz in the spectral data (because fin whales occur in the area throughout the year, the seasonal difference was attributed to blue whales, which only occur in the areas seasonally). When the band of fin whale calls were excluded, the average February 2004 ambient pressure spectrum level was 10–14 dB higher than the February 1965 and 1966 levels over the 10–50 Hz band. Above 100 Hz, there was a 1–2 dB difference between the two sets of February noise data (McDonald *et al.*, 2006).

Noise in the marine environment has received a lot of attention in recent years and is likely to continue to receive attention in the near future. Several investigators have argued that anthropogenic sources of noise have increased ambient noise levels in the ocean over the last 50 years (Richardson *et al.*, 1995). As discussed in the preceding section, much of this increase is due to increased shipping as ships become more numerous and of larger tonnage (National Research Council, 2003). Commercial fishing vessels, cruise ships, transport boats, airplanes, helicopters and recreational boats all contribute sound into the ocean (National Research Council, 2003). The military uses sound to test the construction of new vessels as well as for naval operations. In some areas where oil and gas production takes place, noise originates from the drilling and production platforms, tankers, vessel and aircraft support, seismic surveys, and the explosive removal of platforms (National Research Council, 2003). Many researchers have described behavioral responses of marine mammals to the sounds produced by helicopters and fixed-wing aircraft, boats and ships, as well as dredging, construction, geological explorations, etc. (Richardson *et al.*, 1995).

### ***Integration and Synthesis of the Environmental Baseline***

The direct and indirect effects of changes in land-use and land-cover in the states of Alaska, Delaware, Idaho, Hawaii (only Midway Island), Massachusetts, New Hampshire, Vermont and Washington; the District of Columbia; the territories of American Samoa, Guam, and Puerto Rico; the Commonwealth of the Northern Mariana Islands; the possessions Johnston Atoll and Wake Island; and Indian lands throughout the United States have had lasting effect on the quantity, quality, and distribution of every major terrestrial, aquatic, and coastal ecosystem in those states, district, territories, and possessions. Many native ecosystems exist as small isolated fragments surrounded by expanses of urban and suburban landscapes or “natural” areas that are dominated by non-native species. As a result, many of the native plant and animal species that inhabited those native ecosystems over the past have become extinct, extinct in the wild, endangered, or threatened over the past 200 years.

Beginning in the 1960s, a wide variety of programs undertaken by Federal, State, and local governments, non-governmental organizations, and private individuals have been established to protect or restore our nation's forests, grasslands, wetlands, estuaries, rivers, lakes, and streams. Those programs have helped slow and, for many ecosystems, reverse declining trends that began in the past. However, those efforts have benefited some ecosystems and their associated flora and fauna more than other ecosystems. Despite the efforts of agencies at every level of government, non-governmental organizations, and private individuals, non-point sources of pollution still degraded our rivers, lakes, and streams; freshwater aquifers in coastal areas remain at risk from saltwater intrusion because of water withdrawals; nutrients transported down the Mississippi River remains sufficient to produce an hypoxic zone in the Gulf of Mexico that had more than doubled in size; and the acreage of wetland declined from slightly more than 274 million acres of wetlands to about 107.7 million acres between the 1980s and 2004 (Dahl, 2006).

### **Southern Resident Killer Whales**

As discussed in the *Status of the Species* section of this Opinion, southern resident killer whales were listed as endangered because of their exposure to the various stressors that occur in the action area for this consultation. Exposure to those stressors resulted in the species' decline from around 200 individuals to about 67 individuals in the 1970s and the species' apparent inability to increase in abundance above the 75 to 90 individuals that currently comprise this species. These phenomena would increase the extinction probability of southern resident killer whales and amplify the potential consequences of human-related activities on this species. Based on their population size and population ecology (that is, slow-growing mammals that give birth to single calves with several years between births), we assume that southern resident killer whales would have elevated extinction probabilities because of exogenous threats caused by anthropogenic activities that result in the death or injury of individual whales (for example, ship strikes or entanglement) and natural phenomena (such as disease, predation, or changes in the distribution and abundance of their prey in response to changing climate) *as well as* endogenous threats resulting from the small size of their population. Based on the number of other species in similar circumstances that have become extinct (and the small number of species that have avoided extinction in similar circumstances), the longer southern resident killer whales remain in these circumstances, the greater their extinction probability becomes.

### **Pacific Salmon**

When NMFS listed Sacramento River winter-run Chinook salmon as endangered and designated critical habitat for the species, its final rules to list the species and designated its critical habitat identified water quality degradation associated with the section 404 permits the Corps issued in the Sacramento River, Sacramento River-San Joaquin Delta, and San Francisco Bay as one of several reasons for the listing (57 FR 36626, 59 FR 440). When NMFS proposed Oregon coast, Southern Oregon Northern Coastal California, and Central California Coast coho salmon as threatened, the proposal also identified the loss of wetland habitat, including the Corps failure to consider the cumulative impact of its 404 permits, as one of several reasons for listing these salmon as threatened (60 FR 38011, 61 FR 56138).

Similarly, when NMFS proposed and listed Central California Coast, South Central California Coast, Central Valley, Upper Columbia River, Snake River Basin, Lower Columbia River, and Northern California steelhead as threatened and Southern California steelhead as endangered, NMFS identified the loss of wetland habitat as one of several reasons these steelhead warranted protection under the ESA (61 FR 41541, 62 FR 43937). Rules designating or proposing critical habitat for green and hawksbill sea turtles, several populations of steelhead, and coho salmon have also identified water quality degradation caused by activities authorized by Corps permits as one of several reasons for these critical habitat designations (64 FR 36274, July 6, 1999; 63 FR 46693, September 2, 1998, 64 FR

---

## Effects of the Proposed Action

---

The *Description of the Proposed Action* section of this Opinion summarized the proposed Action. The *Status of the Listed Resources and Environmental Baseline* section then identified the endangered species, threatened species and designated critical habitat under NMFS' jurisdiction that are likely to be adversely affected by the proposed action and summarized the status and trends of those species, their dependence on waters of the United States and other ecological information that might be relevant to our effects analyses, then summarized the consequences of a variety of human activities on endangered species, threatened species and designated critical habitat.

In the *Effects of the Proposed Action* section of this programmatic consultation we evaluate the decision-making process that EPA uses to insure that the activities it authorizes are not likely to result in jeopardy to threatened or endangered species or result in adverse modification of designated critical habitat. For many programmatic consultations, the action agency has structured the program so that neither species nor critical habitat are exposed to the stressors of the action until there is a separate ESA section 7 consultations addressing site specific activities that will result in exposure. However, in this instance, EPA intends to authorize a large number of discharges without subsequent ESA section 7 consultations, except for those discharges that do not qualify for coverage under the general permit and for which the discharger must seek an individual permit. Accordingly, if there is overlap with species, EPA's programmatic action will result in exposure of species and critical habitat to the action.

In this section we approach analyses of the EPA's decisions and actions through a series of steps. The first step identifies those aspects of proposed actions that are likely to have individual, interactive or cumulative direct or indirect physical, chemical and biotic effects on the environment. We refer to these aspects of the action as "potential stressors." Potential stressors include the actual phenomena that cause stress to an organism as well as the events resulting in those phenomena.

The second step of our analyses identifies the endangered or threatened species, or designated critical habitat that are likely to occur in the same space and at the same time as these potential stressors. Once we identify which endangered or threatened species, or designated critical habitat are likely to be exposed to an action's effects and the nature of that exposure, we examine the scientific and commercial data available to determine whether and how those endangered or threatened species, or designated critical habitat are likely to respond given their exposure. This step represents our *Exposure and Response Analyses*. The *Risk Analyses* are the final steps of our analyses and establish the risks those responses pose to the continued existence of listed species or designated critical habitat.

Because the continued existence of listed species depends on the fate of the populations that comprise them, the viability of listed species (i.e. the probability of extinction or probability of persistence) depends on the viability of the populations that comprise these species. Similarly, the continued existence of populations are determined by the fate of the individuals that comprise them; populations grow or decline as the individuals that comprise the population live, die, grow, mature, migrate and reproduce (or fail to do so).

For designated critical habitat, our "destruction or adverse modification" determinations are based on an action's

effects on the conservation value of habitat that has been designated as critical to threatened or endangered species<sup>17</sup>. If critical habitat designation is likely to be exposed to the direct or indirect consequences of the proposed action on the natural environment, we ask if any primary or secondary constituent elements included in the designation or physical, chemical or biotic phenomena are likely to respond to that exposure.

For the final part of our *Effects Analysis*, we examine the EPA's decision making process and the protective control measures it intends to establish to protect listed species or designated critical habitat from the adverse direct or indirect effects of the activities authorized by the permit. We then determine whether these controls are sufficient such that EPA can insure that these activities are not likely to result in jeopardy to the continued existence of any listed species or designated critical habitat under NMFS' jurisdiction. As part of this analysis, we analyze the past performance of similar control measures in the individual and general permits that the EPA has issued and consider the performance of those controls as indicative of how well the controls of the PGP are likely to work.

To conduct these analyses, we rely on all of the evidence available to us<sup>18</sup>. This evidence might consist of monitoring reports submitted by past and present permit holders, reports from NMFS Science Centers, reports prepared by State or Tribal natural resource agencies, reports from non-governmental organizations involved in marine conservation issues and the general scientific literature. In addition to this evidence, we consider reports and other documents (e.g. environmental assessments, environmental impact statements and monitoring reports) prepared by other Federal and State agencies such as the Minerals Management Service, U.S. Coast Guard and U.S. Navy whose operations extend into the marine environment.

### **Potential Stressors**

In this section, we identify those aspects of the proposed action that are likely to have individual, interactive, or cumulative direct or indirect physical, chemical and biotic effects on the environment. In this Opinion we are primarily concerned with the potential adverse effects to endangered or threatened species, or designated critical habitat by pesticides discharged on, over or near waters of the United States as authorized by the issuance of the PGP.

The EPA focused on the active ingredients of pesticide formulations when it registered these compounds for the use patterns to be authorized by the PGP. Many of these pesticide active ingredients persist in the aquatic environment long after their intended uses (see Table 4). In addition, these active ingredients also include adjuvants, surfactants and other additives. The effects of exposure to these other product ingredients were not evaluated in the FIFRA registration process.

The EPA permits more than 4,000 potentially hazardous additives for use in pesticide formulations. For example, nonylphenols are ingredients that may be included in the formulations of pesticide pollutants and are common wastewater contaminants from industrial and municipal sources. A national survey of streams found that nonylphenol was among the most common organic wastewater contaminants in the U.S. and was detected in more than 50% of the samples tested (Koplin *et al.*, 2002a). The common pesticide additive xylene is a neurotoxin and the

---

<sup>17</sup> We are aware that several Courts have ruled that the definition of destruction or adverse modification that appears in the Section 7 regulations at 50 CFR 402.02 is invalid and do not rely on that definition for the determinations we make in this Opinion. Instead, as we explain in the text, we use the "conservation value" of critical habitat for our determinations, which focuses on the designated area's ability to contribute to the conservation of the species for which the area was designated.

<sup>18</sup> Although Section 7(a)(2) of the Endangered Species Act of 1973, as amended, requires us to use the best scientific and commercial data available, at this stage of our analyses, we consider all lines of evidence.

additive coal tar is a known carcinogen. To complicate matters, several permitted additives are also registered pesticide active ingredients.

Because individual components of pesticide formulations other than the active ingredients may themselves be toxic, we consider all pesticides –including adjuvants, surfactants and other additives in the formulations of those pesticides– that are to be authorized to be discharged on, over or near waters of the United States by the proposed PGP to be pesticide pollutants.

**Table 4. Persistence of Some Commonly Used Pesticides in Surface Water and Aquatic Sediments (After Mackay *et al.*, 1997)**

Use Class	Chemical Class	Example	Half Life	
			Surface Water	Aquatic Sediment
Herbicides	Amino acid derivatives	Glyphosate	~2 months	~8 months
	Chlorphenoxy acids	2,4-D,	~2 days	~2 months
	Triazines	Atrazine	~2 years	~2 months
		Simazine	~3 weeks	~8 months
Insecticides	Carbamates	Carbaryl	~1 week	~2 months
		Organophosphates	Chlorpyrifos	~1 week
	Diazinon		~2 months	~8 months
	Malathion		~2 days	~3 weeks

***Use Patterns to be Authorized by the Proposed Permit***

***Mosquito and Other Flying Insect Pest Control***

This use pattern includes any application of pesticides in, over or near waterbodies where these pests spend at least part of their life cycle. Applications may occur to prevent disease outbreaks or other health reasons or to support recreational activities.

The variety of pesticides and formulations that are used will commonly depend on the life stage of mosquito that is being controlled. To control larval stages, formulations of *Bacillus thuringiensis israelensis* and *B. sphaericus* are common while formulations of carbaryl, chlorpyrifos, deltamethrin, malathion and sumithrin are common to control flying adults. The 13 mosquito abatement districts in the State of Idaho, for example, generally apply different formulations of *Bacillus thuringiensis* and *B. sphaericus* to mosquito breeding habitats when their larvae are in the first to third instar stages of life (Anonymous, 2003), although some districts will also apply methoprene or temephos (in the formulation Abate®). To control flying adult mosquitoes, these districts apply ultra-low volumes of insecticides, which include a malathion-based ultra-low volume concentrate, naled, pyrethrins and pyrethroids (Anonymous, 2003).

The Central Massachusetts Mosquito Control Project<sup>19</sup>, as another example, also applies different formulations of

<sup>19</sup> <http://www.cmmcp.org/>

*Bacillus thuringiensis* and *B. sphaericus* to control mosquito larvae, also supplemented with formulations of methoprene. To control flying adult mosquitoes, these districts apply ultra-low volumes of insecticides, which include formulations of sumithrin, deltamethrin and pyrethroids. The State of New Hampshire Department of Health and Human Services<sup>20</sup> uses similar formulations to control mosquitoes.

### ***Aquatic Weed and Algae and Pathogen Control***

The aquatic weed and algae control pesticide use pattern includes the application of pesticides in, over or near waterbodies to control algae and other submergent or emergent nuisance aquatic plants to protect sensitive aquatic habitats and to maintain recreational uses. This is a broad use pattern covering many types of aquatic habitats.

There are a variety of formulations and application methods for this use pattern. For example, the pesticides that the EPA currently authorizes for aquatic weed and algae control in Idaho include 2,4-D, copper compounds, diquat, endothall, fluridone, glyphosate and triclopyr<sup>21</sup>. Application methods include boom sprayers, spreaders, backpack sprayers and aerial applications. Applications under this use pattern include spot treatments or large scale treatments of several acres. These applications are usually made when the target plants are present and not dormant. Because these factors can vary widely between regions and individual waterbodies, these applications may occur at any time of year.

### ***Aquatic Nuisance Animal and Pathogen Control***

The aquatic nuisance animal control use pattern includes the application of pesticides in, over or near waterbodies to control a wide variety of aquatic animals. These uses include fisheries management, invasive species eradication and equipment maintenance.

Aquatic nuisance animal pests include a range of taxa including vertebrates and invertebrates such as insects, mollusks or crustaceans in a variety of aquatic habitats. Examples of the types of pesticides authorized for this use pattern include sodium chlorate and rotenone, which are currently authorized by the EPA use in Idaho<sup>16</sup>. In addition, the EPA authorizes other pesticides such as antimycin-A and TFM for other areas under this use pattern.

Applications are usually made over an entire waterbody and applications methods include drip-feed devices, backpack sprayers, boat bailers and aerial applications. Treatments are usually made several years apart and may occur at any time of year.

### ***Forest Canopy Pest and Pathogen Control***

The forest canopy pest control use pattern includes pesticide applications in and over forest canopies where these pesticides may enter waters of the United States. These applications usually occur over areas in response to specific pest outbreaks. Examples of such pests include gypsy moths, southern pine beetles and locust borers. This is a broad use category and covers a wide range of aquatic habitats with a variety of pesticide formulations and application methods. For example, the EPA authorizes carbaryl, chlorpyrifos and dimethoate for use in Idaho under this use pattern. Other pesticides including diflubenzuron, dispralure, malathion and trichlorfon are authorized by the EPA for forest canopy pest control in other locations. Application methods include hand sprayers, aerial applications and drip or overhead irrigation systems. These applications may occur at any time of year.

---

<sup>20</sup> <http://www.dhhs.nh.gov/dphs/cdcs/arboviral/mosquito.htm>

<sup>21</sup> Idaho State Department of Agriculture: <http://www.kellysolutions.com/ID/searchbyproductname.asp>

## **Spatial Overlap between Use Patterns, Listed Species and Designated Critical Habitat**

### **Location of Use Patterns Authorized by the Permit**

To determine the spatial overlap between the use patterns to be authorized by the PGP and the endangered or threatened species and designated critical habitat under NMFS' authority, we first determined the relative number of operators by location and type that EPA estimates will be authorized to discharge pesticide pollutants by the proposed permit. The results of this analysis are presented in Table 5. The EPA did not identify any differences in the timing, pesticide formulations or application rates to be used between geographic regions for any use pattern.

Based on this analysis, one or more use patterns are expected to overlap with the distributions of endangered or threatened species or designated critical habitat under NMFS' jurisdiction in all of the locations where EPA is the permitting authority. Of the 35,183 total operators that EPA expects to authorize under the proposed permit, in locations where endangered or threatened species under NMFS' jurisdiction occur, most pesticide pollutant discharges will occur in the State of Idaho (47.10%), followed by Massachusetts (6.48%) then by New Hampshire with 2.17%. Operators in Alaska and Indian lands would comprise 1.09% and 0.48% of all operators respectively. Idaho is within the range of listed Chinook salmon, chum salmon, coho salmon, sockeye salmon and steelhead trout species and also contains designated critical habitat for Chinook salmon, sockeye salmon and steelhead trout. New Hampshire is within the range the endangered shortnose sturgeon. Shortnose sturgeon are also found in Massachusetts, especially the Merrimack River.

The majority of mosquito and other flying pest control use pattern operators would occur in New Hampshire (36.36%), followed by Idaho (19.01%). Most of the aquatic weed and algae control operators are in Idaho (48.17%) followed by Massachusetts with 5.96%. Most of the aquatic nuisance animal control operators that overlap with the distribution of endangered or threatened species and designated critical habitat under NMFS' authority are in Massachusetts and Alaska (both at 6.82%), followed by Idaho at 5.45%.

The forest canopy pest control use patterns overlap with the distributions of endangered and threatened species and designated critical habitat under NMFS' jurisdiction in all of the locations where EPA is the permitting authority except the District of Columbia. Of these, most operators are located in Massachusetts (38.93%) followed by New Hampshire with 15.32%.

### ***Pesticide Occurrence in Rivers and Streams***

Pesticides or their degradates were detected in at least one of the water samples from every stream sampled in the U.S. Geological Survey's NAWQA study of California, Idaho, Oregon and Washington waters (Gilliom *et al.*, 2006). Streams in agricultural and urban areas had one or more detectable pesticide or degradate 97% of the time; streams in mixed land-use areas had one or more detectable pesticide or degradate 94% of the time; and streams in undeveloped areas had one or more detectable pesticide or degradate 65% of the time (Gilliom *et al.*, 2006). The NAWQA study concluded that the presence of pesticide compounds in undeveloped watersheds might have resulted from earlier or contemporary uses within the watershed for forest management, maintenance of rights-of-way, uses associated with small areas of urban or agricultural land, or atmospheric transport from other areas.

Of 186 stream sites sampled as part of the NAWQA study (Gilliom *et al.*, 2006), 57% of 83 agricultural streams had concentrations of at least one pesticide that exceeded one or more aquatic-life benchmarks at least once during the year (68% of sites sampled during 1993–1994, 43% during 1995–1997, and 50% during 1998–2000); 83% of 30 urban streams had concentrations of at least one pesticide that exceeded one or more aquatic-life benchmarks at least once during the year (90% of sites sampled during 1993–1994, 100% during 1995–1997, and 64% during 1998–

2000); and 42% of 65 mixed-land-use streams had concentrations of at least one pesticide that exceeded one or more aquatic-life benchmarks at least once during the year (38% of sites sampled during 1993–1994, 40% during 1995–1997 and 46% during 1998–2000). In urban streams, most concentrations greater than a benchmark involved the insecticides diazinon (73% of sites), chlorpyrifos (37%) and malathion (30%). The pesticides detected most frequently in streams and ground water were primarily those had been used the most and had the greatest mobility or persistence in aquatic ecosystems. They included atrazine (and its degradate deethylatrazine), metolachlor, cyanazine, alachlor and acetochlor, which were the most heavily-used agricultural pesticides between 1992 and

**Table 5. Percentage of Operators to be Authorized by the Permit per Location and Type**

<b>Location</b>	<b>Mosquito and Other Flying Insect Control</b>	<b>Aquatic Weed and Algae Control</b>	<b>Aquatic Nuisance Animal Control</b>	<b>Forest Canopy Pest Control</b>	<b>TOTAL</b>
<b>Alaska*</b>	1.65%	1.02%	6.82%	2.95%	<b>1.09%</b>
<b>Idaho*</b>	19.01%	48.17%	5.45%	7.87%	<b>47.10%</b>
<b>Massachusetts*</b>	7.44%	5.96%	6.82%	35.08%	<b>6.48%</b>
<b>New Hampshire*</b>	36.36%	1.83%	3.64%	13.93%	<b>2.17%</b>
<b>New Mexico</b>	10.74%	30.41%	9.55%	4.26%	<b>29.76%</b>
<b>Oklahoma</b>	0.83%	11.36%	33.64%	26.07%	<b>11.72%</b>
<b>District of Columbia*</b>	0.83%	0.02%	0.91%	0.00%	<b>0.03%</b>
<b>Territories*</b>	0.83%	0.92%	17.27%	0.66%	<b>1.01%</b>
<b>Indian Lands*</b>	14.05%	0.27%	11.36%	5.57%	<b>0.48%</b>
<b>Federal Facilities*</b>	8.26%	0.03%	4.55%	3.61%	<b>0.15%</b>

\* Denotes areas where discharges may overlap with the distribution of listed species or designated critical habitat under NMFS' jurisdiction.

2001; simazine, prometon, tebuthiuron, 2,4-D and diuron, which were the most heavily-used non-agricultural pesticides; and diazinon, chlorpyrifos and carbaryl, which were the most heavily-used insecticides between 1992 and 2001. Simazine, prometon, diuron, 2,4-D, diazinon and carbaryl, which are commonly used to control weeds, insects and other pests in urban areas, were frequently found at relatively high levels in urban streams throughout the Nation. Within California, Idaho, Oregon and Washington, malathion was detected in approximately 6% of the samples of surface waters analyzed in river basins included in the NAWQA study (Gilliom *et al.*, 2006). Table 6 identifies the number of detections of chlorpyrifos, diazinon and malathion, the maximum and minimum concentrations of these three active ingredients and summary statistics.

An evaluation of pesticides concentrations in eight tributaries of Idaho's Clearwater River basin (Campbell 2004) detected the pesticides metribuzon (found in 23% of 47 detections), diuron (found in 15% of 47 detections), dicamba (found in 13% of 47 detections), atrazine (found in 11% of 47 detections), picloram (found in 8% of 47 detections),

dimethoate (found in 6% of 47 detections), hexazinone (found in 6% of 47 detections), bromacil (found in 4% of 47 detections), linuron (found in 2% of 47 detections), methomyl (found in 4% of 47 detections), simazine (found in 2% of 47 detections), tralkoxydim (found in 2% of 47 detections) and 2,4-D (found in 2% of 47 detections). Pesticides with the highest detections were diuron (1.1 µg/L), dicamba (0.76 ppb), picloram (0.75 µg/L), methomyl (0.36 ppb) and 2,4-D (0.28 µg/L). Five of the eight streams in this basin – Holes Creek, Little Canyon Creek, Mission Creek, Sweetwater Creek and Six Mile Creek – are listed as impaired because of pesticide concentrations and also support salmon populations. Similar surveys of pesticide concentrations in the Lower Payette River basin and Boise River basin detected 21 and 24 pesticides, respectively, including chlorpyrifos, malathion, methomyl, bromacil, dimethoate, diuron and 2,4-D (Campbell, 2009).

**Table 6. Summary of detections of chlorpyrifos, diazinon and malathion in filtered stream samples collected in California, Idaho, Oregon and Washington streams (Gilliom *et al.*, 2006)**

<b>Chemical</b>	<b>Chlorpyrifos</b>	<b>Diazinon</b>	<b>Malathion</b>
Number of detections	1,131	1,767	272
Minimum (µg/L)	0.004	0.002	0.005
Maximum (µg/L)	0.401	3.800	1.350
Arithmetic Mean (µg/L)	0.022	0.084	0.049
Standard Deviation (µg/L)	0.037	0.230	0.121

### **Degradate Occurrence**

Over time, pesticides are transformed into other compounds by chemical, photochemical and biologically-mediated reactions; these other compounds are generally called “degradates” or “metabolites” (Boxall *et al.*, 2004; Gilliom *et al.*, 2006). Some degradates are as prevalent as parent pesticides while others are more prevalent. For example, deethylatrazine, which is a degradate of atrazine and other triazine herbicides, was one of the most frequently detected pesticide compounds in water and one of the most frequent contributors to pesticide mixtures in the U.S. Geological Survey’s NAWQA analyses (Gilliom *et al.*, 2006). NAWQA surveys also reported that degradates and by-products of organochlorine pesticides were among the most commonly detected pesticide compounds in fish (Gilliom *et al.*, 2006). Many degradates are more persistent and more mobile in the environment than their parent compounds (Boxall *et al.*, 2004; Gilliom *et al.*, 2006).

Degradates, like their parent compounds, have the potential to adversely affect water quality, depending on their toxicity. Degradates may be either more or less toxic than their parent pesticides, although most have toxicities to aquatic life that are similar to, or lower than, those of their parent compounds (Sinclair and Boxall, 2003; Boxall *et al.*, 2004; Gilliom *et al.*, 2006). Sinclair and Boxall (2003) reported that 41% of degradates were less toxic than their parent compounds, 39% had toxicities similar to their parents, 20% were more than 3 times more toxic than their parent compound and 9% were more than 10 times more toxic.

### **Environmental Mixtures**

More than 90% of streams surveyed by the NAWQA study in developed land-use settings detected two or more pesticides or degradates; about 70% of the time, streams had five or more pesticides or degradates, and about 20% of the time, streams had detections of 10 or more pesticides or degradates (Gilliom *et al.*, 2006). Mixtures also were found in streams draining undeveloped watersheds, although these streams have compounds: about 25% of the time, undeveloped streams had detections of five or more pesticides or degradates, but no samples had more than 10 detections.

The individual pesticides that were reported in the NAWQA study were the pesticides that were detected the most often and included the herbicides atrazine (and its degradate deethylatrazine), metolachlor, simazine and prometon, each of which was present in more than 30% of all mixtures found in agricultural and urban areas, and in both streams and ground water (Gilliom *et al.*, 2006). In agricultural streams, cyanazine, alachlor, metribuzin and trifluralin were detected in more than 30% of the mixtures; in urban streams, dacthal and the insecticides diazinon, chlorpyrifos, carbaryl and malathion were detected in more than 30% of the mixtures. The NAWQA study detected more than 6,000 unique mixtures of five pesticides in agricultural streams (Gilliom *et al.*, 2006).

Mixtures of organochlorine pesticide compounds were common in samples of fish-tissue taken from most of the streams that were sampled in the NAWQA study (Gilliom *et al.*, 2006). About 90% of fish samples collected in urban streams contained two or more pesticide compounds and 33% contained 10 or more; about 75% of fish samples from streams draining watersheds with agricultural and mixed land use contained two or more pesticide compounds while 10% had 10 or more. Mixtures were detected least often in fish from undeveloped streams, in which two or more compounds were detected in about 25% of the fish-tissue samples.

Surveys of pesticide concentrations in five streams in the Boise River basin detected up to 17 pesticides in some streams (Mason Creek and Fifteenmile); the lowest number of detections was 10 pesticides (Campbell, 2009). Detections included degradates of atrazine (Campbell, 2009).

### ***Consequences of Exposing Listed Species and Designated Critical Habitat***

The preceding section of this Opinion presented the evidence that leads us to conclude that endangered or threatened species and designated critical habitat under the jurisdiction of the NMFS are likely to co-occur with discharges of pesticide pollutants on, over or near waters of the United States. In this section of this Opinion, we summarize information on the probable physical, physiological, behavioral, social and ecological responses of endangered or threatened species or constituent elements of critical habitat given exposure to active ingredients in formulations, other ingredients of formulations, degradates of these ingredients, or chemical mixtures. Our purpose is not to provide a comprehensive review of the probable responses of endangered or threatened species to formulations that include all 171 of the active ingredients for which formulations the PGP would authorize discharges on, over or near waters of the United States; instead, our intention is to identify the range of representative responses we would expect listed species to exhibit given exposure to these chemicals.

EPA's proposed PGP would authorize discharges of pesticide formulations that include about 171 active ingredients on, over or near waters of the United States. The EPA provided NMFS with a list of these active ingredients. Table 8 organizes those 171 active ingredients by class of pesticide, which includes benzoic acids, botanical pesticides, carbamate pesticides, inorganic pesticides, microbial pesticides, organophosphate pesticides, pyrethroid pesticides and rodenticides. Discharges in compliance with FIFRA labels are authorized without the imposition of additional protective measures.

### **Consequences of Exposure to Active Ingredients and Formulations**

All pesticide products contain one or more active ingredients. Most pesticide products also contain ingredients called "adjuvants" (which are designed to increase the effectiveness of the active ingredient and are usually referred to as inert ingredients on product labels) "surfactants" (which reduce the interfacial or surface tension of a system or a surface-active substance) and carriers, as well as other ingredients. Some formulations may contain multiple active ingredients.

Piperonyl butoxide, nonylphenol and nonylphenol polyethoxylates are examples of "inert" ingredients that may be

formulated in pesticide products or added as adjuvant ingredients during pesticide applications. Piperonyl butoxide is a common synergist in formulations of synthetic pyrethroids. Nonylphenol and nonylphenol polyethoxylates are common ingredients in detergents, cosmetics and other industrial products. These compounds are also common wastewater contaminants from industrial and municipal sources. A national survey of streams found that nonylphenol was among the most common organic wastewater contaminants in the U.S. and was detected in more than 50% of the samples tested. The median concentration of nonylphenol in streams was 0.8 µg/L and the maximum concentration detected was 40.0 µg/L. Related compounds were also detected at a relatively high frequency (Koplin *et al.*, 2002b).

For an example of the other ingredients that might appear in formulations, registered pesticide products containing chlorpyrifos, diazinon and malathion always include other ingredients such as carriers and surfactants and may include other registered active ingredients (Table 7).

Because the proposed PGP will authorize discharges of formulations of pesticides on, over or near waters of the United States, we are concerned about those components of formulations that might be toxic to endangered or threatened species under our jurisdiction. Therefore, the summary of the literature that follows discusses various ingredients that appear in pesticides formulations. Some of these ingredients would be listed as “active ingredients” on a pesticide label while others would be listed as “inert” ingredients.

Research that has been conducted over several decades has established that many, but not all, of the 171 ingredients in the 24 classes of pesticides pose serious risks for many aquatic organisms. When they are exposed at some concentration of some pesticides, individuals of some species or stages of species die as a result of their exposure. Other individuals of aquatic species experience reductions in developmental patterns, rates of growth or reproductive success as a direct result of the exposure or because of the chemical’s effect on their behavioral patterns. Exposure to some of the chemicals whose discharges would be authorized by EPA’s proposed Pesticides General Permit has been demonstrated to have physical, physiological or neural effects on individuals that have been exposed and these changes increase their probability of being captured and killed by predators.

Some of the pesticides in the 24 classes identified in Table 8 have been reported to have few, if any, adverse consequences for aquatic organisms, including endangered or threatened species. For example, despite a half-life that is estimated to be about two months in clean river water that is low in sediment, bromacil is not toxic to invertebrates and is only slightly toxic to fish. The 48-hour LC<sub>50</sub> for bromacil in rainbow trout is 56-75 mg/L, in bluegill sunfish is 71 mg/L and in carp is 164 mg/L. The 96-hour LC<sub>50</sub> in fathead minnows is 182 mg/L. The microbial insecticide *Bacillus thuringiensis* (or *B.t.*) did not adversely affect aquatic vertebrates, including brook trout, white suckers and smallmouth bass even a month after aerial applications, although it may adversely affect non-target invertebrates, including butterflies (Lepidoptera).

Some of the chemicals in the 24 classes identified in Table 8 have more severe consequences for organisms that are exposed to them, although the different groups of chemicals affect species through different modes of action. Organophosphates and carbamates inhibit acetylcholinesterase; organotins prevent the formation of adenosine triphosphate; pyrethroids keep sodium channels in neuronal membranes open, which affects the peripheral and central nervous systems and cause a hyper-excitable state; symptoms include tremors, lack of coordination, hyperactivity and paralysis; rotenone which inhibits respiratory enzymes; and limonene which affects the sensory nerves of the peripheral nervous system.

## Botanicals

The botanicals included in the proposed PGP are cube resins (other than rotenone) and Rotenone. Rotenone is used as a fish toxin (piscicide) so we would expect to be highly toxic to fish, including endangered and threatened species of fish. Cheng and Farrell (2007) reported that rotenone was not toxic to juvenile rainbow trout when they were exposed at concentrations of 5.0 µg/L during 96-hour tests, but 100% of the juveniles died when at concentrations of 6.6 µg/L for 96 hours. Johnson and Finley (1980) reported 96-hour LC<sub>50</sub> for rotenone was 23 µg/L for rainbow trout and 2.6 µg/L for channel catfish. Finlayson *et al.*, (2010) exposed rainbow trout for 4 and 8 hours to concentrations of synergized and non-synergized formulations of rotenone. Exposing rainbow trout to a CFT Legumine formulation of rotenone at 5.3 µg/L for an average of eight hours killed half of the rainbow trout. Exposure to a Nusyn-Noxfish formulation of rotenone at 6.2 µg/L for an average of 8 hours also killed half of the rainbow trout.

In addition, populations of aquatic invertebrates have been eliminated in streams that have been treated with rotenone. Binns (1965) reported that aquatic invertebrate populations in the Green River, Wyoming were almost completely eliminated following rotenone treatments. Mangum and Madrigal (1999) reported that the richness of Ephemeroptera in the Strawberry River in north eastern Utah had been reduced by 67-100%, Plecoptera by 67-100% and Trichoptera by 61-100% after two rotenone treatments, of 3 mg/L for 48 hours. In Great Basin National Park, rotenone treatments reduced species in these taxa by 99% for one month.

## Carbamates

The carbamates whose uses would be authorized by the proposed PGP include carbaryl, asulam and sodium salt. Numerous authors have studied and reported the responses of vertebrate species exposed to carbamates (Shea and Berry, 1983; Zinkl *et al.*, 1987; Hanazato, 1991; Sharma *et al.*, 1993; Beyers *et al.*, 1994; Beyers and Sikoski, 1994; Relyea and Mills, 2001; Relyea, 2004; Boran *et al.*, 2007; Davidson and Knapp, 2007). Carbaryl, which is also known by the trade name Sevin, is an example of the group known as N-methyl carbamates, which includes other pesticides like carbofuran and methomyl. These chemicals act as neurotoxicants by impairing nerve cell transmission in vertebrates and invertebrates; specifically, they interfere with normal nerve transmissions and, as a result, can affect a wide array of physiological systems. Organophosphates have the same mode of action and produce similar physiological responses.

Beyers *et al.*, (1994) studied the toxicity of technical carbaryl (1-naphthyl methylcarbamate, 99%) and Sevin-4-Oil (a formulation containing 49% carbaryl and petroleum distillates) to Federally endangered Colorado squawfish (*Ptychocheilus lucius*) and bonytail (*Gila elegans*). In Colorado squawfish, median lethal concentrations for technical carbaryl were 1.31 mg/L (95% confidence interval: 1.23-1.40 mg/L) and were 3.18 mg/L (95% confidence interval: 2.87-3.52 mg/L) for Sevin-4-Oil. In bonytail, median lethal concentrations for technical carbaryl were 2.02 mg/L (95% confidence interval: 1.78 -2.25 mg/L) and were 3.31 mg/L (3.06,-3.55 mg/L) for Sevin-4-Oil. Because Colorado squawfish and bonytail are about as sensitive to carbaryl as cutthroat trout (*Oncorhynchus clarki*), rainbow trout, Atlantic salmon (*Salmo salar*) and brook trout (*Salvelinus fontinalis*), these results should also be applicable to ESA listed Atlantic salmon and listed steelhead (Beyers *et al.*, 1994).

Carlson (1971) exposed fathead minnows to five treatments of carbaryl (8, 17, 62, 210 and 680 µg/L) in a flow through system for nine months; capturing the life cycle of the species. Fathead minnows showed reduced number of eggs per female and reduced number of eggs spawned when exposed to 680 µg/L; none of the eggs that were spawned hatched. Zinkl *et al.*, (1987) reported that carbaryl killed rainbow trout when they were exposed to concentrations at or above 1,000 µg/L for as few as 90 minutes. In this same study, trout exposed to concentrations of 250 – 4,000 µg/L for 24 hours exhibited 61 to 91% AChE inhibition.

**Table 7. Example of listed ingredients on labels of some products containing chlorpyrifos, diazinon and malathion (after NMFS 2008a)**

EPA Product Registration Number	Active Ingredients	Other Ingredients
499-405	chlorpyrifos 8%, cyfluthrin 1.6%	90.4%
4329-36	chlorpyrifos 12% permethrin 4%	84%
39039-6	chlorpyrifos 12% diazinon 4%	60%
655-441	chlorpyrifos 13%, dichlorvos 4.82%	82.18%
66222-19	chlorpyrifos 42.5%	57.5%
7501-112-5905	diazinon 15%, lindane 25%, carboxin 14%	46%
11556-123	diazinon 20%, coumaphos 20%	60%
270-260	diazinon 18%, piperonyl butoxide 2%	80%
61483-92	diazinon 40%, tetrachlorvinphos 10%	50%
4-122	malathion 6%, carbaryl 0.3%, captan 11.8%	81.9%
4-59	malathion 3%, carbaryl 0.5%, captan 5.87%	90.63%
4-355	malathion 6%, sulfur 25%, captan 6.03%	62.97%
4-157	malathion 13.5%, captan 13.5%	73%
7401-163	malathion 7.5%, PCNB 12.5%	80%
11474-96	malathion 2%, piperonyl butoxide 0.12%, pyrethrins 0.05%	97.83%
5481-275	malathion 2%, carbaryl 2%	96%
8329-29	malathion 30.6%, piperonyl butoxide 4.96 %, resmethrin 1.88%	62.66%
769-646	malathion 5.5%, petroleum distillates and mineral oil 89.0%	5.5%

Exposure to carbaryl appears to make cutthroat trout more susceptible to predation, perhaps by inhibiting AChE activity in brain and muscle. Cutthroat trout experienced higher predation rates when exposed to carbaryl at concentrations of 200 µg/L, 500 µg/L and 1,000 µg/L. At 200 µg/L, an increase in predation was evident (Labenia *et al.*, 2007). Little *et al.*, (1990) reported similar results from their studies of the effects of exposing rainbow trout fry (0.5-1.0 g) to carbaryl at 10, 100 and 1,000 µg/L for 96 hours. At all of these exposure concentrations, significantly more rainbow trout were consumed compared with unexposed fish. At concentrations of 1,000 µg/L, exposed rainbow trout fry experienced significant reductions in swimming capacity, swimming activity, prey strike frequency, daphnids consumed, percent consuming daphnids and percent survival from predation.

In its 2009 Biological Opinion<sup>22</sup>, NMFS concluded that FIFRA registered uses of carbamates carbofuran, carbaryl and methomyl were likely to jeopardize most listed salmonid species and adversely modify most of the designated critical habitat.

### Organophosphates

The organophosphates whose uses would be authorized by the proposed PGP include acephate, chlorpyrifos,

<sup>22</sup> <http://www.nmfs.noaa.gov/pr/pdfs/carbamate.pdf>

diazinon, dichlorvos, dimethoate, malathion, naled, temephos, trichlorfon and triclofon. Numerous authors have studied and reported the responses of vertebrate species exposed to organophosphates (Shea and Berry, 1983; Zinkl *et al.*, 1987; Hanazato, 1991; Sharma *et al.*, 1993; Beyers *et al.*, 1994; Beyers and Sikoski, 1994; Relyea and Mills, 2001; Relyea, 2004; Boran *et al.*, 2007; Davidson and Knapp, 2007). Like carbamates, these chemicals act as neurotoxicants by impairing nerve cell transmission in vertebrates and invertebrates; specifically, they interfere with normal nerve transmissions and, as a result, can affect a wide array of physiological systems.

Chlorpyrifos is highly toxic to freshwater fish, aquatic invertebrates and estuarine and marine organisms. EPA's Office of Pesticide Programs estimated environmental concentrations for formulations of chlorpyrifos that assumed that 10% of the applied rate may drift to surface water. As a result, an application rate of 0.025 lbs chlorpyrifos per acre would result in concentrations of 1.5 – 18.5 µg/L chlorpyrifos in surface water at depths of six inches to six feet. The EPA (1989) reported that application of concentrations as low as 0.01 pounds of active ingredient per acre may cause fish and aquatic invertebrate deaths. The 96-hour LC<sub>50</sub> for chlorpyrifos is 0.009 mg/L in mature rainbow trout, 0.098 mg/L in lake trout, 0.806 mg/L in goldfish, 0.01 mg/L in bluegill sunfish and 0.331 mg/L in fathead minnow (EPA, 1986). Therefore, mature rainbow trout exposed to chlorpyrifos concentrations produced by application rates of 0.025 lbs of chlorpyrifos per acre would be expected to have a 50% probability of dying after 96 hours of exposure (alternatively, we would expect about half of an exposed population of rainbow trout to die as a result of their exposure to these concentrations of chlorpyrifos for 96 hours).

When fathead minnows were exposed to Dursban (a formulation of chlorpyrifos) growth was reduced within 30 days at 2.68 micrograms/liter and within 60 days at 1.21 µg/L. The maturation rate of first-generation fish was reduced at all Dursban exposure concentration and reproduction was significantly reduced at concentrations of at least 0.63 micrograms/liter. Growth rates and estimated biomass of 30-day-old second-generation fish were significantly reduced when they were exposed at concentrations of 0.12 micrograms/liter (Jarvinen *et al.*, 1983). Carp (*Cyprinus carpio*) fingerlings exposed to concentrations of chlorpyrifos ranging from 0.120 to 0.200 mg/L for 96 hours had acute toxicities at concentrations of 0.160 mg/L. When these carp were exposed for 1, 7 and 14 days at concentrations of 0.0224 mg/L and 0.0112 mg/L, they exhibited irregular, erratic and darting swimming movements, hyper-excitability and loss of equilibrium and sinking to the bottom. Caudal bending was also reported during exposures (Ramesh and David, 2009).

Diazinon exposures have been implicated in five fish kills reported in California since 2002. One of the fish kills, which EPA classified as probably caused by the use of diazinon, occurred in June 2002 and consisted of 2,000 salmon that were found Tembladera Slough and the Old Salinas River channel in Monterey County, California. Monterey County Agricultural Commissioner staff indicated that a small number of applications of diazinon had been made in the general area when the fish kill occurred. Water samples collected from the sites detected diazinon in four of six samples with concentrations ranging from 0.095 – 0.183 µg/L. Gill samples from all five fish showed recent exposure to chlorpyrifos with concentrations ranging from 5 - 40 µg/kg. Methidathion, another

**Table 8. Classification of the 171 active ingredients by class of pesticide. Ingredients that are listed in bold type are discussed in greater detail in the document**

<b>Pesticide Class</b>	<b>Pesticide Active Ingredient, as listed in Biological Evaluation</b>
Benzoic acid	Dicamba, Dicamba, diglycoamine salt, Dicamba, dimethylamine salt, Dicamba, sodium salt
Biochemical	2, 4-Dodecadienoic acid, 11-methoxy-3, 7, 11-trimethyl-, 1-met, Methoprene, Nonanoic acid
Botanical	Cube Resins other than rotenone, <b>Rotenone</b>
Bromine Compound	Bromine chloride, Sodium bromide
Carbamate	<b>Carbaryl, Asulam</b> , sodium salt
Chlorine Compound	Calcium hypochlorite, Chlorine, Chlorine dioxide, Sodium hypochlorite
Dinitroaniline	2, 4-Dinitro-N3, N3-dipropyl-6-(trifluoromethyl)-1, 3-benzenedia, Oryzalin, Pendimethalin
Hydantoin	1, 3-Dibromo-5, 5-dimethylhydantoin, 1-Bromo-3-chloro-5, 5-dimethylhydantoin
Imidazolinone	(+)-2-(4, 5-Dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1H-imida, Imazapic, Imazapic-ammonium, Imazapyr, Imazapyr, isopropylamine salt, Imazaquin, monoammonium salt
Inorganic	Copper as metallic (in the form of chelates of copper citrate), Copper carbonate, basic, Copper ethanolamine complex, Copper ethylenediamine complex, <b>Copper sulfate pentahydrate</b> , Copper triethanolamine complex, Hydrogen peroxide, Sodium chlorate, Sodium metaborate (NaBO <sub>2</sub> ), Zinc sulfate monohydrate
Microbial	Antimycin A, Bacillus thuringiensis subspecies israelensis Strain BMP, Bacillus licheniformis SB3086, Bacillus sphaericus, <b>Bacillus thuringiensis</b> subspecies israelensis, Bacillus thuringiensis subspecies aizawai, Bacillus thuringiensis subspecies kurstaki, Bacillus thuringiensis subspecies tenebrionis, Polyhedral inclusion bodies of gypsy moth nucleopolyhedrosis virus, Lagenidium giganteum, mycelium or oospores
Organophosphate	<b>Acephate, Chlorpyrifos, Diazinon</b> , Dichlorvos, <b>Dimethoate, Malathion</b> , Naled, <b>Temephos, Trichlorfon</b> , Triclorfon
Other	<b>Acrolein</b> , Saflufenacil, <b>Diflubenzuron</b> , Diquat dibromide, Tebufenozide, Oxyfluorfen, Dodecylguanidine hydrochloride, Imidacloprid, Monosodium acid methanearsonate, Methoxychlor, (**)-Trifluoro-4-nitro-m-cresol (**) = alpha, alpha, alpha-, 1-Bromo-1-(bromomethyl)-1, 3-propanedicarbonitrile, 2-(1-Methyl-2-(4-phenoxyphenoxy)ethoxy)pyridine, 2, 2-Dibromo-3-nitrilopropionamide, Benzenesulfonamide, 2-(2, 2-difluoroethoxy)-N-(5, 8-dimethoxy[1, Carfentrazone-ethyl, CAS Reg. No. 68038-71-1, Endothall, dipotassium salt, Endothall, mono(N, N-dimethylcocoamine) salt, Erioglaucine, Ethyl 2-chloro-5-[4-chloro-(5-difluoromethoxy)-1-methyl-1H-py, Etofenprox, Fluridone, Fosamine ammonium, <b>Glufosinate-ammonium</b> , Glutaral, Methanone, [3-(4, 5-dihydro-3-isoxazolyl)-2-methyl-4-(methylsu, Methyl 9-hydroxyfluorene-9-carboxylate, Mono-molecular surface film, Niclosamide, Phenol, 4-nitro-3-(trifluoromethyl), Poly(oxyethylene(dimethyliminio)ethylene(dimethyliminio)ethyl, Saccharopolyspora spinosa fermentation product containing Spi, Sodium percarbonate, Spinosad, Tartrazine, Tetrakis(hydroxymethyl)phosphonium sulphate (THPS), Chlorflurenol, methyl ester, Methyl 2, 7-dichlorohydroxyfluorene-9-carboxylate, Peroxyacetic acid, Cis-7, 8-Epoxy-2-methyloctadecane, POE isoctadecanol
Petroleum derivative	Espesol 3A, Mineral oil, Mineral oil - includes paraffin oil from 063503, Petroleum distillate

**Table 8. Classification of the 171 active ingredients by class of pesticide. Ingredients that are listed in bold type are discussed in greater detail in the document**

Phenoxy	(R)-2-(2, 4-Dichlorophenoxy)propanoic acid, dimethylamine salt, 2-4, D, 2-Ethylhexyl (R)-2-(2, 4-dichlorophenoxy)propionate, 2-Ethylhexyl 2-(2, 4-dichlorophenoxy)propionate, Acetic acid, (2, 4-dichlorophenoxy)-, 2-ethylhexyl ester, Butoxyethyl 2, 4-dichlorophenoxyacetate, Diethanolamine (2, 4-dichlorophenoxy)acetate, Dimethylamine (R)-2-(2-methyl-4-chlorophenoxy)propionate, Dimethylamine 2, 4-dichlorophenoxyacetate, Isooctyl 2-(2, 4-dichlorophenoxy)propionate, Isopropylamine 2, 4-dichlorophenoxyacetate, MCPA, dimethylamine salt, Mecoprop (and salts and esters), Sodium 2, 4-dichlorophenoxyacetate, Triisopropanolamine 2, 4-dichlorophenoxyacetate
Phosphonoglycine	Glycine, N-(phosphonomethyl)- potassium salt, Glycine, N-(phosphonomethyl)-, diammonium salt, <b>Glyphosate</b> , Glyphosate, ammonium salt, Glyphosate, isopropylamine salt
Pyrethroids, Pyrethrins & Synergists	Phenothrin, Bifenthrin, Deltamethrin, D-Phenothrin, N-Octyl bicycloheptene dicarboximide, Permethrin, Permethrin, mixed cis, trans, Piperonyl butoxide, Prallethrin, Pyrethrins, Resmethrin, Sumithrin, Tau-fluvalinate
Pyridine	Butoxyethyl triclopyr, CAS Reg. No. 566191-87-5, CAS Reg. No. 566191-89-7, Clopyralid, Clopyralid, monoethanolamine salt, Clopyralid, triethanolamine, Fluroxypyr 1-methylheptyl ester, Picloram, triisopropanolamine salt, <b>Triclopyr</b> , Triethylamine triclopyr
Quaternary Compound	Alkyl* dimethyl benzyl ammonium chloride *(50%C14, 40%C12, 10, Alkyl* dimethyl benzyl ammonium chloride *(60%C14, 30%C16, 5%, Alkyl* dimethyl ethylbenzyl ammonium chloride *(68%C12, 32%C1, Didecyl dimethyl ammonium chloride
Rodenticide	Chlorophacinone, Difethialone, Diphacinone, Zinc phosphide (Zn3P2)
Sulfonylurea	1-(4, 6-dimethoxypyrimidin-2-yl)-3-(2-ethylsulfonylimidazo{1, 2, Chlorsulfuron, Metsulfuron-methyl, Rimsulfuron, Sulfometuron methyl
Triazine/Triazinetrione/Triazinone	Prometon, Sodium dichloroisocyanurate dihydrate, Sodium dichloro-s-triazinetrione, Trichloro-s-triazinetrione, Hexazinone, Sulfentrazone
Uracil	<b>Bromacil</b> , Bromacil, lithium salt
Urea	<b>Diuron</b> , Tebuthiuron

organophosphate, was also detected at low concentrations in the water but was absent in gill tissue. Although concentrations of diazinon in the water column were well below median lethal concentrations for fish that had been observed in the laboratory, peak concentrations probably had not been detected because diazinon concentrations had probably dissipated in the few days between the occurrence of the fish kill and sampling.

Diazinon also affects the olfaction of juvenile salmon, which mediates a suite of fish behaviors involved in feeding, predator avoidance, kin recognition, spawning, homing and migration. For example, Moore and Waring (1996) studied the effects of diazinon exposure on olfaction in Atlantic salmon parr. They first exposed male parr to diazinon concentrations (0, 0.1, 1.0, 2.0, 5.0, 10 and 20 µg/L) for 30 minutes and determined the parrs' ability to detect priming odorant released by female salmon that synchronizes spawning and also has a role as a primer on male plasma steroids and gonadotropin production. At 1.0 µg/L, diazinon significantly reduced the capacity for parr to detect the priming odorant by 22% (compared with controls); at 20 µg/L, diazinon inhibited olfaction by 79%. Olfaction was affected for up to 4-5 hours following exposure.

They also studied the effect of longer-term exposure to diazinon on male parrs' plasma reproductive steroid levels after the males were exposed to the urine of ovulating females. Diazinon concentrations of 0.3 – 45 µg/L abolished the induction of male hormones, although levels of testosterone and one ketotestosterone were not significantly affected by the diazinon exposure. Milt production was reduced by about 28% at concentrations of diazinon ranging from 0.3 - 45 µg/L. We would expect these outcomes to impair Atlantic salmon's ability to detect and respond to reproductive scents and increase their probability of missing spawning opportunities, which would reduce the lifetime reproductive success of individuals that experience this response.

Scholz *et al.*, (2000) also studied the effects of 24 hour exposures to diazinon on the swimming and feeding behavior of juvenile coho salmon. They reported statistically significant effects on swimming and feeding behaviors in the presence of an alarm cue following exposures at concentrations of diazinon at 1 and 10 µg/L (compared to control fish) and reduced homing at 0.1 µg/L.

Temephos shows a wide range of toxicity to aquatic organisms, depending on the formulation. Generally, the technical grade compound is considered moderately toxic while the emulsifiable concentrate and wettable powder formulations are highly to very highly toxic. The most sensitive species of fish is the rainbow trout with a temephos LD<sub>50</sub> ranging from 0.16 mg/L to 3.49 mg/L (Johnson and Finley, 1980). Other 96-hour LD<sub>50</sub> values are reported as: coho salmon 0.35 mg/L, largemouth bass 1.44 mg/L, channel catfish 3.23 mg/L to >10 mg/L, bluegill sunfish 1.14 mg/L to 21.8 mg/L, and Atlantic salmon 6.7 mg/L to 21 mg/L (Johnson and Finley, 1980; Kidd and James, 1991).

Trichlorfon is also highly toxic to several species of fish and aquatic invertebrates, including species like Daphnia and stoneflies that are prey for fish. LC<sub>50</sub> (96-hour) values for trichlorfon are 0.18 mg/L (48-hour) in Daphnia, 0.01 mg/L in stoneflies, 7.8 mg/L in crayfish, 1.4 mg/L in rainbow trout, 2.5 mg/L in brook trout, 0.88 mg/L in channel catfish and 0.26 mg/L in bluegill (Hudson *et al.*, 1984; Hill and Camardese, 1986).

In 2008, NMFS concluded in its Biological Opinion<sup>23</sup> that FIFRA registered uses of chlorpyrifos, diazinon and malathion were likely to jeopardize most listed salmonid species and adversely modify most of their designated

---

<sup>23</sup> [http://www.nmfs.noaa.gov/pr/pdfs/pesticide\\_biop.pdf](http://www.nmfs.noaa.gov/pr/pdfs/pesticide_biop.pdf)

critical habitat.

### Pyrethroids, Pyrethrins and Synergists

The pyrethroids, pyrethrins and synergists whose uses would be authorized by the proposed PGP include permethrin, permethrin, mixed cis, trans, resmethrin, sumithrin, piperonyl butoxide and n-octyl bicycloheptene dicarboximide. The latter substances, piperonyl butoxide and n-octyl bicycloheptene dicarboximide (mgk-264) are synergists. As we described previously, formulations of these pesticides are used to control adult mosquitoes.

Paul *et al.*, (2005) compared the toxicity of synergized and technical formulations of permethrin, sumithrin and resmethrin to brook trout (*Salvelinus fontinalis*) and brown trout (*Salmo trutta*). They reported that the toxicity of the synergized permethrin formulation was significantly increased in 24, 48 and 96-hour tests, compared to tests with the technical formulation. There was little difference in the toxicity of synergized and technical formulations of sumithrin until 48 hours had elapsed. They reported that many test fish were strongly intoxicated by either formulation of permethrin or sumithrin, but the synergized formulations of both chemicals affected fish at lower concentrations. Intoxication was potentially severe enough to reduce the survival of these fish in the wild. Finally, they tested the ability of exposed fish to swim against a current and concluded that fish exposed for 6 hours to synergized permethrin and resmethrin had far less swimming stamina than those exposed to technical formulations. They did not find a difference in the effect on swimming between the synergized and technical formulation of sumithrin. They concluded that the synergized formulations of these pesticides appeared to cause a faster response than the technical formulations and this response increased the lethal and sublethal effect of the insecticides on the trout.

### 'Inert' ingredients

Some of the other ingredients of formulations of these pesticides are also toxic. For example, piperonyl butoxide is a common constituent of insecticide containing formulations (for example, it is a common synergist in formulations of synthetic pyrethroids) and is toxic to aquatic invertebrates and fish. EPA (2006) reported an LC<sub>50</sub> for rainbow trout of 1.9 mg/L. In longer term exposures piperonyl butoxide affects fish and aquatic invertebrates at concentrations as low as 0.11 mg/L. Piperonyl butoxide is highly toxic to aquatic invertebrates with a reported EC<sub>50</sub> of 0.51 mg/L for *Daphnia magna* (EPA, 2006).

As another example, methoxychlor is a co-constituent in formulations with malathion. Formulated products are more toxic than methoxychlor alone. It is also an organo-chlorine insecticide that is toxic to fish and aquatic invertebrates. Johnson and Finley (1980) reported LC<sub>50s</sub> less than 20 µg/L and one 96-hour LC<sub>50</sub> of 1.7 µg/L was reported for Atlantic salmon (Howard, 1991).

### Consequences of Exposure to Degradates

As we discussed in the preceding subsection, over time, pesticides are transformed into other compounds by chemical, photochemical and biologically-mediated reactions; these other compounds are generally called "degradates" or "metabolites" (Boxall *et al.*, 2004; Gilliom *et al.*, 2006). Degradates, like their parent compounds, have the potential to adversely affect water quality, depending on their toxicity. Sinclair and Boxall (2003) reported that 41% of degradates were less toxic than their parent compounds, 39% had toxicities similar to their parents, 20% were more than 3 times more toxic than their parent compound and 9% were more than 10 times more toxic.

For example, the major metabolite of carbaryl is 1-naphthol, which is formed by abiotic and microbially mediated processes and has been reported to represent up to 67% of the applied carbaryl in degradation studies. This degradate is more toxic than carbaryl itself. For example, Shea and Berry (1983) compared 10-day acute lethality

between carbaryl and 1-naphthol in goldfish (*Carassius auratus*) and killifish (*Fundulus heteroclitus*). They concluded that 1-naphthol was about five times more toxic than carbaryl in goldfish and twice as toxic as carbaryl in killifish. In addition, fish exposed to 1-naphthol showed neurological trauma including erratic swimming behaviors and increased opercula beats following 4-hour exposures at 5 mg/L and 24-hour exposures at 10 mg/L. They did not observe any of these symptoms in the carbaryl treatments.

### **Consequences of Exposure to Mixtures**

As we also discussed in the preceding subsection, most aquatic species are likely to be exposed to mixtures of pesticides, their degradates and other chemicals that exist in the environment. Once in a mixture, co-occurring pesticides (including their degradates) can either act independently of one another (called an “independent” effect); they can have additive effects (for example, this might be expected, for example, for pesticides with a common mode of action and similar chemical structure); they can have synergistic effects in which their combined toxicity is greater than their additive toxicity; or they can have combined toxicity that is less than their additive toxicity (called an “antagonistic” effect).

As an example of synergistic effects, (Relyea and Mills, 2001; 2004) exposed amphibians to a combination of pesticides and chemical cues mimicking natural predators and found that these combinations induced stress and, as a result, increased the mortality rates of the amphibians (see also Sih *et al.*, 2004). For some species, exposing the amphibians to combinations of pesticides and natural stressors produced mortality rates that were substantially greater than mortality rates associated with each individual stressor. For example, carbaryl was up to 46 times more lethal to gray treefrog tadpoles (*Hyla versicolor*) when they were exposed to a combination of this pesticide and chemical cues emitted by aquatic predators (Relyea and Mills, 2001). When they were exposed to malathion at concentrations of 5 mg/L, 42% of the gray treefrog tadpoles died when predator cues were absent, but 82% died when predator cues were present (Rhatigan, 2004).

Mixtures containing malathion resulted in additive effects (when mixed with DDT, toxaphene), synergistic effects (when mixed with Baytex, parathion, carbaryl, perthane) and antagonistic effects (when mixed with copper sulfate) (Macek, 1975). Mixtures of diazinon and parathion killed more bluegill sunfish than predicted. Tierney *et al.* (2008), exposed juvenile steelhead to environmentally realistic concentrations of a mixture that included chlorpyrifos, diazinon and malathion (the realistic mixture contained chlorpyrifos at 13.4 ng/L; diazinon at 157 ng/L; and malathion at 46.3 ng/L, respectively). Exposures to this mixture for 96 hours compromised the ability of juvenile steelhead to detect changes in odorant concentrations, which would impair behavior that rely on smell such as homing and migration.

Mixtures that paired two organophosphates produced a greater degree of synergism than mixtures containing one or two carbamates, particularly mixtures containing malathion coupled with either diazinon or chlorpyrifos Table 9. At the highest exposure treatment, 1.0 EC<sub>50</sub> (malathion at 37.3 µg/L, chlorpyrifos at 2 µg/L, diazinon at 72.5 µg/L), binary combinations produced synergistic toxicity. Coho salmon exposed to combinations of diazinon and malathion as well as chlorpyrifos and malathion all died (Laetz *et al.*, 2009). Fish exposed to these organophosphate mixtures showed toxic signs of inhibition of AChE, including loss of equilibrium, rapid gilling, altered startle response and increased mucus production before dying. Organophosphate combinations were also synergistic at the lowest concentrations tested. Diazinon and chlorpyrifos were synergistic when combined at 7.3 µg/L and 0.1 µg/L, respectively. The pairing of diazinon (7.3 µg/L) with malathion (3.7 µg/L) produced severe (> 90%) AChE inhibition including classical signs of poisoning as well as death with some combinations. For binary combinations of malathion, diazinon and chlorpyrifos synergism was likely to occur at exposure concentrations that were below

the lowest used by Laetz *et al.*, (2009) i.e., chlorpyrifos concentrations lower than 0.1 µg/L; diazinon concentrations lower than 7.3 µg/L; malathion concentrations lower than 3.7 µg/L.

**Table 9. Mixture concentrations resulting in 100% mortality of juvenile coho following 96h exposures (after NMFS 2008a)**

Mixture	Concentration, µg/L
diazinon + malathion	72.5 diazinon, 37.3 malathion 29.0 diazinon, 14.9 malathion
chlorpyrifos + malathion	chlorpyrifos, 37.3 malathion

In our 2008 biological opinion on the EPA’s registration of pesticides containing chlorpyrifos, diazinon and malathion, NMFS concluded that anadromous salmonids were likely to die following short term exposure (less than 96 hours) to these three insecticides. Concentrations of chlorpyrifos, diazinon and malathion can occur at levels well over 100µg/l and upwards of 1,000 µg/l based on measured environmental concentrations and exposure models. We concluded that the youngest, swimming salmonids appeared to be the most likely to die from short-term, acute exposures, although adult salmon were also susceptible at higher concentrations. We did not expect acute exposures to these pesticides to kill eggs.

### **Trophic Consequences of the Proposed PGP on Listed Cetaceans**

Salmon are a significant contributor to the overall ecological food web throughout their range. Two significant indirect effects of the proposed action to Chinook, coho, sockeye and chum salmon and steelhead could result in the further loss of prey species for southern resident killer whales and Cook Inlet beluga whales. Such reductions would also likely result in the loss of nutrient transport to freshwater systems that are important to Pacific salmonids themselves. Bilby *et al.*, (1996) demonstrate that juvenile and older age classes of salmon grow more rapidly with the appearance of spawners because these younger fish will feed on eggs and spawner carcasses. Salmon carcasses in rivers and streambanks are a significant source of food to a wide number of animals and affect the overall productivity of nutrient-poor systems (Bilby *et al.*, 1996; Cederholm *et al.*, 2000). The loss of these “marine derived nutrients” would reduce the survival of their own species, particularly in nutrient poor streams. Bilby *et al.*, (1996) showed that up to 45% of the carbon in cutthroat trout and 40% of the carbon in young coho comes from the decaying carcasses of the previous generation of salmon. Increased body size is directly correlated to increases in over winter survival and marine survival. They suggest that reduced nutrient transport is one important indicator of ecosystem failure and is contributing to the observed reductions in abundance we have seen in many salmon populations, which could further diminish the success of recovery efforts. Given many salmon populations comprise the prey component of killer whale and beluga whale critical habitat, any additional reduction in prey attributable to the PGP could adversely modify their critical habitat.

Southern resident killer whales feed primarily on salmon. Any reductions in salmon populations as a result of this action can be expected to have adverse effects on southern resident killer whales via reductions in the prey component of their designated critical habitat. Based on killer whale stomach contents from stranded whales and field observations of predation, Ford *et al.*, (1998) determined that 95% of the diet of resident killer whales consists of fish, with roughly 66% being Chinook salmon. The authors suggested that killer whales might preferentially hunt Chinook salmon because these fish have large body sizes and a high fat content. A reduction in Pacific salmon – Chinook salmon in particular– from effects from the proposed action is likely to have adverse effects on the fitness of southern resident killer whales and their population viability. As noted earlier, a 50% reduction in killer whale calving has been correlated with years of low Chinook salmon abundance (Ward *et al.*, 2009a).

A reduction in the number of adult Chinook salmon in the Puget Sound would reduce the forage base for southern resident killer whales. Southern resident killer whales are not restricted to Puget Sound, but do spend a large portion of time in Puget Sound, the Strait of Juan de Fuca and Haro Strait. Prey losses could also be realized throughout their range, including Oregon and California. Such reductions in prey could impede recovery.

Pacific salmon and eulachon (Calkins, 1989) are an important prey species for Cook Inlet beluga whales. Pacific salmon are an especially important prey item as these whales build their lipid body stores essential to their winter survival (Abookire and Piatt, 2005; Litzow *et al.*, 2006). As a result, Cook Inlet beluga whales could similarly experience a reduction in their most abundant summer and fall prey species (most of which are non-listed Chinook, coho, sockeye and chum species). These losses could reduce the forage base of Cook Inlet beluga whales and as a result, could impede recovery.

### **Critical Habitat of Southern Resident Killer Whales**

We evaluated the potential effects of EPA's issuance of their PGP on critical habitat by first reviewing the essential features or primary constituent elements of critical habitat for listed designations. Based on our analysis, the primary features that may be affected by pesticide pollutant discharges authorized by the issuance of this permit are those designated as "prey species of sufficient quantity, quality and availability to support individual growth, reproduction and development, as well as overall population growth." Based on our analysis, EPA has not insured that the actions it authorizes will not reduce the availability of Pacific salmonid species to southern resident killer whales. As a result, these species may experience reductions in population. These losses could diminish the ability of critical habitat to provide for conservation of the southern resident killer whales.

### **Proposed Critical Habitat of Cook Inlet Beluga Whales**

We evaluated the potential effects of EPA's issuance of their PGP on critical habitat by first reviewing the essential features or primary constituent elements of critical habitat for the proposed designation for Cook Inlet beluga whales. Based on our analysis, the primary features that may be affected by pesticide pollutant discharges authorized by the issuance of this permit are those designated as "prey species of sufficient quantity, quality and availability to support individual growth, reproduction and development, as well as overall population growth." Based on our analysis, EPA has not insured that the actions it authorizes will not reduce the availability of Pacific salmonid species to Cook Inlet beluga whales. As a result, these species may experience reductions in population. These losses could diminish the ability of critical habitat to provide for conservation of Cook Inlet beluga whales.

### ***Components of the Proposed PGP Designed to Minimize or Prevent Exposure***

The EPA proposes several control measures to minimize any environmental effects resulting from these activities authorized by the permit. These include the existing statutory requirements of the CWA and FIFRA and the additional controls to be included specifically in the proposed permit. Given the large number of pesticide discharges that EPA intends to authorize, we determine whether these control measures are sufficient such that EPA can insure that these activities are not likely to result in jeopardy to the continued existence of any listed species or designated critical habitat under NMFS' jurisdiction.

To accomplish this, we examine existing risk assessments for pesticides produced by EPA and NMFS and contrast the approach used to register pesticides under FIFRA and with that used to derive water quality criteria under the CWA. We then examine the effectiveness of the NPDES program that will administer the PGP. We analyze the performance of similar control measures in previous general permits that the EPA has issued and consider the performance of those controls as an indicator of how well the controls of the proposed PGP are likely to work.

Finally, we analyze the general conditions specific to the PGP that are designed to mitigate the exposures of pesticides to ESA listed species or designated critical habitat. We determine whether these controls are sufficient to insure that the actions authorized by the permit are not likely to expose endangered or threatened species, or designated critical habitat to the effects of the actions it authorizes.

The control measures intended to minimize any direct or indirect environmental effects resulting from activities authorized by the permit are described below.

### **Clean Water Act**

The stated objective of the CWA is to "...restore and maintain the chemical, physical and biological integrity of the Nation's waters." The Act further states: "...it is the national policy that the discharge of toxic pollutants in toxic amounts be prohibited." Identification of toxic pollutants in toxic amounts is provided for by §304(a)(1) of the CWA which requires that EPA develop National Water Quality Criteria (WQC) that accurately reflect the latest scientific knowledge about the effects of priority chemical pollutants on aquatic life. These criteria represent numeric limits on the amounts of specific pollutants that can be present in waters of the United States without causing "harm"<sup>24</sup> to aquatic life. The WQC were developed for the 120 priority pollutants listed in section 307 of the CWA and an additional 47 non-priority pollutants. These WQC are applied through the basic framework of programs, such as NPDES, established by the CWA to control sources of pollutants that may impair or threaten water quality. The recommended WQC are intended to be protective of the majority of aquatic communities in the U.S. Individual States may adopt these criteria directly or they may adjust them, with EPA's approval, to suit State needs or designated uses for specific bodies of water.

The EPA's *Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses* (National Guidelines<sup>25</sup>) (Stephen *et al.*, 1985) describe an objective way of deriving national criteria intended to provide an appropriate level of protection for aquatic organisms. Aquatic life criteria are based on the National Guidelines and consist of two metrics: 1) The Criterion Maximum Concentration (CMC) intended to protect against severe acute effects; and 2) The Criterion Continuous Concentration (CCC) intended to protect against longer-term effects on survival, growth and reproduction. The acute criterion limits peak exposures by requiring that 1-hour averages of exposure concentrations not exceed the CMC more often than once in three years on average. The chronic criterion limits more prolonged exposures by requiring that 4-day averages of exposure concentrations not exceed the CCC more often than once in three years on average. The CMC and CCC are calculated using endpoints derived from standard toxicity tests in which organisms are exposed to a range of concentrations of a toxicant. These tests use standard surrogate species to represent large groups of taxa. For example, rainbow trout (*Oncorhynchus mykiss*) are considered acceptable surrogates for coldwater fish (Dwyer, 1995). Organism responses at each concentration are recorded.

The results of the exposures are then analyzed to produce standardized endpoint values described in the following paragraphs. The acute criterion is based on available acute endpoint values: median lethal concentrations (LC<sub>50</sub>)<sup>26</sup> or

---

<sup>24</sup> For the purposes of the Clean Water Act, EPA defines the term "harm" to include increased mortality or reductions in growth or reproduction as well as the accumulation of harmful levels of toxic chemicals in the tissues of aquatic organisms that may adversely affect consumers of such organisms. This usage should not be confused with how NMFS has defined "harm" for the purposes of the ESA.

<sup>25</sup> <http://water.epa.gov/scitech/swguidance/waterquality/standards/criteria/aqlife/upload/85guidelines.pdf>

<sup>26</sup> LC<sub>50</sub> = concentration at which 50% of exposed organisms die.

median effect concentrations ( $EC_{50}^{27}$ ) for severe acute effects such as immobilization from acute toxicity tests (48- to 96-hours long) meeting certain data quality requirements. To compute an acute criterion, EPA's National Guidelines require that acceptable acute values be available for at least eight families to address a range of taxonomic diversity. These minimum data requirements include three vertebrates (a salmonid, another bony fish and another vertebrate) and five invertebrates (a planktonic crustacean, a benthic crustacean, an insect, a species from a phylum other than *Chordata* or *Arthropoda* and a species from another order of insect or another phylum not already represented).

For each genus, the EPA calculates a Genus Mean Acute Value (GMAV) by first taking the geometric mean of the available acute values within each species (Species Mean Acute Value, [SMAV]) and then the geometric mean of the SMAVs within the genus. The GMAVs are then ranked and a regression analysis is performed on the four most sensitive GMAVs resulting in an estimate of the concentration of the pollutant corresponding to a cumulative probability of 0.05 (the 5<sup>th</sup> percentile of the species sensitivity distribution). This is the Final Acute Value (FAV). When appropriate, the EPA may lower the FAV to equal the SMAV of an important, sensitive species. The FAV is then divided by two to derive the acute Criterion Maximum Concentration value (CMC) that is expected to fall below where any acute adverse effects to organisms are observed.

Chronic tests for invertebrate species are required to include the entire life-cycle, but for fish species partial life-cycle and/or early life-stage tests may be accepted. Sufficient data for chronic toxicity are rarely available for deriving criteria as described for acute criterion above. When such data are available, the chronic criterion (CCC) is calculated in the same manner as the FAV. If chronic values are available for at least one fish, one invertebrate and one acutely sensitive species, then the chronic criterion may be estimated by dividing the FAV by a Final Acute to Chronic Ratio based on the available paired acute and chronic values. A chronic criterion may not be calculated if fewer chronic values are available. Alternatively, the chronic criterion may be based on plant toxicity data if aquatic plants are more sensitive than aquatic animals.

#### National Pollution Discharge Elimination System (NPDES)

Among the programs established by the CWA to control sources of pollutants, Section 402 of the CWA authorizes the EPA to issue permits for the discharge of pollutants under NPDES. Permits establish effluent limitations that are designed to prevent the discharge of toxic pollutants in toxic amounts such that pollutant levels in receiving water do not violate WQC or other permit-specific standards. An NPDES permit is required for entities that discharge pollutants from a point source on, over or near waters of the United States. An individual permit is specifically tailored to an individual discharger, while a general permit covers multiple dischargers within a specific category. According to the NPDES regulations (40 CFR 122.28), general permits like the PGP may be written to cover categories of point source discharges that have common elements. General permits may only be issued to dischargers within a specific geographical area. This allows EPA to cover a large group of individual without putting forth the resources necessary to review applications and issue permits on a case-by-case basis. When developing and issuing general NPDES permits, the EPA generally collects data to demonstrate that a category of dischargers has enough similar attributes to warrant a general permit, such as:

---

<sup>27</sup>  $EC_{50}$  = concentration at which 50% of exposed organisms are affected.

1. The number of dischargers or facilities to be authorized.
2. Any similarities in production processes or activities among dischargers.
3. Any similarities in the pollutants to be discharged among dischargers.

The EPA then develops the draft general permit and fact sheet and makes it available for public comment. After the public comment period, EPA addresses the comments and makes any necessary changes before the final general permit is issued. After issuance of the final general permit, entities that wish to be authorized under the general permit may submit an NOI to the EPA. The EPA then has the authority to request additional information. After review of the additional information, the applicant is notified either that their planned activities are authorized under the general permit or that they must apply for an individual permit.

The EPA is authorized to directly implement the NPDES program or to authorize States, Territories or Tribes to implement all or parts of the national program. Any State, Territory or Tribe may seek the authority to implement the NPDES program. The EPA no longer administers NPDES permits or administers any parts of this program once a State, Territory or Tribe is authorized to conduct these activities. The EPA does reserve the right to review each permit issued by the State, Territory or Tribe and may object to elements that conflict with Federal requirements. Once a permit is issued through a government agency, it is enforceable by the approved State, Territorial, Tribal and Federal agencies with authority to implement and enforce the permit. If the State, Territory or Tribe does not have approval for administering the NPDES program, the EPA will operate the NPDES program. Once a permit is issued, it is enforceable by the approved State, Territorial, Tribal and Federal agencies with authority to implement and enforce the permit.

All NPDES permits consist of at least five general sections:

1. A Cover Page: A statement with the name and location of the facility or discharger, a description of the permitted activity and the specific locations where discharges are authorized.
2. Effluent Limits: A statement describing the means for controlling discharges of pollutants based on applicable standards.
3. Monitoring and Reporting Requirements: A statement that characterizes streams and receiving waters, evaluates pollution reducing efficiency and determines compliance with permit conditions.
4. Special Conditions: A statement describing measures to supplement effluent limit guidelines such as: Best Management Practices (BMPs), additional monitoring activities, surveys and toxicity reduction evaluations (TREs).
5. Standard Condition: A statement describing the legal, administrative and procedural requirements of permit conditions that apply to all NPDES permits.

While monitoring and reporting requirements set forth in a permit are the primary component of compliance monitoring, the permitting authority may also conduct inspections to verify that permit requirements are being met. Specifically, inspections are conducted to: determine if permittee is in compliance with regulations, permit conditions and other program requirements, verify the accuracy of information submitted and verify the adequacy of sampling and monitoring. An inspection may also be conducted to obtain information that supports the permitting

process, gather evidence to support enforcement actions, or to assess compliance with orders or consent decrees.

EPA oversight of permits, both those it administers and those administered by non-Federal authorized agencies, includes collection of compliance information. Depending on the State or territory of origin, this data is entered into one of two national databases: the Permit Compliance System (PCS) and the Integrated Compliance Information System for the National Pollutant Discharge Elimination System (ICIS-NPDES). These databases track information on the number of self-reported violations, the number of compliance evaluations performed, the number of non-compliances found, the number of formal and informal enforcement actions taken and the penalties assessed.

### Water Quality Standards

Water Quality Standards are mandated by the Clean Water Act and define the goals for a water body by designating that waterbody's uses, setting criteria to protect those designated uses and preventing degradation of water quality through antidegradation provisions.

### Designated Uses

Designated uses are statements of management objectives and expectations for water bodies under State or Tribal jurisdiction. As defined in 40 CFR 131.3, designated uses are specified for each water body or water body segment regardless of whether or not they are being attained. Designated uses include, but are not limited to: water supply (domestic, industrial and agricultural); stock watering; fish and shellfish uses (salmonid migration, rearing, spawning and harvesting; other fish migration, rearing, spawning and harvesting); wildlife habitat; ceremonial and religious water use; recreation (primary contact recreation; sport fishing; boating and aesthetic enjoyment); and commerce and navigation.

The water quality standards regulation requires that States and Tribes specify which water uses are to be achieved and protected. These uses are determined by considering the value and suitability of water bodies based on their physical, chemical and biological characteristics as well as their geographical settings, aesthetic qualities and economic attributes. Each water body does not necessarily require a unique set of uses. Rather, water bodies sharing characteristics necessary to support a use can be grouped together. If water quality standards specify designated uses of a lower standard than those that are actually being attained, the State or Tribe is required to revise its standards to reflect these uses.

Only California and Puerto Rico explicitly address threatened or endangered species as part of their designated uses. California's designated uses include a broad statement that the waters must support the survival and maintenance of aquatic species that are protected, and Puerto Rico's designated uses note that endangered and threatened species are included as part of the broader category of desirable species (Table 10). Other states have revised their designated uses to incorporate the specific needs of certain threatened or endangered species (e.g., Oregon and Washington adopted designated uses for the protection of Pacific salmon). Washington's designated uses explicitly denote the following categories of aquatic life uses: char spawning and rearing; core summer salmonid habitat; salmonid spawning; rearing and migration; salmonid rearing and migration only and several others (WAC 173-201A-200). Washington's designated uses should provide additional protection for Washington's native char, bull trout and Dolly Varden and several species of Pacific salmon that are listed as threatened or endangered, as well as others that are not listed.

**Table 10. State Designated Uses that Explicitly Address Listed Species**

State	Designated Use Description	EPA Effective Date
CA Regions 1, 2, 3, 4, 5, 6, 7, 8, 9	Uses of water that support aquatic habitats necessary, at least in part, for the survival and successful maintenance of plant or animal species established under State or Federal law as rare, threatened or endangered.	8/18/1994
PR	Coastal waters and estuarine waters intended for use in primary and secondary contact recreation and for propagation and preservation of desirable species, including threatened or endangered species.	6/26/2003

### Antidegradation

The water quality standards regulation also requires that States and Tribes establish a three-tiered antidegradation program. The specific steps to be followed depend upon which tier or tiers apply. These tiers are listed below:

- Tier 1: These requirements are applicable to all surface waters. They protect existing uses and water quality conditions necessary to support such uses. These uses can be established if they can be demonstrated to have actually occurred since November 28, 1975, or if water quality can be demonstrated to be suitable for such uses. If an existing use is established, it must be protected even if it is not listed in the water quality standards as a designated use.
- Tier 2: These requirements maintain and protect "high quality" water bodies where existing conditions are better than those necessary to support CWA § 101(a)(2) "fishable/swimmable" uses. Although the water quality in these water bodies can be lowered, States and Tribes must identify procedures that must be followed and questions that must be answered before a reduction in water quality can be allowed. The water quality of these water bodies cannot be lowered to a level that would interfere with existing or designated uses.
- Tier 3: These requirements maintain and protect water quality in outstanding national resource waters (ONRWs) and generally include the highest quality waters of the United States ONRW classification also offers special protection for waters of exceptional ecological significance. Except for certain temporary changes, water quality cannot be lowered in these waters. States and Tribes decide which water bodies qualify as ONRWs.

In a January 27, 2005, memorandum to its Regional Offices, EPA concluded that ESA Section 7 consultation does not apply to EPA's approvals of State antidegradation policies because EPA's approval action does not meet the "Applicability" standard defined in the regulations implementing Section 7 of the ESA (EPA 2005; 50 CFR 402.03). Section 402.03 of the consultation regulations (50 CFR Part 402) states that Section 7 and the requirements of 50 CFR parts 402 apply to all actions in which there is discretionary Federal involvement or control.

EPA concluded that they are compelled to approve State antidegradation policies if State submissions meet all applicable requirements of the *Water Quality Standards Regulation* (40 CFR part 131) and lack discretion to implement measures that would benefit listed species. As a result, EPA determined that consultation is not warranted on antidegradation policies because the Agency does not possess the regulatory authority to require more than the minimum required elements of the regulations. For these reasons, EPA's approvals of State antidegradation policies are not part of this consultation.

## FIFRA

The EPA regulates pesticides under FIFRA, as amended by the FQPA of 1996 and the Pesticide Registration Improvement Act of 2003. Under FIFRA, the EPA is responsible for evaluating and registering all pesticide uses in the U.S. To do so, the EPA evaluates scientific data provided by the applicants and other sources of evidence including data from the open literature (as presented in their Ecotoxicology [ECOTOX] database<sup>28</sup>). To determine whether those data demonstrate that the registration of these pesticide uses will not cause “unreasonable adverse effects on the environment,” which is defined “any unreasonable risk to man or the environment, taking into account the economic, social, and environmental costs and benefits of the use of any pesticide...”). This is important because under FIFRA, the EPA must weigh the economic and social costs of registering pesticide uses against the environmental costs and benefits they may pose. Under Section 7 of the ESA, the Services do not include such considerations in jeopardy to species or destruction or adverse modification of designated critical habitat determinations.

Under FIFRA, the EPA does not consider the toxicity or potential environmental impacts of specific pesticides in relation to other pesticides during the registration process. Instead, the EPA evaluates the potential direct and indirect environmental effects of these pesticide uses on a case-by-case basis and does not recommend that any pesticide be used as opposed to any other pesticide.

The EPA works with stakeholders to develop voluntary measures or regulatory controls to reduce risks pesticides may pose to human health and to the environment. For aquatic systems, the EPA relies on computer models to calculate Estimated Environmental Concentrations (EECs) in the environment. These models simulate the expected behavior of these pesticides in a: “standard pond” receiving direct application or spray drift, runoff and transport through soil pore water from treated areas. A “standard pond” is modeled as having constant volume and without flow. These models incorporate variables such as chemical properties of the pesticide, average rainfall in the area, transpiration of water from vegetation, hydrology and chemical transport. These models assume 5% spray drift from aerial pesticide applications and 1% spray drift for applications from the ground. Where water-monitoring data are available, EPA will take into consideration whether measured pesticide concentrations are higher than estimated by computer models.

The EPA risk assessment process compares EECs to species toxicity endpoints derived from standard toxicity tests<sup>29</sup> where standard test species are exposed to concentration gradients of pesticide active ingredients, formulated pesticide products or degradates. Organism responses at each concentration are recorded and analyzed to produce standardized endpoint values. The standard test species used are intended to represent large groups of taxa. The EPA may use data on other species from other sources to inform their risk assessments if it deems that the studies that produced these data were at least as stringent as the standard tests. The acute and chronic toxicity endpoints for animals and endpoints for terrestrial listed and non-listed plants relevant to our Opinion are summarized in Table 11.

The EPA then uses a Risk Quotient (RQ) method to estimate the potential direct effects of pesticides to non-target organisms. To calculate RQs, the EPA divides the EECs by the endpoint values described above ( $RQ = EEC/Endpoint$ )<sup>30</sup>. The measure of exposure for assessing direct effects to aquatic animals is the modeled peak

---

<sup>28</sup> The ECOTOX database may be found online at: <http://cfpub.epa.gov/ecotox/>.

<sup>29</sup> See EPA’s Office of Chemical Safety and Pollution Prevention (OCSPP) test guidelines for more information: <http://www.epa.gov/ocspp/pubs/frs/home/draftguidelines.htm>

<sup>30</sup> See: <http://www.epa.gov/espp/consultation/ecorisk-overview.pdf>

EEC for acute effects compared to the lowest tested EC<sub>50</sub> or LC<sub>50</sub> for representative freshwater and estuarine/marine fish and invertebrates.

A rolling mean modeled EEC is used to estimate chronic effects and compared to the lowest NOEC for representative freshwater and estuarine/marine fish and invertebrate early life-stage or full life-cycle tests. The modeled EEC for 60 days after a pesticide application, or series of applications, is used for assessing chronic exposure for fish. The modeled EEC for 21 days after pesticide application is used for assessing chronic exposure for aquatic invertebrates.

These RQs are then compared to the Levels of Concern (LOCs) that EPA has established to estimate potential risk to non-target organisms for chronic and acute exposures. These LOCs are as follows:

- Non-listed Species Direct Acute Risk: RQ > 0.5 for aquatic animals (greater than 50% of the laboratory test organisms exposed to the peak EECs would be expected to exhibit an effect greater than or equal to that described by the standard acute toxicity endpoint.)
- Non-listed Species Direct Acute for Restricted Use<sup>31</sup> Pesticides: RQ > 0.1 for aquatic animals (greater than 10% of the laboratory test organisms exposed to the peak EECs would be expected to exhibit an effect greater than or equal to that described by the standard acute endpoint.)
- ESA Listed Species Direct Acute: RQ > 0.05 for aquatic animals (greater than 5% of the laboratory test organisms exposed to the peak EECs would be expected to exhibit an effect greater than or equal to that described by the standard acute endpoint.)
- Direct Chronic Risk: RQ > 1 for both ESA listed and non-listed animals (The long term EECs would be greater than the NOEC for 100% of the laboratory test organisms)
- Non-listed Species Aquatic and Terrestrial Plant Direct Effects: RQ > 1 (100% of the laboratory test organisms exposed to the EECs would be expected to exhibit an effect greater than or equal to that described by the standard endpoint for non-listed species.)
- ESA Listed Species Aquatic and Terrestrial Plant Direct Effects: RQ > 1 (100% of the laboratory test organisms exposed to the EECs would be expected to exhibit an effect greater than or equal to that described by the standard endpoint for listed plant species.)

The EPA has set its ESA listed animal species acute LOCs an order of magnitude lower than those for non-listed species but does not make a distinction between the chronic effect risk LOCs between listed and non-listed animal species. The LOCs for listed plants are the same as for non-listed species, but the RQs for listed terrestrial plants are calculated using lower toxicity endpoints than non-listed plants. The EPA gives no such consideration to ESA listed aquatic plant species.

---

<sup>31</sup> The "Restricted Use" classification restricts a product, or its uses, to use by a certificated pesticide applicator or under the direct supervision of a certified applicator.

---

**Table 11. EPA's FIFRA Standard Test Endpoints.**

---

**Aquatic Animals**

Acute Toxicity assessment	Lowest tested EC <sub>50</sub> or LC <sub>50</sub> for freshwater fish and invertebrates and estuarine/marine fish and invertebrates acute toxicity tests.
Chronic Toxicity assessment	Lowest NOEC <sup>1</sup> for freshwater fish and invertebrates and estuarine/marine fish and invertebrates early life-stage or full life-cycle tests.

---

**Plants**

Terrestrial Listed	Lowest EC <sub>25</sub> <sup>2</sup> values from both seedling emergence and vegetative vigor for both monocots and dicots.
Aquatic (Listed and Non-listed)	Lowest EC <sub>50</sub> for both vascular and algae.
Terrestrial Non-listed	Lowest EC <sub>05</sub> <sup>3</sup> or NOEC for both seedling emergence and vegetative vigor for both monocots and dicots.

---

<sup>1</sup>No Observed Effect Concentration: The highest concentration of a pesticide that resulted in no observed effect to any tested organism. For fish, this value is typically obtained from a standard life cycle test where “fish should be cultured in the presence of the test substance from one stage of the life cycle to at least the same stage of the next generation (e.g. egg to egg)  
[http://www.epa.gov/ocspp/pubs/frs/publications/OPPTS\\_Harmonized/850\\_Ecological\\_Effects\\_Test\\_Guidelines/Drafts/850-1500.pdf](http://www.epa.gov/ocspp/pubs/frs/publications/OPPTS_Harmonized/850_Ecological_Effects_Test_Guidelines/Drafts/850-1500.pdf). If no such data are available, the EPA estimates this value using and Acute to Chronic Ratio (ACR) based on data for similar species.

<sup>2</sup>Effective Concentration 25: The concentration of pesticide that resulted in 25% of individuals tested exhibiting an effect.

<sup>3</sup>Effective Concentration 5: The concentration of pesticide that resulted in 5% of individuals tested exhibiting an effect.

When registering pesticides, the EPA generally considers that any species for which the RQs do not exceed their designated LOC to not be at risk from the pesticide use being evaluated. If the RQs for a taxonomic group in question exceed LOCs, the EPA may conduct additional analyses and then must weigh the economic and social costs of registering that pesticide use against the environmental costs and benefits such a pesticide use may pose.

It is important to note that for acute aquatic animal effect estimations, the EPA uses an endpoint based on the amount of the pesticide that is observed to kill test species. This is the case for non-listed species as well as threatened or endangered species. Based on this methodology, EECs for pesticide pollutants in the water could be expected to kill or adversely affect threatened or endangered species under NMFS' jurisdiction without exceeding the EPA's LOC.

In order to analyze indirect effects to ESA listed organisms, the EPA uses the direct effects LOCs for each taxonomic group upon which a listed species may rely for survival. If the RQs for these taxonomic groups are below the direct effect listed species LOCs, the EPA considers any effects to these resources and indirect effects that these exposures may cause to ESA listed species to be of no concern. These determinations are designed to capture any effects to designated critical habitat.

**Additional Requirements of the PGP**

The EPA's conclusion, as presented in its BE, is that the additional requirements provided in the proposed PGP will likely reduce the potential adverse effects to ESA listed species from those that would be expected from current pesticide applications approved and registered under the FIFRA. These additional requirements are presented in the *Description of the Proposed Action* section of this Opinion and are summarized below.

### Technology Based Effluent Limitations

Under this requirement of the permit, operators would be required to implement control measures to minimize the discharge of pesticide pollutants to waters of the United States through the use of technology based effluent limitations to the extent technologically available and economically achievable and practicable. All operators must review or modify pest management measures if an event occurs such as an unauthorized discharge, water quality standards are not met, operators failed to use the amount of pesticide and frequency of pesticide application necessary to control the target pest, pesticide application equipment is not kept in proper operating condition, weather conditions are not considered, an adverse incident occurs or an inspection by EPA, State, Tribal or local entities reveal modifications are necessary to meet applicable water quality standards. An operator must make such changes before or –if not practicable– as soon as possible before the next discharge.

### Water Quality Standards

All operators would be required to control discharges to meet applicable numeric and narrative State, Territory or Tribal water quality standards. If at any time the permittee becomes aware, or EPA determines, that the discharge causes or contributes to an excursion of applicable water quality standards, the permittee must take corrective action.

### Pesticide Discharge Management Plan

Decision makers that exceed NOI thresholds (except for those made in response to a declared pest emergency) and are “large entities” must prepare a PDMP to document the selection and implementation of control measures used to comply with the effluent limitations described earlier. The permit defines “large entities” as any: 1) public entity that serves a population greater than 10,000; or 2) a private enterprise that exceeds the Small Business Administration size standard. Pesticide discharge management team information, problem identification, pest management options evaluation, spill and adverse incident response procedures are required to be included in the PDMP by the permit.

### Oversight and Corrective Actions

All operators would be required by the permit to allow EPA or an authorized representative to enter the premises where a regulated facility or activity is located or conducted; have access to any records that must be kept under the conditions of the permit; inspect any facilities, equipment practices, or operations regulated or required under the permit; and sample or monitor for the purposes of assuring permit compliance.

If an operator becomes aware that: an adverse incident occurs; an unauthorized discharge occurs; control measures are not sufficient to meet applicable water quality standards; the operator failed to use the optimum frequency of pesticide applications necessary to control the target pest; the operator failed to perform regular maintenance activities to reduce unintended discharges; the operator failed to maintain pesticide application equipment; or, if an inspection or evaluation by an EPA official, or local, State, Territorial or Tribal entity determines that modifications to the control measures are necessary to meet the non-numeric effluent limits, that operator must review and revise the evaluation and selection of their control measures as necessary to insure that the situation is eliminated and will not be repeated in the future.

If an operator determines that changes to its control measures are necessary, such changes must be made before the next pesticide application if practicable, or if not, as soon as possible thereafter.

The occurrence of a situations requiring revision of control measures (as defined above) may constitute a violation of the permit. The EPA will consider the appropriateness and promptness of corrective action in determining enforcement responses to permit violations and, along with the Courts, may impose additional requirements and schedules of compliance.

### Limitations on Coverage

The proposed PGP would not authorize the discharge of pesticide to impaired Water of the U.S. that is such impaired by the specific pesticide, or degradates of the pesticide, to be permitted to be discharged. In this case, the operator would have to obtain coverage under an individual permit for such a discharge or chose some other means of pest management.

If a proposed discharge is already authorized under another permit, the operator is ineligible for coverage under the PGP permit. If the intended discharge was included in a permit that has been or is in the process of being denied, terminated or revoked by EPA in the past five years, the proposed discharge is ineligible for coverage under this permit.

### IPM/Pest Management Measures

Under the PGP, operators are required to use Pest Management Measures not currently required under FIFRA. The EPA anticipates that these requirements will lead to a decrease in the amount of pesticides used and an increase in the use of non-chemical pest control methods. For each use pattern, the permit requires that each decision maker evaluate the use of non-chemical methods and to consider impacts to non-target organisms.

### NOI and Determinations of Potential Effects to ESA listed Resources

Under the PGP, all decision makers expecting to discharge pesticides on, over or near waters of the United States. on Federal lands or into designated Tier 3 waters are required to submit an NOI containing information on whether these discharges will overlap with the distributions of endangered or threatened species, or designated critical habitat (listed resource effect determinations). All State or Federal operators and mosquito, irrigation and aquatic weed control or other pest control districts must submit NOIs. All other decision makers, including decision makers expecting to discharge on Indian lands, are required to submit an NOI to obtain coverage for discharges resulting from the application of pesticides if it has reason to believe it will exceed one or more of the treatment area thresholds. Decision makers who do not expect to exceed one or more of the treatment area thresholds are not required to submit an NOI; those discharges would automatically be authorized under the proposed permit.

To determine the appropriate thresholds that would trigger the NOI requirements, the EPA discussed these proposed thresholds with the U.S. Department of Agriculture and industry representatives. The EPA then developed annual treatment area thresholds based on these discussions as well as from comments received during the public comment process. These thresholds are meant to differentiate between applications to small and larger areas. EPA's assumption was that the larger areas "are believed to have a greater potential for impact on Waters of the US."

Earlier in the consultation process, the EPA<sup>32</sup> stated that they were:

"assuming that 100% of categories 1 [mosquito and other flying insect pests control] and 3 [aquatic nuisance animal control] will submit NOIs; a significantly lesser percentage will submit NOIs for category 2 [aquatic nuisance weed and algae control] (<10%); and it seems as though about 10% of the category 4 [forest canopy pest control] activities will be required to submit an NOI..."

However, on December 16, 2010, EPA notified NMFS that it was raising the NOI thresholds for some of the use patterns. NOI threshold requirements for nuisance aquatic plant and animal treatments increased fourfold from 20 to 80 square acres (the linear area threshold remained unchanged at 20 miles). The EPA also raised the NOI thresholds for forest canopy applications and mosquito adulticide applications an order of magnitude from 640 ac to 6,400 ac

---

<sup>32</sup> April 5, 2010 Email from the EPA on affected operator estimated numbers.

(ten square miles).

### **Monitoring and Reporting**

Under the conditions of the PGP, all operators would be required to: monitor the amount of pesticide and frequency of pesticide application used to control the target pest; monitor pesticide application activities to insure pesticide application equipment is maintained in proper operating conditions; and monitor weather conditions in the treatment area to insure application is consistent with all applicable Federal requirements. If a reportable spill occurs, the operator must contact the National Response Center immediately. The operator must document and retain information on the spill within 30 days.

All operators must keep records of adverse incidents reports; a copy of corrective action determinations and a copy of any spill or other non-permitted discharges. Any decision maker that is not a “large entity” and is required to submit an NOI must also keep records of the NOI and any correspondence with EPA about the NOI; documentation of equipment calibration; and Information on each treatment area. These decision makers must also submit an annual report to EPA.

The permit also requires visual monitoring assessments by all operators of the application area and notification to the permitting authority if adverse effects are observed. The EPA also states in its BE that: “[Visual monitoring by permittees]... should provide valuable information to EPA and the States about where adverse environmental effects are occurring. This knowledge will help EPA identify where problems may remain and where improvements can be made in the next PGP.”

### ***Evaluation of Those Components of the Proposed PGP Designed to Minimize or Prevent Exposure***

#### **EPA’s Ability to Estimate the Number and Locations of Discharges Authorized by the PGP**

To reliably estimate the probable individual or cumulative effects to ESA listed species or designated critical habitat, the EPA would need to know or reliably estimate the probable number of discharges that it would authorize under the permit. The EPA is proposing to rely on a small subset of the estimated 35,000+ operators to file NOIs to obtain this information. In addition, the NOIs that EPA expects provide very little information prior to discharge. These NOIs would contain: 1) The name, address, type and contact information of the operator expected to discharge pollutants; and 2) Pesticide use patterns and planned locations of these applications. These NOIs would only provide information on the planned locations of discharges to waters of the United States where listed species or designated critical habitat occurs, but not the actual locations or timings of actual discharges that occur. Nor would the discharger be required to identify which product or products would be used. Further, most routine dischargers would file only one NOI at the beginning of the five year period. The number of operators that the EPA estimates will be affected by the proposed general permit is listed in Table 12.

If a decision maker is a Federal facility and intends to discharge into designated Tier 3 waters or has reason to believe that it will exceed the annual treatment thresholds established by the EPA as described in the proposed general permit, that decision maker is required to submit a Notice of Intent (NOI) to obtain coverage. The NOIs are to contain a section where the decision maker is to self-certify whether pesticide application activities will overlap with the distribution of endangered or threatened species, or designated critical habitat and, if so, whether these applications have undergone ESA Section 7 consultations or received an ESA Section 10 permit for take of listed species or designated critical habitat. The permit would cover the decision maker 10 days after EPA posts a receipt of a complete and accurate NOI. Any decision maker that expects to exceed any area thresholds must submit an NOI by January 9, 2012. It is also important to note that because of this, discharges to waters of the United States made

by that decision maker would immediately be authorized under the permit before any NOI is required.

The EPA's Office of Water; Office of Pesticides, Pollution and Toxic Substances; and Regional Offices, engaged in discussions with USDA and representatives from industry to determine the thresholds that would trigger NOI requirements for the remaining operators. The EPA then developed annual treatment area thresholds that differentiate between smaller applications and the larger applications that it believes to have a greater potential for adverse impacts to waters of the United States All State or Federal operators and operators that are mosquito, irrigation and aquatic weed control or other pest control districts must submit NOIs.

The EPA originally estimated that roughly 100% of operators under the Mosquito and other Flying Insect Control and Aquatic Nuisance Animal Control would be required to file NOIs. Less than 10% of operators under the Aquatic Weed and Algae control and roughly 10% of the Forest Canopy Pest Control operators were originally estimated to be required to file NOIs. NMFS estimated corrected numbers of non-Federal operators expected to be required to file NOIs. Based on the original information given by EPA, NMFS adjusted the expected number of operators who would file NOIs based on the changes in the most recent version of the permit that raised the threshold numbers.

The NOI threshold for mosquitoes and other flying insect pest control is 6,400 acres. The EPA did not provide us with estimates of the number of decision makers that would be required to submit NOIs containing endangered or threatened species or designated critical habitat effects determinations. However, all State or Federal operators and operators that are mosquito or other pest control districts must submit NOIs.

We believe discharges of pesticides to waters of the United States from mosquito and other flying insect pest control will occur in areas where listed species under NMFS' jurisdiction occur. This is of concern because in addition to direct toxicity, these pesticides are toxic to invertebrates that constitute the prey base of ESA listed species and make up the ecological communities on which these species depend for survival. We expect that these discharges are likely to expose ESA listed species under NMFS' jurisdiction, their prey and habitat to pesticides and that these exposures may cause adverse effects to those species or to designated critical habitat. For those decision makers who fall under the threshold, there will be no mechanism for EPA to know or reliably estimate the number and locations of discharges.

The EPA originally estimated that less than 10% of operators under the aquatic weed and algae control would exceed the area threshold required to submit NOIs. However, these estimates were based on proposed treatment thresholds of 20 acres with a linear treatment threshold of 20 linear miles and the assumption that not all Federal, State and aquatic weed control or other pest control districts would be required to submit NOIs. The EPA since raised the NOI threshold for aquatic weed and algae control to 80 acres of treatment area. The current proposed permit now requires that all State or Federal operators and operators that are aquatic weed control or other pest control districts must submit NOIs. The EPA also changed the requirement that these estimates be cumulative on an annual basis, to being mere single application estimates, meaning that a decision maker could discharge pesticides into an unlimited amount of area as long as the FIFRA approved pesticide label was followed and no single application exceeds 80 square acres or 20 linear miles. For many decision makers under this category, EPA will have no mechanism for determining the number and location of discharges. This is of concern because aquatic plants contribute a large part to the overall health of aquatic ecosystems. In fact, without aquatic plants, there would be no aquatic ecosystems.

**Table 12. EPA Estimated Number of Operators to be Affected by the PGP**

	<b>Mosquito and Other Flying Insect Control</b>	<b>Aquatic Weed and Algae Control</b>	<b>Aquatic Nuisance Animal Control</b>	<b>Forest Canopy Pest Control</b>	<b>TOTAL</b>
<b>Alaska*</b>	2	325	15	18	<b>385</b>
<b>Idaho*</b>	23	16,489	12	48	<b>16,572</b>
<b>Massachusetts*</b>	9	2,041	15	214	<b>2,279</b>
<b>New Hampshire*</b>	44	627	8	85	<b>764</b>
<b>New Mexico</b>	13	10,411	21	26	<b>10,471</b>
<b>Oklahoma</b>	1	3,889	74	159	<b>4,123</b>
<b>District of Columbia*</b>	1	8	2	0	<b>11</b>
<b>Territories*</b>	1	314	38	4	<b>357</b>
<b>Tribes*</b>	17	93	25	34	<b>169</b>
<b>Federal Facilities*</b>	10	10	10	22	<b>52</b>
<b>Total</b>	121	34,232	220	610	<b>35,183</b>

\* Denotes areas where discharges may affect ESA listed species or designated critical habitat under NMFS' jurisdiction.

In addition, the death of aquatic plants from herbicide exposure can result in hypoxic conditions in these ecosystems that are not easily observed, but may have adverse consequences to ESA listed species under NMFS' jurisdiction and their designated critical habitat. As a result, we expect that the aquatic weed and algae control actions authorized by the permit may expose endangered or threatened species, or designated critical habitat to pesticides and that these exposures may cause adverse effects to these resources.

The EPA originally estimated that approximately 100% of operators under the aquatic nuisance animal control use pattern would exceed the area threshold required to submit NOIs. However, these estimates were based on treatment thresholds of 20 acres. The EPA since raised this NOI threshold to 80 acres. All Federal and State decision makers would be required to submit NOIs under the proposed permit. While EPA did not provide us with adequate information to determine how many non-Federal or State operators would now be required to submit NOIs for this use pattern, this number would be fewer than originally estimated. As a result, we believe discharges of pesticides to waters of the United States from aquatic nuisance animal control activities authorized by the permit will occur in areas where listed species under NMFS' jurisdiction occur. This is especially concerning because many of the pesticides under this use category are lethal to fish, including listed species. We expect that these discharges are likely to result in exposures of pesticides to endangered or threatened species or designated critical habitat under NMFS' jurisdiction and that these exposures may cause adverse effects to those species or to designated critical habitat. For the decision makers who will not be required to submit NOIs, there will be no mechanism to prevent these exposures from occurring because no identification of these potential exposures will now be required.

The EPA originally estimated that approximately 10% of operators discharging under the forest canopy pest control use category would be required to submit NOIs. However this estimate was based on an earlier threshold of 640 acres. The NOI threshold for forest canopy pest control activities was raised to 6,400 acres. As a result, we estimate that only roughly 1% of the forest canopy pest control applicators would now be required to submit NOIs and that ~99% of these decision makers would be automatically authorized without being required to submit any endangered

or threatened species, or designated critical habitat effects determinations to the EPA. Thus, the vast majority of applicators authorized to discharge pesticides on, over or near waters of the United States for this use category under the permit would therefore not be required to make any listed resource effects determinations or to consider the impacts that these pesticides may have to these resources. We expect that these discharges are likely to result in exposures of pesticides to ESA listed species or designated critical habitat under NMFS' jurisdiction. This is of concern because these pesticides may have effects to those species and their prey and, given the wide pesticide application pattern for this use, many streams upon which listed species depend for survival may be exposed. Thus, it is our opinion that these exposures will cause adverse effects to ESA listed species or designated critical habitat under NMFS' jurisdiction.

The current draft of the permit does require that all Federal facilities and decision makers who intend to discharge pesticides into Tier 3 waters submit NOIs and accompanying listed resource effect determinations. However, even if all decision makers were required to submit NOIs containing listed resource effect determinations, these decision makers would have little incentive to make a positive effect determination because such determinations could negatively affect them economically. It is also unlikely that most decision makers would possess the ability or resources to make accurate effects determinations in the first place. Furthermore, the EPA has not explained how –or if– it intends to assess the effect determinations it does receive. The EPA has also not stated what consequences a positive effect determination would have to the decision maker's ability to discharge pesticides in areas where endangered or threatened species or designated critical habitat occur.

Any decision maker that is a "large entity" and is required to submit an NOI must also submit an annual report to EPA that includes: 1) A description of the treatment area; 2) Identification of any waters receiving discharged pesticides; and 3) Any adverse incidents and a description of any corrective actions. The permit defines "large entities" as: 1) Any public entity that serves a population greater than 10,000; or 2) A private enterprise that exceeds the Small Business Administration size standard.

Most operators discharging pesticide pollutants on, over or near waters of the United States as authorized by the proposed general permit would not be required to provide NOIs or annual reports. Because of this, the EPA would not know how many pesticide pollutant discharges it would authorize under the proposed general permit or where these discharges occur. Those discharges that the EPA will require operators to report will only be reported after those discharges have happened. Furthermore, decision makers would immediately be authorized under the permit before any NOI would be required. As such, the EPA has not structured the proposed general permit so that it could know or reliably estimate the number of discharges that it would authorize under the permit, nor can it know or reliably estimate the probable locations of these discharges. Accordingly, the EPA cannot reliably estimate the effects of the discharges it proposes to authorize under the PGP to ESA listed species or designated critical habitat.

### **EPA's Ability to Estimate Stressors Produced from the Proposed Actions Authorized by the PGP**

To know or reliably estimate the physical, chemical or biotic stressors that are likely to be produced as a direct or indirect result of the discharges of pesticide pollutants that would be authorized by the PGP, the EPA would need to know or be able to reliably estimate whether those discharges have occurred in concentrations, frequencies or for durations that violate the terms of the proposed PGP.

Under the proposed permit, all operators would be required to control discharges to meet applicable numeric and narrative State, Territory or Tribal water quality standards. As noted above, numeric standards have not been identified for most of the pesticide active ingredients and degradates. If at any time the permittee becomes aware

that the discharge causes or contributes to an excursion of applicable water quality standards, the permittee must take corrective action. However, it is unlikely that any operator would become aware that its discharge has resulted in an exceedance of a water quality standard because the proposed general permit does not require either the operator or EPA to monitor for such exceedances for the vast majority of the discharges to be authorized. As such, the EPA cannot know or reliably estimate the physical, chemical or biotic stressors that are likely to be produced as a direct or indirect result of the activities to be authorized by the proposed permit.

### **EPA's Ability to Estimate Compliance with the Permit**

To know or be able to determine reliably whether or to what degree operators are complying with the conditions, restrictions or mitigation measures the proposed general permit requires when they discharge pesticide pollutants on, over or near waters of the United States, the EPA must have an effective means of oversight. Under the conditions of the permit, any operator would be required to allow EPA or an authorized representative to: 1) Enter the premises where a regulated facility or activity is located or conducted; 2) Have access to and copy, at reasonable times, any records that must be kept under the conditions of the permit; 3) Inspect at reasonable times any facilities, equipment, practices, or operations regulated or required under the permit; and 4) Sample or monitor at reasonable times, for the purposes of assuring permit compliance or as otherwise authorized by the Clean Water Act, any substances or parameters at any location.

However, it is not explained how often, or if the EPA plans to carry out such oversight. The proposed general permit only states that the operator must allow EPA to do so. While we cannot know in advance the compliance rate for the PGP, the compliance rates of existing general permits provide an insight into the effectiveness of general permits in protecting water quality. A list of the general types and number of NPDES general permits is listed in Table 13.

EPA's Online Tracking Information System (OTIS) was used to query NPDES compliance data in the Permit Compliance System (PCS) and Integrated Compliance Information System - National Pollutant Discharge Elimination System (ICIS-NPDES) databases<sup>33</sup>. The database was downloaded on January 5, 2011. The PCS and ICIS-NPDES databases track the number of inspections and enforcement actions over five years, along with the number of non-compliance and effluent guideline exceedances over three years. The data are divided between major and minor dischargers. Major dischargers are typically facilities with a flow of one million gallons per day or greater. Examples of major dischargers are cities, towns or regional sewer districts. For the purposes of this consultation, we consider all operators to be authorized to discharge pesticide pollutants on, over or near waters of the United States as minor dischargers.

---

<sup>33</sup> The PCS was the original tracking mechanism for NPDES permits and currently includes data for 21 states. State by state, the data in PCS is being migrated into the newer ICIS-NPDES. The ICIS-NPDES currently tracks data for the remaining states not represented in PCS, U.S. territories, the Navajo Nation, and the St. Regis Tribe.

**Table 13. Types and Current Number of NPDES General Permits**

Activity	# General Permits
Aquaculture	90
Concentrated Animal Feed Operation	105
Construction General Permit	168
Cooling Water	23
Drinking Water	53
Groundwater Remediation	23
Hydroelectric Facilities	27
Hydrostatic Testing	4
Industrial	6
Industrial Storm Water	128
Log Transfer Facilities	84
Mining	590
Municipal Storm Water	48
Oil & Gas	2888
Other	386
Publicly Owned Treatment Works (POTW)	119
Seafood Processors	264

We focused on general and individual permits for entities where EPA is the permitting authority as identified in the *Description of the Proposed Action* section of this Biological Opinion. To avoid bias from permits with multiple inspections due to compliance and enforcement actions, we converted the frequency data into presence/absence of inspection, compliance and enforcement events. In this way, each permit was equally weighted in the analysis. Table 14 shows that the majority of major dischargers (66%) were inspected at least once in the past 5 years. However, among minor dischargers, a much smaller proportion of general permittees (14%) were inspected relative to the proportion of individual permittees inspected.

**Table 14. Number and Relative Proportion of Inspected Permittees According to Permit Type**

Discharger Type	Permit Type	Never Inspected	Inspected	Proportion Inspected
<b>Major</b>	<i>General</i>	0	41	100%
	<i>Individual</i>	3	405	99%
<b>Minor</b>	<i>General</i>	4292	673	14%
	<i>Individual</i>	375	735	66%

The relationship between inspections and the detection of violations within general and individual permits is illustrated in Table 15. Uninspected operators had fewer violations than inspected permittees. Substantially fewer violations were reported for the uninspected general permittees relative to those permittees that were inspected. Half of the inspected general permittees were found in violation at least once in the past three years while only 15% of the uninspected general permittees were reported to be in violation over that time period. This suggests that the reduced inspection rate among general permits for minor dischargers results in a fairly large number of undetected violations.

**Table 15. Frequency and Relative Rate of Permit Violations for Minor Dischargers with and without Inspections**

Permit Type	Inspected?	No Permit Violations	Permit Violations	Proportion Violations
<b>General</b>	<i>Never</i>	3658	634	15%
	<i>Yes</i>	335	338	50%
<b>Individual</b>	<i>Never</i>	135	240	64%
	<i>Yes</i>	173	562	76%

Due to the nature of general permits, only seven percent (356) of the general permittees had effluent limit data available. The rates of effluent violations for those permits with effluent limits are detailed in Table 16. The proportion of effluent violations detected for minor dischargers with individual permits had similar violation rates, with the inspected permit violation rate at 91% and the uninspected permit violation rate of 83%. Effluent violations for uninspected minor dischargers with general permits were detected at a substantially lower rate (47%) than inspected operators, whose violation rate was 92%.

**Table 16. Frequency and Relative Rate of Permit Effluent Limit Violations with and without Inspections**

Permit Type	Inspected?	No Effluent Limit Violations	Effluent Limit Violations	Proportion with effluent violations
<b>General</b>	<i>Never</i>	133	117	47%
	<i>Yes</i>	4	102	96%
<b>Individual</b>	<i>Never</i>	42	203	83%
	<i>Yes</i>	46	500	92%

These analyses suggest that general permits for minor dischargers have substantial undetected violations and that these violations include exceedances of effluent limits. The severity of a given violation is reflected by the enforcement action taken. Formal enforcement actions are triggered by the failure to achieve compliance within a specified period of time under informal enforcement measures or for violations of sufficiently serious nature triggering formal enforcement action with subsequent penalty order or judicial action.<sup>34</sup> Enforcement actions were more frequently pursued against major dischargers than minor dischargers irrespective of permit type (see Table 17). Informal enforcement actions were more common than formal enforcement actions among general permits for both minor and major dischargers.

**Table 17. Relative Distribution of Enforcement Actions among Different Permit Types**

Discharger Type	Permit Type	Formal	Informal	No Enforcement
<b>Major</b>	<i>General</i>	3%	52%	39%
	<i>Individual</i>	24%	18%	38%
<b>Minor</b>	<i>General</i>	2%	30%	67%
	<i>Individual</i>	18%	11%	70%

While the dominance of informal enforcement actions for general permits suggests that these violations were less severe than violations committed under individual permits, this could be due to the absence of effluent limits among

<sup>34</sup> USEPA 1989. The Enforcement Management System: National Pollutant Discharge Elimination System, (Clean Water Act). Office of Water. # PB95-156527

the general permits. If a formal enforcement action is more likely to be linked to an effluent limit violation, then formal enforcement actions are less likely to occur among general permits. If this were the case, one would expect that an examination of enforcement actions for only those permits with effluent violations would show similar rates of formal enforcement actions. Table 18 details the results of such an analysis. Among permits with effluent limit violations, general permits were less likely than individual permits to receive a formal enforcement action. However, it is interesting to note that general permits with effluent limit violations were somewhat less likely than individual permits to be met with any enforcement action.

**Table 18. Relative Distribution of Enforcement Actions Among Permits with Effluent Violations**

<b>Discharger Type</b>	<b>Permit Type</b>	<b>Formal</b>	<b>Informal</b>	<b>No Enforcement</b>
<b>Major</b>	<i>General</i>	0%	50%	50%
	<i>Individual</i>	47%	15%	39%
<b>Minor</b>	<i>General</i>	3%	10%	88%
	<i>Individual</i>	21%	12%	67%

A review of inspection and compliance patterns for general permits recorded in EPA databases produced evidence that the reduced rate of inspections of minor dischargers with general permits likely results in a substantial number of undetected permit violations and that these violations include exceedances of effluent limits. General permit violations for minor dischargers are less likely to be met with formal enforcement actions, suggesting that general permit violations are less severe than violations found under individual permits. However, the disparity in the rate of formal enforcement actions for individual and general permits could be due to the differing nature of their discharges and the specificity of the constraints listed within the permits. Individual permittees are largely wastewater treatment facilities and industrial dischargers releasing effluents with known constituents (more or less) at a predictable rate from discrete point sources. This allows more specific monitoring and reporting requirements within a permit and, as a consequence, a greater probability of violating the permit conditions. These dischargers are also more likely to release constituents for which there are water quality criteria. Discharges of such constituents from a point source at a known rate are more easily monitored than the diffuse, episodic discharges typical of general permits.

Previous investigations of general permits have examined the reliability of self-identification for permit coverage and self-reporting for permit violations. One investigation reported grossly incomplete compliance with State and EPA administered storm water general permits 10 years after implementation (Duke and Augustenborg, 2006). The researchers also determined that general permits administered by EPA attained higher compliance rates than State administered general permits. Another study found a compliance rate of 10% under Florida’s State wide general permit. Only 14 of the 136 industries examined which should have filed an NOI did so (Cross and Duke, 2008).

Analysis of EPA’s permitting and compliance databases indicate high levels of non-compliance and lower rate of enforcement actions with general permits as opposed to individual permits. Further, among general permits, those that were never inspected were half as likely to be listed with effluent violations. The lower rate of inspections for minor dischargers, such as those to be authorized by the proposed PGP, appears to be a weak point in compliance with existing NPDES general permits. Given the findings of this analysis, NMFS expects that the EPA cannot insure compliance with the protective provisions of NPDES general permits. Because of this, the EPA is not likely to know, or be able to determine reliably, whether, or to what degree, operators that are to be authorized to discharge pesticide pollutants would be complying with the conditions, restrictions or mitigation measures that the proposed PGP requires.

### **EPA's Ability to Determine Exposures of Listed Resources to the Effects of the Proposed Action**

The EPA proposes to employ the NOI process in order to know or be able to reliably estimate whether or what degree specific endangered or threatened species are likely to be exposed to the direct or indirect effects of the activities to be authorized by the proposed permit. The NOIs are to contain a section where the decision maker is to self-certify whether its pesticide application activities will overlap with the distribution of ESA listed species or designated critical habitat, and if so, must state: 1) If these applications have undergone ESA Section 7 consultations or received an ESA Section 10 permit and, 2) Which of these endangered or threatened species, or designated critical habitat overlap with treatment areas. However, as mentioned previously, the majority of operators would be authorized by the proposed general permit without filing such NOIs. In addition, some operators would be authorized to discharge pesticide pollutants before any such NOI would be required.

Even if all decision makers were required to submit NOIs with ESA listed species and designated critical habitat effect determinations, these decision makers would have little incentive to make a positive effect determination given that such a determination could preclude their ability to apply pesticides and would therefore affect them economically. Furthermore, it is unlikely that the majority of decision makers would possess the ability or resources to make accurate effects determinations.

Section 7(a)(2) of the ESA requires Federal Agencies to use the best scientific and commercial data available to insure that any action authorized, funded or carried out by such Agency is not likely to jeopardize the continued existence of any listed resource. The conditions that EPA proposes to add to the permit require permittees to be responsible for complying with this requirement by determining whether the specific actions those permittees carry out, as authorized by the proposed general permit, may affect ESA listed species or designated critical habitat. However it is unlikely that the majority of these operators would have access to the best scientific and commercial data available to make such determinations. Furthermore, the EPA has not explained how –or if– it intends to assess the effect determinations it does receive for accuracy. The EPA has also not stated what consequences such a positive effect determination would have to the decision maker's ability to discharge pesticides in areas where endangered or threatened species or designated critical habitat occur.

The condition that permittees be required to assess potential effects to ESA listed species from the activities authorized by the permit is not sufficient to insure that these actions are not likely to expose endangered or threatened species, or designated critical habitat, to the direct or indirect effects of the actions. Because of the small percentage of decision makers that are required to submit NOIs containing determinations as to the presence of ESA listed species or designated critical habitat in the areas where pesticides are to be applied; and the fact that it is not likely that those few decision makers who are required to submit such determinations would possess the knowledge, skills or resources to make such determinations accurately; and that it is not clear how –or if– the EPA will evaluate the few determinations it does receive; or what the consequences of any such determinations would be; the NOI process is not sufficient such that the EPA would know or be able to reliably estimate whether or what degree ESA listed species are likely to be exposed to the direct or indirect effects of the activities to be authorized by the proposed permit.

### **EPA's Ability to Monitor Adverse Effects from Activities Authorized by the PGP**

In order to continually identify, collect and analyze information that suggests that the discharges of pesticide pollutants on, over or near waters of the United States may expose endangered or threatened species or designated critical habitat to pesticide pollutants at concentrations, durations or frequencies that are known or suspected to produce physical, physiological, behavioral or ecological responses that have potential individual or cumulative

adverse consequences for individual organisms or constituent elements of critical habitat, the EPA proposes to require that operators self-monitor for adverse effects resulting from these discharges. Under requirements of the PGP, permittees are required to monitor and report any adverse incidents resulting from activities authorized by the permit. This places the responsibility for oversight largely on the permittees who would have little incentive to do so given that such observations could result in a violation of the permit and result in enforcement responses by the EPA.

Adequate monitoring by the operator that would be sufficient to insure that no adverse exposures occurred from authorized discharges would be time and resource intensive. It is also unclear how an operator will have the ability to visually detect all adverse responses to pesticide exposures to ESA listed species or their designated critical habitat. For example, while operators might have the ability to observe the mortality of adult or juvenile listed fish, they likely would not have the resources or ability to visually detect the death of the eggs or alevins of these species. Nor would they likely have the resources or ability to observe reductions in the reproduction or growth rates of these species as a result of pesticide exposures. The EPA states in its BE that:

“[Visual monitoring by permittees] ... should provide valuable information to EPA and the States about where adverse environmental effects are occurring. This knowledge will help EPA identify where problems may remain and where improvements can be made in the next PGP.”

While we agree that these monitoring efforts may certainly improve the permit over time, it is unlikely that the self-monitoring and self-reporting conditions of the permit are sufficient such that the EPA can continually identify, collect and analyze information that suggests that the discharges of pesticide pollutants on, over or near waters of the United States may expose endangered or threatened species or designated critical habitat under NMFS' jurisdiction to pesticide pollutants at concentrations, durations or frequencies that are known or suspected to produce physical, physiological, behavioral or ecological responses that have potential individual or cumulative adverse consequences for individual organisms or constituent elements of critical habitat.

### **EPA's Consideration of Species' Status and Population Effects**

The EPA makes its determinations of the potential effects pesticides may have on ESA listed species through an ecological risk assessment process specifically designed to address the active ingredients in pesticides under FIFRA. In order to prevent or mitigate risks to ESA listed species and their designated critical habitat, the EPA employs a screening level risk assessment that uses a generic risk quotient (RQ) method to estimate the potential direct effects of individual pesticides to non-target organisms. An RQ is the ratio of the Estimated Environmental Concentrations (EECs) in the environment and an endpoint value derived from a standard toxicity test exposing standard species to a gradient of pesticide concentrations<sup>35</sup> ( $RQ = EEC/Endpoint$ ). The degree to which an endpoint value exceeds the EEC is classified according to pre-established levels of concern (LOC).

To determine estimated environmental concentrations of pesticide pollutants in the water, the EPA employs computer models to simulate the expected behavior of these pesticide pollutants in a “standard pond” receiving direct applications of pesticides or receiving pesticide pollutants from spray drift, runoff or transport through soil pore water from treated areas. The “standard pond” covers an area of 1 hectare, is 2 meters deep, has no flow and contains 20,000 cubic meters of water. However, endangered and threatened anadromous fish species under NMFS' jurisdiction use a variety of river and stream habitats through their life cycle. These habitats have a broad range of

---

<sup>35</sup> See EPA's Office of Chemical Safety and Pollution Prevention (OCSPP) test guidelines for more information: <http://www.epa.gov/ocspp/pubs/frs/home/draftguidelines.htm>

geological features and flow regimes.

In many cases, the estimated environmental concentrations as modeled by the “standard pond” scenario may represent a conservative estimate. However, backwater areas that are connected to streams, creeks, rivers or alcoves are also ESA listed anadromous fish habitats and may not adequately be represented by the “standard pond” scenario. Furthermore, the EPA uses an endpoint based on the concentration of pesticide pollutant required to kill test species to determine direct acute effects. As such, comparing a lethality derived endpoint to peak estimated environmental concentrations derived from a “standard pond” model may not capture all expected direct acute effects to the survival of ESA listed anadromous fish species.

Similarly, EPA compares a growth and reproduction derived endpoint -such as a life-cycle test No Observed Adverse Effect Concentration/Level to a computer modeled 60 day rolling mean estimated environmental concentration. This approach may not capture all chronic, behavioral, reproductive or sublethal effects to those species. Anadromous species exhibit chemical avoidance and other behavioral responses that can influence migration. EPA’s comparison of a computer modeled 60 day rolling mean of estimated environmental pesticide pollutant concentrations to a no observed adverse effect concentration/level based on a life-cycle test may not capture such effects.

In order to analyze indirect effects to ESA listed organisms, the EPA uses the direct effects LOCs for each taxonomic group upon which an ESA listed species may rely for survival. If the RQs for these taxonomic groups are below the direct effect ESA listed species LOCs, the EPA considers any effects to these resources and indirect effects that these effects may cause to ESA listed species to be of no concern. These determinations are designed to capture any effects to designated critical habitat.

The FIFRA registration process described above addresses toxicity for a single exposure to a single stressor in the lifetime of a standard test organism. It does not integrate the status and trends of ESA listed species and critical habitat, the demographic and ecological status of ESA listed species populations and individuals comprising those populations, environmental baseline or the pre-existing stressors in the watersheds where they occur. The exposure modeling employed does not examine the specific direct and indirect pathways through which ESA listed species and designated critical habitat are exposed.

### **Summary of EPA’s Ability to Minimize or Prevent Exposure**

As the proposed general permit is structured, the EPA would not know the total number of pesticide pollutant discharges it would authorize under the proposed general permit or where or when these discharges would occur. In addition, some of the discharges that the EPA would require operators to report would only be reported after the fact.

Though operators would be required to control discharges to meet applicable numeric and narrative State, Territory or Tribal water quality standards under the current draft general permit, the majority of operators would not monitor water quality and would thus have no way of knowing whether a discharge has exceeded a water quality standard. Because of this, the EPA cannot know or reliably estimate the physical, chemical or biotic stressors that are likely to be produced as a direct or indirect result of the activities to be authorized by the proposed permit.

There is a high level of non-compliance and lower rate of enforcement actions with general permits. There is also a low rate of inspections for minor dischargers, such as those to be authorized by the proposed PGP. Because of this, the EPA is not likely to know or be able to determine reliably whether or to what degree operators are complying

with the conditions, restrictions or mitigation measures the proposed general permit requires when they discharge pesticide pollutants on, over or near waters of the United States.

The majority of operators will not be required to submit NOIs containing determinations as to the presence of ESA listed species or designated critical habitat in the areas where pesticide pollutants are to be discharged. Furthermore, it is not clear how –or if– the EPA will evaluate the determinations it does receive, or what the consequences of any such determinations would be. Because of these reasons, the NOI process is not sufficient such that the EPA would know or be able to reliably estimate whether or what degree ESA listed species are likely to be exposed to the direct or indirect effects of the activities to be authorized by the proposed permit.

The self-monitoring and self-reporting conditions of the permit are not sufficient such that the EPA can continually identify, collect and analyze information that would suggest that the discharges of pesticide pollutants may expose endangered or threatened species or designated critical habitat to pesticide pollutants. Because of this, the EPA would not know if these exposures are occurring at concentrations, durations or frequencies that are known or suspected to produce adverse effects to ESA listed species or constituent elements of critical habitat.

The current draft general permit is not sufficient such that the EPA can reliably estimate whether or to what degree specific endangered or threatened species are likely to be affected by the direct or indirect effects of the activities to be authorized by the proposed permit. The FIFRA registration process that originally authorized the pesticide uses to be authorized under the proposed general permit does not integrate information on the status and trends of ESA listed species and critical habitat, the demographic and ecological status of ESA listed species populations and individuals comprising those populations, or the pre-existing stressors in the watersheds where they occur.

Because of these insufficiencies, the EPA would not be likely to know where or when most of the discharges it intends to authorize by the proposed general permit would occur; if these discharges were resulting in exposures to pesticide pollutants in concentrations, durations or frequencies that would cause adverse effects to ESA listed species or designated critical habitat or whether the permittees were complying with the conditions of the permit designed to prevent exposures to ESA listed species and designated critical habitat. As such, the EPA would not likely be able to implement preventive measures to stop such exposures.

Therefore, the EPA has not structured the proposed PGP so that it will be able to prevent endangered or threatened species from being exposed to discharges of pesticide pollutants: (a) At concentrations, durations, or frequencies that are potentially harmful to individual listed organisms, populations or the species; (b) In mixtures that are potentially harmful to individual listed organisms, populations or the species; or (c) To ecological consequences that are potentially harmful to individual listed organisms, populations, species or Primary Constituent Elements of designated critical habitat.

### **Cumulative Effects**

Cumulative effects include the effects of future state, Tribal, local or private actions that are reasonably certain to occur in the action area considered in this Biological Opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to Section 7 of the ESA.

The biological evaluation that EPA submitted to support its request for formal consultation and which is required to discuss cumulative effects (as they are defined for the purposes of section 7 of the ESA) did not identify future State, Tribal, local, or private actions that were reasonably certain to occur in the action area and that would not require

Federal authorization, Federal funding, or the actions of a Federal agency. During this consultation, NMFS searched for information on future State, Tribal, local or private actions that were reasonably certain to occur in the action area. NMFS conducted electronic searches of business journals, trade journals and newspapers using *First Search*, Google and other electronic search engines. Those searches produced no evidence of future private action in the action area that would not require Federal authorization or funding and is reasonably certain to occur. As a result, NMFS is not aware of any actions of this kind that are likely to occur in the action area during the near future.

---

### Integration and Synthesis of Effects

---

In the *Assessment Approach* section of this Opinion, our risk analyses began by identifying the probable risks actions pose to ESA listed individuals that are likely to be exposed to an action's effects. We identify risks to individuals of endangered or threatened species using changes in the individuals' "fitness" or the individual's growth, survival, annual reproductive success and lifetime reproductive success. When we do not expect listed plants or animals exposed to an action's effects to experience reductions in fitness, we would not expect the action to have adverse consequences on the viability of the populations those individuals represent or the species those populations comprise (Stearns, 1977; Mills and Beatty, 1979; Stearns, 1992; Anderson, 2000). As a result, if we conclude that listed plants or animals are *not* likely to experience reductions in their fitness, we would conclude our assessment. If, however, we conclude that listed plants or animals are likely to experience reductions in their fitness, we would assess the potential consequences of those fitness reductions for the population or populations the individuals in an action area represent.

As part of our risk analyses, we consider the consequences of exposing endangered or threatened species to the stressors associated with the proposed actions, individually and cumulatively, given that the individuals in the action areas for this consultation are also exposed to other stressors in the action area and elsewhere in their geographic range. These stressors or the response of individual animals to those stressors can produce consequences - or "cumulative impacts" (in the National Environmental Policy Act sense of the term) - that would not occur if animals were only exposed to a single stressor.

In the *Effects of the Proposed Action* section of this Opinion, we presented the evidence that leads us to conclude that endangered or threatened species and designated critical habitat under the jurisdiction of the NMFS are likely to co-occur with discharges of pesticide pollutants on, over or near waters of the United States. As we discussed in the *Approach to the Assessment* section of this Opinion, the purpose of those analyses was to establish whether or to what degree endangered or threatened species or designated critical habitat are likely to be adversely affected if they are exposed to discharges of formulations of the 171 active ingredients.

Based on our review of the commercial and scientific literature, many, but not all, of the 171 ingredients in the 24 classes of pesticides pose serious risks for many aquatic organisms. When they are exposed to concentrations of some pesticides that we would expect to result from discharges of formulations of these pesticides on, over or near waters of the United States, individuals of some species or life stages of species are likely to die as a result of their exposure. Other individuals of aquatic species experience reductions in developmental patterns, rates of growth, reproductive success as a direct result of the exposure or because of the chemical's effect on their behavioral patterns. Exposure to some of the chemicals whose discharges would be authorized by EPA's proposed PGP has been demonstrated to have physical, physiological or neural effects on individuals that have been exposed and these

changes increase their probability of being captured and killed by predators. Because of the action of these chemicals on primary production (aquatic plants), invertebrate populations (insects) and other aquatic animals, the discharges of pesticide pollutants on, over or near waters of the United States, endangered and threatened species under NMFS' jurisdiction could be exposed to changes in their prey base, changes in the distribution of abundance of predators and competitors. These changes in the ecological community of the endangered and threatened aquatic animals are likely to represent changes in listed species, the populations they comprise and their designated critical habitat.

Because some of the species that have been studied in investigations into the responses of aquatic species to pesticides are taxonomically identical to species that have been listed as endangered or threatened (for example, *Oncorhynchus mykiss* and *Salmo salar*), we assume that the responses of the endangered and threatened taxa would be the same as those reported for the non-listed members of these taxa. We would expect the responses of listed salmon to be generally similar to the responses that have been reported for *O. mykiss*.

We are not certain whether or to what degree the responses reported in the literature would be representative of the responses in the various species of sturgeon that have been listed or southern eulachon, but we do not have evidence that would lead us to conclude that their responses would not be representative of those species that have been studied. Therefore, we assume that the responses of these other endangered and threatened species will be generally similar to those reported in the literature, although the exposure concentrations and durations might differ.

A Biological Opinion NMFS issued in 2008 concluded that the registration of chlorpyrifos, diazinon and malathion was likely to jeopardize the continued existence of 27 species of endangered and threatened salmon and was likely to destroy or adversely modify critical habitat designated for 25 of those species (NMFS, 2008a). A separate Biological Opinion NMFS issued in 2009 concluded that the proposed registration of carbaryl, carbofuran and methomyl was likely to jeopardize the continued existence of 22 species of endangered and threatened salmon and was likely to destroy or adversely modify critical habitat designated for 20 of those species (NMFS, 2009a). The literature review that we conducted for this consultation updates and reaffirms the conclusions we reached in those prior Biological Opinions on carbaryl, chlorpyrifos, diazinon, malathion and methomyl: exposing endangered and threatened species of anadromous fish under NMFS' jurisdiction to concentrations of these active ingredients, mixtures of these active ingredients, or degradates of these active ingredients or other components of formulations containing these active ingredients would increase their likelihood of becoming extinct in the foreseeable future.

---

## Conclusion

---

### Listed Species and Critical Habitat

After reviewing the current status of the listed species, the environmental baseline for the action area, the potential direct and indirect effects of the EPA's proposal to issue a Pesticides General Permit that authorizes point-source discharges of pesticide pollutants into a wide variety of aquatic habitats from the application of pesticides to or over, including near, waters of the United States where the EPA is the permitting authority, an examination of the controls EPA proposes to implement to mitigate these effects, and cumulative effects, it is our Biological Opinion that EPA has failed to insure that the discharges of pesticide pollutants it proposes to authorize using the proposed Pesticides General Permit are not likely to result in jeopardy to any listed threatened or endangered species under NMFS'

jurisdiction.

As a result of that failure and based on our review of the best scientific and commercial data available, it is NMFS' Biological Opinion that discharges of pesticide pollutants that would be authorized by the Pesticides General Permit are likely to jeopardize the continued existence of California coastal Chinook salmon, Central Valley spring-run Chinook salmon, Lower Columbia River Chinook salmon, Upper Columbia River spring-run Chinook salmon, Puget Sound Chinook salmon, Sacramento River winter-run Chinook salmon, Snake River fall-run Chinook salmon, Snake River spring/summer-run Chinook salmon, Upper Willamette River Chinook salmon, Columbia River chum salmon, Hood Canal summer-run chum salmon, Central California Coast coho salmon, Lower Columbia River coho salmon, Southern Oregon and Northern California Coast coho salmon, Oregon Coast coho salmon, Pacific eulachon, Southern green sturgeon, Shortnose sturgeon, Lake Ozette sockeye salmon, Snake River sockeye salmon, Central California Coast steelhead, California Central Valley steelhead, Lower Columbia River steelhead, Middle Columbia River steelhead, Northern California steelhead, Puget Sound steelhead, Snake River steelhead, South-Central California Coast steelhead, Southern California coast steelhead, Upper Columbia river steelhead, Upper Willamette River steelhead, Killer whale (southern resident) and Beluga whale (Cook Inlet).

After reviewing the current status of the critical habitat that has been designated for endangered and threatened species, the environmental baseline of the action area, the potential direct and indirect effects of the action, an examination of the controls EPA proposes to implement to mitigate these effects, and cumulative effects, it is our Biological Opinion that EPA has not insured that the activities it proposes to authorize under its proposed PGP are not likely to destroy or adversely modify designated critical habitat. As a result of that failure and based on our review of the best scientific and commercial data available, it is NMFS' Biological Opinion that discharges of pesticide pollutants that would be authorized by the Pesticides General Permit are, likely to result in the destruction or adverse modification of designated critical habitat for California coastal Chinook salmon, Central Valley spring-run Chinook salmon, Lower Columbia River Chinook salmon, Upper Columbia River spring-run Chinook salmon, Puget Sound Chinook salmon, Sacramento River winter-run Chinook salmon, Snake River fall-run Chinook salmon, Snake River spring/summer-run Chinook salmon, Upper Willamette River Chinook salmon, Columbia River chum salmon, Hood Canal summer-run chum salmon, Central California Coast coho salmon, Lower Columbia River coho salmon, Southern Oregon and Northern California Coast coho salmon, Oregon Coast coho salmon, Southern green sturgeon, Lake Ozette sockeye salmon, Snake River sockeye salmon, Central California Coast steelhead, California Central Valley steelhead, Lower Columbia River steelhead, Middle Columbia River steelhead, Northern California steelhead, Snake River steelhead, South-Central California Coast steelhead, Southern California coast steelhead, Upper Columbia river steelhead and Upper Willamette River steelhead, Cook Inlet beluga whale and killer whale (southern resident).

---

### **Reasonable and Prudent Alternative**

---

This Opinion has concluded that EPA's issuance of the PGP is likely to jeopardize the continued existence of 33 endangered or threatened species under NMFS' jurisdiction and result in the destruction or adverse modification of critical habitat that has been designated for 29 of those species. The clause "jeopardize the continued existence of" means "to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of ESA listed species in the wild by reducing the reproduction, numbers

or distribution of that species (50 CFR §402.02).

NMFS reached this conclusion because as the general permit is currently structured, the EPA would not be likely to know where or when most of the activities it intends to authorize would occur; if these activities were resulting in exposures of endangered or threatened species under NMFS' jurisdiction to pesticide pollutants in concentrations, durations or frequencies that would cause adverse effects to those species or designated critical habitat and would thus not be in a position to take measures to avoid those adverse effects; or whether the permittees were complying with the conditions of the permit designed to protect endangered and threatened species and designated critical habitat under NMFS' jurisdiction from being exposed.

Because we have concluded that the proposed general permit fails to comply with the requirements of section 7(a)(2) of the ESA, we have provided a Reasonable and Prudent Alternative (RPA) that would allow EPA to comply with those requirements. Regulations implementing Section 7 of the Act (50 CFR 402.02) define RPAs as alternative actions, identified during formal consultation, that: (1) Can be implemented in a manner consistent with the intended purpose of the action; (2) Can be implemented consistent with the scope of the action agency's legal authority and jurisdiction; (3) Are economically and technologically feasible for the action agency to implement; and (4) Would, in NMFS' opinion, avoid the likelihood of jeopardizing the continued existence of endangered or threatened species or resulting in the destruction or adverse modification of critical habitat. Because the general permit, for purposes of endangered or threatened species under NMFS' jurisdiction, authorizes discharges in the District of Columbia, Idaho, Massachusetts and New Hampshire, all Indian lands and Federal lands in Delaware, Vermont and Washington State, the RPA described below applies only in those locations. In addition, this RPA is not applicable to discharges to waters of the United States on Federal lands for which an existing consultation covers those activities.

The RPA is comprised of two required elements which must be implemented in their entirety to insure that the actions authorized by the general permit are not likely to jeopardize endangered or threatened species under the jurisdiction of NMFS or destroy or adversely modify critical habitat that has been designated for any of these species.

Because this Biological Opinion has concluded that the EPA's proposed PGP is likely to jeopardize the continued existence of endangered and threatened species under the jurisdiction of NMFS and is likely to result in the destruction or adverse modification of designated critical habitat, the EPA is required to notify the NMFS Office of Protected Resources of its final decision on implementation of the reasonable and prudent alternatives.

The Reasonable and Prudent Alternative is as follows:

#### **RPA Element 1**

For discharges to waters of the US where endangered or threatened species and designated critical habitat under NMFS' jurisdiction occur, the EPA will, with the technical assistance of NMFS, identify the discharges that are eligible to proceed under the general permit with or without additional conditions on the discharge, or not eligible for coverage under the general permit.

#### **Planned Discharges**

For discharges not made in response to a Declared Pest Emergency Situation, any decision maker that plans to discharge pesticide pollutants into waters of the United States containing endangered or threatened species and

designated critical habitat under NMFS' jurisdiction must file a Notice of Intent (NOI) to discharge at least 30 days prior to any discharge. The NOI must describe:

1. The location of the pest management area in detail, or a detailed map of the location;
2. The pest(s) to be controlled;
3. The pesticide product(s) to be discharged and method of application;
4. The planned quantity and rate of discharge(s) for each method of application;
5. The number of planned discharges;
6. The approximate date(s) of planned discharge(s); and
7. The rationale for supporting a determination that the discharge is not likely to adversely affect listed species, including situations in which the pest to be controlled presents a greater threat to endangered or threatened species under NMFS' jurisdiction than any exposure to the pesticide pollutant(s) planned to be used, including appropriate measures to be taken to avoid or eliminate the likelihood of adverse effects.

The EPA will promptly post a complete and accurate NOI on the Internet and will provide NMFS with a copy of the NOI on the same day. Discharges are not authorized prior to 30 days after the posting of the NOI on the Internet. Within 30 days after receipt of such an NOI, NMFS will provide EPA with a determination as to whether the eligibility criteria of "not likely to adversely affect listed species or designated critical habitat" including those situations in which the pest being controlled poses a greater threat to the species and the critical habitat than would the exposure to that pesticide pollutant(s), has been met, could be met with conditions that NMFS identifies, or has not been met. NMFS expects that the EPA will rely on NMFS' determinations when determining whether to allow permit coverage, whether to require additional conditions or whether to withhold authorization under the general permit.

After EPA has concluded that the planned discharge or discharges, as planned or with additional conditions, are eligible for coverage under the general permit, any decision maker who plans to make any changes to the discharges must file a new NOI at least 30 days prior to making any change in the planned discharges. The new NOI will be processed in the same fashion as the earlier NOI.

### **Discharges made in Response to a Declared Pesticide Emergency Situation**

Any decision maker may begin application of pesticides immediately to waters of the United States containing endangered or threatened species under NMFS' jurisdiction in response to a Declared Pest Emergency Situation, as declared by a Federal or State agency, or a designee authorized to make such a declaration. Such discharges are authorized for an initial 60 days. The decision maker must file an NOI no later than 15 days after beginning discharge. The NOI must describe:

1. The location of the pest management area in detail, or a detailed map of the location;
2. The pest(s) to be controlled;
3. The pesticide product(s) to be discharged and method of application;
4. The planned quantity and rate of discharge(s) for each method of application;
5. The number of planned discharges;

6. The approximate date(s) of planned discharge(s); and
7. The rationale for supporting a determination that the discharge is not likely to adversely affect listed species, including situations in which the pest to be controlled presents a greater threat to endangered or threatened species under NMFS' jurisdiction than any exposure to the pesticide pollutant(s) planned to be used, including appropriate measures to be taken to avoid or eliminate the likelihood of adverse effects.

An NOI filed 15 days after beginning discharges to address a Declared Pest Emergency Situation must also include equivalent information contained in items 1 through 6 for those discharges that have already occurred.

The EPA will promptly post the NOI on the Internet and will provide NMFS with a copy of the NOI on the same day it posts the NOI on the Internet. Within 30 days of receipt of the NOI filed in response to a Declared Pest Emergency Situation, NMFS will advise EPA whether the past and planned future discharges meet the eligibility criteria of "not likely to adversely affect listed species or designated critical habitat," including those situations in which the pest being controlled poses a greater threat to NMFS' species and critical habitat than would the exposure to that pesticide pollutant(s), has been met, could be met with conditions that NMFS identifies, or has not been met.

The EPA will advise the decision maker within 15 days after NMFS' notification whether the discharge or discharges are no longer covered by the general permit or whether additional conditions are required to make the discharge or discharges qualify for coverage beyond the 60 day authorization general permit. If the EPA identifies additional conditions or prohibitions to qualify discharges as eligible for coverage beyond 60 days under the general permit, those conditions or prohibitions remain in effect for the life of the general permit. NMFS expects that the EPA will rely on NMFS' determinations when determining whether to allow permit coverage, whether to require additional conditions or whether to withhold authorization under the general permit. After the EPA has concluded that the planned discharge or discharges, as planned or with additional conditions, are eligible for coverage under the general permit, any decision maker who plans to make any changes to the discharges must file a new NOI at least 30 days prior to making any change in the planned discharges. The new NOI will be processed in the same fashion as an NOI filed for Planned Discharges.

### **Provision of Information to NMFS**

To facilitate NMFS' review of NOIs, within 60 days from the date of issuance of the permit the EPA shall provide a summary of the current registered application rates, the expected environmental concentrations (EECs) of pesticides in water resulting from those applications and the toxicity information used to assess the risk to endangered and threatened species as presented in the EPA's most recent FIFRA risk assessment documents for all pesticide uses to be authorized under the general permit. For NMFS' reference, the EPA shall also provide to NMFS the original risk assessment documents from which these summaries were derived.

### **Annual Reporting**

Any decision maker that plans to discharge pesticide pollutants into waters of the United States containing endangered or threatened species under NMFS' jurisdiction must also file an annual report containing:

1. A description of treatment area, including location and size;
2. The approximate date of any discharge;
3. Identification of any waters of the United States to which pesticide pollutants are discharged;

4. The pesticide use pattern resulting in any discharge (i.e., mosquito and other flying insect pest control, aquatic weed and algae control, aquatic nuisance animal control, or forest canopy pest control);
5. Any target pest;
6. Contact information for the decision maker or any pesticide applicator, if different from the decision maker;
7. The total amount of each pesticide product applied for the reporting year by application method;
8. If applicable, an annual report of any adverse incidents as a result of any discharge; and
9. If applicable, a description of any corrective action. The EPA must collect and summarize these reports and provide this summary to NMFS.

### ***Rationale***

Under the proposed general permit, only those decision makers who meet the eligibility requirements to submit an NOI would be required to notify the EPA if their discharge would expose any endangered or threatened species under NMFS' jurisdiction to a pesticide pollutant. According to EPA estimates, only a small fraction of the total number of operators that would discharge within the range of endangered or threatened species under NMFS' jurisdiction would be required to file such a notification. In addition, it is unlikely that those few decision makers that would be required to file these notifications would possess the ability or resources to make such determinations accurately. For these reasons, the EPA would not know if the majority of discharges it plans to authorize would expose endangered or threatened species under NMFS' jurisdiction to the direct or indirect effects of the activities to be authorized by the proposed general permit. Because of this, the EPA cannot reliably estimate the probable individual or cumulative effects of those activities to those species or to their designated critical habitat.

This RPA element addresses these insufficiencies by requiring all operators that intend to discharge into waters of the United States containing endangered or threatened species or designated critical habitat under NMFS' jurisdiction to file an NOI at least 30 days prior to beginning discharge or, in the case of a Declared Pest Emergency Situation, no later than 15 days after beginning to discharge. In the NOI, the operator must identify where and when such discharges would occur, what those discharges would be and of which use patterns these discharges would consist. NMFS will have the opportunity to review every discharge that might result in exposure to endangered and threatened species or designated critical habitat under NMFS jurisdiction. NMFS will then determine whether the planned discharge or discharge(s) (future discharge or discharges in the case of Declared Pest Emergency Situations) meets the general permit's eligibility criteria of not likely to adversely affect NMFS Listed Resources of Concern, would meet it with additional conditions or would not meet the eligibility criteria. The NOI process is designed to ensure that no individual discharge or combination of discharges is likely to adversely affect listed species or designated critical habitat, with the limited exception of discharges in response to a Declared Pest Emergency Situation, described below. Although operators will make the initial determination that their discharges are not likely to adversely affect listed species, EPA will rely on NMFS' determination and not that of the individual operator. EPA must make the final determination as to whether any particular discharge qualifies for coverage under the general permit. However, NMFS and EPA expect that EPA will rely on NMFS' determination in making the decision regarding coverage under the general permit.

While the general permit does authorize discharges to address Declared Pest Emergency Situations prior to review of discharges by NMFS, this authorization has significant limits. Only a responsible government entity can make a declaration of a Declared Pest Emergency Situation. NMFS expects such declarations will be rare.

Once NMFS has reviewed a past or ongoing discharge pursuant to the NOI process for declared pest emergencies and provided its determination to EPA on whether the discharge(s) meet or could have met the eligibility criteria, any conditions or prohibitions applied by EPA remain in effect for the life of the permit for that discharger. This element of the RPA is designed to prevent repeated declarations of pest emergencies by the same operator, with a recurring 60 day of discharge authorization under the general permit without any conditions or prohibitions in place.

Because of the insufficiencies identified in this Biological Opinion regarding the FIFRA risk assessment process to evaluate effects to endangered and threatened species and designated critical habitat under NMFS' jurisdiction, NMFS will consider other evidence when reviewing NIOs. NMFS has issued four Biological Opinions on the authorization of the use of 24 pesticides under FIFRA. NMFS determined that the use of some of those pesticides was likely to jeopardize endangered or threatened species, or destroy or adversely modify designated critical habitat, under NMFS' jurisdiction. NMFS will consider this information when evaluating whether any discharges authorized by the PGP would be likely to have any adverse effects on listed resources.

By implementing this RPA element, the EPA would know or be able to reliably estimate whether or to what degree ESA listed species and designated critical habitat under NMFS' jurisdiction would be likely to be exposed to the direct or indirect effects of the activities to be authorized by the general permit and would be able to put measures in place to avoid or eliminate any likely adversely affect to listed species or designated critical habitat. This RPA element also allows the EPA to reliably estimate the probable individual or cumulative effects to endangered and threatened species and designated critical habitat under NMFS' jurisdiction by requiring that all decision makers that discharge into waters of the United States within the range of ESA listed species under NMFS' jurisdiction file an annual report that includes information on the total amount of each pesticide product applied, any adverse incidents that occurred as a result of any such discharges and a description of any corrective action that was undertaken. This gives the EPA the ability to make corrective actions or to implement preventive or corrective measures based on this information received on those probable individual or cumulative effects. This also allows the EPA to know whether reinitiation of formal consultation is required as provided in 50 CFR 402.16.

By preventing direct adverse effects to endangered or threatened salmonid fish species under NMFS' jurisdiction, unless the pest being controlled poses a greater threat to the survival of those species than would the exposure to that pesticide pollutant, this element of the RPA would prevent the salmonid fish prey base of southern resident killer whales and Cook Inlet beluga whales from becoming appreciably diminished by the activities authorized by the issuance of the proposed general permit.

## **RPA Element 2**

In addition to the current monitoring requirements in the general permit, the EPA will also solicit and collect information and water quality monitoring and other data from Federal agencies, States and other entities on water quality to help determine the presence of pesticides, degradates, metabolites, etc. in habitats where endangered or threatened species, or designated critical habitat occur to insure that the pesticide pollutant discharges it authorizes under the general permit do not exceed any EPA recommended Water Quality Criterion or occur in concentrations that are likely to result in adverse effects to endangered or threatened species or to designated critical habitat under NMFS' jurisdiction.

The EPA will encourage States, Federal agencies, and other entities to collect this information. The Agency will compile and analyze this information and data and will meet with NMFS annually during the permit term to present and discuss the results and identify data gaps and possible approaches to address the gaps.

### ***Rationale***

The majority of operators who are eligible for coverage under the proposed general permit would not monitor water quality and would thus have no way of knowing whether a discharge has exceeded a Water Quality Criterion or resulted in a pesticide pollutant in the water in a toxic amount. As a result, the proposed general permit is not currently structured such that the EPA can continually identify, collect and analyze information that would indicate whether authorized discharges of pesticide pollutants on, over or near waters of the United States may expose endangered or threatened species or designated critical habitat under NMFS' jurisdiction to pesticide pollutants at concentrations, durations or frequencies that are known or suspected to produce physical, physiological, behavioral or ecological responses that have potential individual or cumulative adverse consequences for individual organisms or constituent elements of critical habitat.

In addition, there is a greater level of non-compliance and lower rate of enforcement actions with general permits. There is also a low rate of inspections for minor dischargers, such as those to be authorized by the proposed PGP. Because of the lack of water quality monitoring requirements in the proposed general permit, the EPA is not likely to know or be able to determine reliably whether or to what degree operators are complying with the conditions, restrictions or mitigation measures the proposed general permit requires when they discharge pesticide pollutants on, over or near waters of the United States.

To address these insufficiencies, this element of the RPA requires that the EPA collect data to monitor for any exceedance of any EPA recommended Water Quality Criterion for the pesticide being applied or for any pesticide pollutant occurring in excess of levels known not to have adverse effects to endangered or threatened species or designated critical habitat under NMFS' jurisdiction, to identify gaps in water quality data, and to develop approaches to address those gaps. By monitoring for such concentrations in representative habitats where and when endangered or threatened species, or designated critical habitat under NMFS' jurisdiction may be exposed to these discharges, the EPA will be able to know or reliably determine whether or to what degree operators are complying with the conditions, restrictions or mitigation measures required by the general permit or imposed by EPA following review by NMFS of NOIs, , and whether those conditions, restrictions or mitigation measures suffice to avoid jeopardy or adverse modification. As a result, the EPA can know whether those discharges are exposing endangered or threatened species or designated critical habitat under NMFS' jurisdiction to pesticide pollutants at concentrations, durations or frequencies that are known or suspected to produce potential individual or cumulative adverse consequences. The EPA can then make corrective or enforcement actions as necessary. This also allows the EPA to know whether reinitiation of formal consultation is required as provided in 50 CFR 402.16.

By identifying all operators who discharge into waters of the United States within the range of endangered or threatened species and designated critical habitat under NMFS' jurisdiction, and by assuring that, with the exception of discharges authorized for 60 days as a result of Declared Pest Emergency Situation, no activities authorized by the general permit would be expected to cause adverse effects to endangered or threatened species under NMFS' jurisdiction, including those situations in which the pest being controlled poses a greater threat to listed species and designated critical habitat than would the exposure to that pesticide pollutant(s) as required by the first element of the RPA, and if all of those operators comply with the terms of the general permit, including any conditions, restrictions or other measures imposed by EPA following review by NMFS of NOIs and those measures are

effective, as would be assured by the second element of the RPA, the EPA can insure that the actions it proposes to authorize by the general permit will not jeopardize the continued existence of any endangered or threatened species under NMFS' jurisdiction or result in the destruction or adverse modification of any designated critical habitat of those species.

---

### **Incidental Take Statement**

---

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to: "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct." Harm is further defined by NMFS to include significant habitat modification or degradation that results in death or injury to ESA listed species by significantly impairing essential behavioral patterns, including breeding, feeding or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of Section 7(b)(4) and Section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

### **Amount or Extent of Take**

This programmatic consultation focuses on whether the EPA has insured that their issuance of the general permit is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of critical habitat of such species. It does not address specific actions that the general permit would authorize. The RPAs are designed to reduce or in most cases prevent the exposure of endangered or threatened species under NMFS' jurisdiction to pesticide pollutants as a result of activities authorized by the general permit. However, it is possible that such exposures may still take place as a result of those activities, and it is possible that these exposures may cause incidental take. In particular, NMFS anticipates that incidental take could occur in those situations in which EPA has determined, with the technical assistance of NMFS, that a discharge of a pesticide that adversely affects listed species is preferable to exposing the species to the pest. As a result, incidental take of endangered or threatened species is possible over the duration of the proposed general permit.

Because of the large scale and broad scope of the proposed action, even the best scientific and commercial data available are not sufficient to enable NMFS to estimate the specific amount of potential incidental take associated with the action. Therefore, NMFS identifies, as a surrogate for the allowable extent of take, the ability of this action to proceed without any adverse incident as defined in Appendix A of the PGP (see Appendix A of this Opinion) to fish of any species, that is attributed to any pesticide pollutant discharged in accordance with the general permit in the range of listed endangered or threatened species under NMFS' jurisdiction. An adverse incident to fish is considered attributable to a pesticide pollutant discharged in accordance with the general permit if that pesticide pollutant is known to have been discharged prior to, and near or upstream of the adverse incident and there is evidence that the pesticide pollutant caused the adverse incident (e.g. the pesticide pollutant is detected in water samples from the area or in tissue samples of affected fish).

## Reasonable and Prudent Measures

The measures to avoid or minimize take described below are non-discretionary and must be undertaken by the EPA so that they become a binding condition of any applicant, as appropriate, for the exemption in section 7(o)(2) to apply. The EPA has a continuing duty to regulate the activity covered by this incidental take statement. The protective coverage of section 7(o)(2) may lapse if the EPA: (1) Fails to assume and implement the terms and conditions; or (2) Fails to require any applicant to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the general permit. In order to monitor the impact of incidental take, the EPA must report the progress of the action and its impact on the species to NMFS OPR as specified in the incidental take statement (50 CFR§402.14(i)(3)). The reporting requirements will be established in accordance with 50 CFR 220.45 and 228.5.

To satisfy its obligations pursuant to section 7(a)(2) of the ESA, the EPA must: (1) Monitor the direct, indirect, and cumulative impacts of the activities authorized by the issuance of the general permit; and (2) Evaluate the direct, indirect, or cumulative impacts of the activities authorized by the issuance of the general permit and the consequences of those effects on endangered and threatened species under NMFS' jurisdiction. The purpose of the monitoring is to provide data for the EPA to use to identify necessary modifications to the general permit in order to reduce exposures to endangered and threatened species under NMFS' jurisdiction. NMFS believes all measures described as part of the proposed action, together with use of the Reasonable and Prudent Measures and Terms and Conditions described below, are necessary and appropriate to minimize the likelihood of incidental take of ESA listed species due to implementation of the proposed action.

The EPA shall:

1. Monitor any incidental take or surrogate measure of take that occurs from the action; and
2. Report annually to NMFS OPR on the monitoring results from the previous year.

## Terms and Conditions

To be exempt from the prohibitions of section 9 of the ESA, the EPA must comply with the following condition. This condition implements the reasonable and prudent measures described above. This condition is non-discretionary.

The EPA shall include the following instructions requiring reporting of adverse incidents to fish in the general permit:

*“NOTICE:* Incidents where fish appear injured or killed as a result of discharges into Waters of the United States from pesticide applications as authorized by this permit in the range of endangered or threatened species under the jurisdiction of the National Marine Fisheries Service shall be reported to the National Marine Fisheries Service, Office of Protected Resources at (301) 713.1401 and EPA at (202) 564.0748. The finder should leave the fish alone, make note of any circumstances likely causing the death or injury, note the location and number of fish involved and, if possible, take photographs. Adult fish should not be disturbed unless circumstances arise where an adult fish is obviously injured or killed by pesticide exposure, or some unnatural cause.

The finder may be asked to carry out instructions provided by NMFS OPR to collect specimens or take other measures to ensure that evidence intrinsic to the specimen is preserved.”

---

---

### **Conservation Recommendations**

---

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on ESA listed species or critical habitat, to help implement recovery plans, or to develop information.

The following conservation recommendations would provide information for future consultation involving EPA’s approval of State water quality standards:

1. The EPA should work with States with the delegated authority to implement the NPDES program to develop their permits in a manner that is protective of endangered or threatened species or designated critical habitat and to create monitoring programs that evaluate whether these permits are successful in accomplishing that goal.

In order to keep NMFS’ Endangered Species Division informed of actions minimizing or avoiding adverse effects or benefiting ESA listed species or their habitats, the U.S. Environmental Protection Agency should notify the Endangered Species Division of any conservation recommendations they implement in their final action.

---

---

### **Reinitiation Notice**

---

This concludes formal consultation on the U.S. Environmental Protection Agency’s issuance of the Pesticides General Permit. As provided in 50 CFR 402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) New information reveals effects of the agency action that may affect endangered or threatened species under NMFS’ jurisdiction or to designated critical habitat in a manner or to an extent not considered in this Opinion; (2) The agency action is subsequently modified in a manner that causes an effect to the ESA listed species or critical habitat not considered in this Opinion; (3) A new species is listed or critical habitat designated that may be affected by the action; or (4) The amount or extent to take specified in the incidental take statement is exceeded. In instances where the amount or extent of take specified in the incidental take statement is exceeded, the U.S. Environmental Protection Agency must immediately request reinitiation of Section 7 consultation.

---

## Literature Cited

---

- Abler, R., 1976. The Comparative Atlas of America's Great Cities: Selection of Variables and Cartographic Techniques. p. 52.
- Abookire, A., Piatt, J., 2005. Oceanographic conditions structure forage fishes into lipid-rich and lipid-poor communities in lower Cook Inlet, Alaska, USA. *Mar. Ecol. Prog. Ser.* 287, 229-240.
- Adams, P.B., Grimes, C., Hightower, J.E., Lindley, S.T., Moser, M.L., Parsley, M.J., 2007. Population status of North American green sturgeon, *Acipenser medirostris*. *Environ. Biol. Fishes* 79, 339-356.
- Adams, P.B., Grimes, C.B., Hightower, J.E., Lindley, S.T., Moser, M.L., 2002. Status Review for the North American green sturgeon. NOAA, National Marine Fisheries Service, Southwest Fisheries Science Center, Santa Cruz, California.
- Allen, B.M., Angliss, R.P., 2010. Beluga Whale, Cook Inlet Stock, pages 87 -92 in Alaska Marine Mammal Stock Assessments, 2009. NOAA-TM-AFSC-206. Available at: <http://www.nmfs.noaa.gov/pr/sars/region.htm>.
- Allen, M.J., Smith, G.B., 1988. Atlas and zoogeography of common fishes in the Bering Sea and Northeastern Pacific. NOAA Tech Rep NMFS 66.
- Allen, P., Cech, J., 2007. Age/size effects on juvenile green sturgeon, *Acipenser medirostris*, oxygen consumption, growth, and osmoregulation in saline environments. *Environmental Biology of Fishes* 79, 211-229.
- Allen, P.J., Hobbs, J.A., Cech, J.J., Van Eenennaam, J.P., Doroshov, S.I., 2009. Using Trace Elements in Pectoral Fin Rays to Assess Life History Movements in Sturgeon: Estimating Age at Initial Seawater Entry in Klamath River Green Sturgeon. *Trans. Am. Fish. Soc.* 138, 240-250.
- Anders, P., Richards, D., Powell, M.S., 2002. The first endangered white sturgeon population: Repercussions in an altered large river-floodplain ecosystem. In: Webster, V.W. (Ed.), *Biology, management, and protection of North American sturgeon*, Symposium 28. American Fisheries Society, Bethesda, Maryland, pp. 67-82.
- Anderson, J.J., 2000. A vitality-based model relating stressors and environmental properties to organism survival. *Ecological Monographs* 70, 445-470.
- Andrew, R.K., Howe, B.M., Mercer, J.A., Dzieciuch, M.A., 2002. Ocean ambient sound: Comparing the 1960s with the 1990s for a receiver off the California coast. *Acoustic Research Letters Online* 3, 65-70.
- Angliss, R.P., DeMaster, D.P., Lopez, A.L., 2001. Alaska marine mammal stock assessments, 2001. NOAA Technical Memorandum U.S. Department of Commerce.
- Anonymous, 2003. Arbovirus surveillance and mosquito control in Idaho. Guidance for Counties, Version 10.3. Boise, Idaho.
- Asper, E.D., Young, W.G., Walsh, M.T., 1988. Observations on the birth and development of a captive-born killer whale (*Orcinus orca*). *International Zoo Yearbook* 27, 295-304.
- Auth, T.D., Brodeur, R.D., 2006. Distribution and community structure of ichthyoplankton off the coast of Oregon, USA, in 2000 and 2002. *Mar. Ecol. Prog. Ser.* 319, 199-213.
- Bailey, K.M., Houde, E.D., 1989. Predation on eggs and larvae of marine fishes and the recruitment problem. *Advances in Marine Biology* 25, 1-83.
- Bain, D., 1990. Examining the validity of inferences drawn from photo-identification data, with special reference to studies of the killer whale (*Orcinus orca*) in British Columbia. Report of the International Whaling Commission, Special Issue 12, 93-100.
- Bain, D.E., Dahlheim, M.E., 1994. Effects of masking noise on detection thresholds of killer whales. In: Loughlin, T.R. (Ed.), *Marine mammals and the Exxon Valdez*. Academic Press, San Diego, California, pp. 243-256.

- Bain, M.B., Haley, N., Peterson, D., Arend, K.K., Mills, K.E., Sullivan, P.J., 2000. Shortnose sturgeon of the Hudson River: an endangered species recovery success. 20th Annual Meeting of the American Fisheries Society, St. Louis, MO, p. 14.
- Baird, R.W., 2000. The Killer Whale. In: Mann, J., Conner, R., Tyack, P.L., Whitehead, H. (Eds.), *Cetacean Societies: Field Studies of Dolphins and Whales*. University of Chicago Press, Chicago, Illinois, pp. 127-153.
- Baird, R.W., Hanson, M.B., Ashe, E.E., Heithaus, M.R., Marshall, G.J., 2003. Studies of foraging in "Southern Resident" killer whales during July 2002: dive depths, bursts in speed, and the use of a "crittercam" system for examining sub-surface behavior. National Marine Fisheries Service, National Marine Mammal Laboratory, Seattle, WA, p. 18.
- Baird, R.W., Hanson, M.B., Dill, L.M., 2005. Factors influencing the diving behaviour of fish-eating killer whales: sex differences and diel and interannual variation in diving rates. *Canadian Journal of Zoology* 83, 257-267.
- Barnhart, R.A., 1986. Species profiles: Life histories and environmental requirements of coastal fishes and invertebrates (Pacific Southwest): Steelhead. Technical Report. Humboldt State University, Arcata, California.
- Barracough, W.E., 1964. Contribution to the marine life history of the eulachon *Thaleichthys pacificus*. *Journal of the Fisheries Research Board of Canada* 21, 1333-1337.
- Barrett-Lennard, L.G., 2000. Population structure and mating patterns of killer whales (*Orcinus orca*) as revealed by DNA analysis. Ph.D. Dissertation, University of British Columbia, Canada. 108p.
- Barrett-Lennard, L.G., Ellis, G.M., 2001. Population structure and genetic variability in northeastern Pacific killer whales: towards an assessment of population viability. *Canadian Science Advisory Secretariat*, p. 35.
- Barrett-Lennard, L.G., Ford, J.K.B., Heise, K.A., 1996. The mixed blessing of echolocation: differences in sonar use by fish-eating and mammal-eating killer whales. *Animal Behaviour* 51, 553-565.
- Bax, N.J., 1983. The early marine migration of juvenile chum salmon (*Oncorhynchus keta*) through Hood Canal - its variability and consequences. Ph.D. thesis. University of Washington, Seattle, Washington, 196 p.
- Beacham, T.D., Hay, D.E., Le, K.D., 2005. Population structure and stock identification of eulachon (*Thaleichthys pacificus*), an anadromous smelt, in the Pacific Northwest. *Marine Biotechnology* 7, 363-372.
- Beamesderfer, R.C.P., Webb, M.A.H., 2002. Green sturgeon status review information. S.P. Cramer and Associates, Gresham, Oregon.
- Becker, P.R., 2000. Concentration of Chlorinated Hydrocarbons and Heavy Metals in Alaska Arctic Marine Mammals. *Marine Pollution Bulletin* 40, 819-829.
- Becker, P.R., Krahn, M.M., Mackey, E.A., Demiralp, R., Schantz, M.M., Epstein, M.S., Donais, M.K., Porter, B.J., Muir, D.C.G., Wise, S.A., 2000. Concentrations of Polychlorinated Biphenyls (PCB's), Chlorinated Pesticides, and Heavy Metals and Other Elements in Tissues of Belugas, *Delphinapterus leucas*, from Cook Inlet, Alaska. *Marine Fisheries Review* 62, 81-98.
- Berg, L., 2001. Yakima Subbasin Summary (Draft). Northwest Power Planning Council, Portland, Oregon.
- Beyers, D.W., Keefe, T.J., Carlson, C.A., 1994. Toxicity of carbaryl and malathion to two federally endangered fishes, as estimated by regression and ANOVA. *Environmental Toxicology and Chemistry* 13, 101.
- Beyers, D.W., Sikoski, P.J., 1994. Acetylcholinesterase inhibition in federally endangered Colorado squawfish exposed to carbaryl and malathion. *Environmental Toxicology and Chemistry* 13, 935.
- Bigg, M., 1982. An assessment of killer whale (*Orcinus orca*) stocks off Vancouver Island, British Columbia. Report of the International Whaling Commission 32:655-666. International Whaling Commission, pp. 655-666.
- Bigg, M.A., Olesiuk, P.F., Ellis, G.M., Ford, J.K.B., K. C. Balcomb, I., 1990. Social organization and genealogy of resident killer whales (*Orcinus orca*) in the coastal waters of British Columbia and Washington State. Report of the International Whaling Commission, Special Issue 12, 383-405.
- Bilby, R., Fransen, B., Bisson, P., 1996. Incorporation of nitrogen and carbon from spawning coho salmon into the

- trophic system of small streams: evidence from stable isotopes. *Can. J. Fish. Aquat. Sci* 53, 164-173.
- Binns, N.A., 1965. Effects of rotenone treatment on the fauna of the Green River, Wyoming. Oregon State University, Corvallis, Oregon.
- Bisson, P., Sullivan, A.K., Nielsen, J.L., 1988. Channel hydraulics, habitat use, and body form of juvenile coho salmon, steelhead, and cutthroat trout in streams. *Transactions of the American Fisheries Society* 117, 262-273.
- Bjorkstedt, E., Spence, B.C., Garza, J.C., Hankin, D.G., Fuller, D., Jones, W.E., Smith, J.J., Macedo, R., 2005. An analysis of historical population structure for evolutionarily significant units of Chinook salmon, coho salmon, and steelhead in the north-Central California Coast Recovery Domain.
- Bjornn, T., Craddock, D., Corley, D., 1968. Migration and survival of Redfish Lake, Idaho, sockeye salmon, *Oncorhynchus nerka*. *Transactions of the American Fisheries Society* 97, 360-373.
- Black, R.W., Silkey, M., 1998. Water-quality assessment of the Puget Sound Basin, Washington: Summary of stream biological data through 1995.
- Blum, J.P., 1988. Assessment of factors affecting sockeye salmon (*Oncorhynchus nerka*) production in Ozette Lake, WA. University of Washington, Seattle, Washington.
- Boran, M., Altinok, I., Capkin, E., Karacam, H., Bicer, V., 2007. Acute toxicity of carbaryl, methiocarb, and carbosulfan to the rainbow trout (*Oncorhynchus mykiss*) and guppy (*Poecilia reticulata*). *Turkish Journal of Veterinary & Animal Sciences* 31, 39-46.
- Boughton, D.A., Adams, P.B., Anderson, E., Fusaro, C., Keller, E., Kelley, E., Lentsch, L., Nielsen, J., Perry, K., Regan, H., Smith, J., Swift, C., Thompson, L., Watson, F., 2007. Viability criteria for steelhead of the south-central and southern California coast. NOAA-NMFS-SWFSC.
- Boxall, A.B.A., Sinclair, C.J., Fenner, K., Kolpin, D., Maund, S.J., 2004. When synthetic chemicals degrade in the environment. *Environmental Science & Technology* 38, 368A-375A.
- Brady, S.J., Flather, C.H., 1994. Changes in wetlands on nonfederal rural land of the conterminous United States from 1982 to 1987. *Environ. Manage.* 18, 693-705.
- Brennan, J.S., Higgins, K.F., Cordell, J.R., Stamatiou, V.A., 2004. Juvenile salmon composition, timing, distribution, and diet in the marine nearshore waters of central Puget Sound in 2001-2002. King County Department of Natural Resources and Parks, Seattle, Washington, p. 164 p.
- Brown, L.R., Moyle, P.B., Yoshiyama, R.M., 1994. Historical decline and current status of coho salmon in California. *North American Journal of Fisheries Management* 14, 237-261.
- Brundage III, H.M., O'Herron Biological and Environmental Consulting, 2006. Final Report of Shortnose Sturgeon Population Studies in the Delaware River, January 1999 through March 2003. NOAA Fisheries, NJ Division of Fish and Wildlife, p. 13.
- Buhle, E.R., Holsman, K.K., Scheuerell, M.D., Albaugh, A., 2009. Using an unplanned experiment to evaluate the effects of hatcheries and environmental variation on threatened populations of wild salmon. *Biological Conservation* 142, 2449-2455.
- Burakowski, E.A., Wake, C.P., Braswell, B., Brown, D.P., 2008. Trends in wintertime climate in the northeastern United States: 1965–2005. *Journal of Geophysical Research* 113, D20114.
- Burgner, R.L., 1991. The life history of sockeye salmon (*Oncorhynchus nerka*). In: Groot, C., Margolis, L. (Eds.), *Life history of Pacific salmon*. University of British Columbia Press, Vancouver, British Columbia, Canada, pp. 3-117.
- Burns, J.J., Seaman, G.A., 1986. Investigations of beluga whales in coastal waters of western and northern Alaska. II Biology and ecology. OCSEAP Final Rep. , pp. 221-357.
- Burtenshaw, J.C., Oleson, E.M., Hildebrand, J.A., McDonald, M.A., Andrew, R.K., Howe, B.M., Mercer, J.A., 2004. Acoustic and satellite remote sensing of blue whale seasonality and habitat in the Northeast Pacific. *Deep Sea*

Research Part II: Topical Studies in Oceanography 51, 967-986.

Busby, P.J., Wainwright, T.C., Bryant, G.J., Lierheimer, L.J., Waples, R.S., Waknitz, F.W., Lagomarsine, I.V., 1996. Status review of steelhead from Washington, Oregon, and California., NOAA Technical Memorandum. U.S. Department of Commerce, National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, WA.

Butler, J., Neuman, M., Pinkard, D., Kvitek, R., Cochrane, G., 2006. The use of multibeam sonar mapping techniques to refine population estimates of the endangered white abalone (*Haliotis sorenseni*). Fishery Bulletin NOAA. 104:521–532.

CACSS, 1988. Restoring the balance. Annual Report. California Advisory Committee on Salmon and Steelhead Trout, California Department of Fish and Game, Sacramento, California, p. 84.

Calkins, D.G., 1989. Status of Beluga Whales in Cook Inlet. The Gulf of Alaska, Cook Inlet, and North Aleutian Basin Information Update Meeting, February 7-8, 1989, Anchorage, AK, pp. 109-112.

Campbell-Lendrum, D.H., Woodruff, R., 2007. Climate change: quantifying the health impact at national and local levels. Environmental Burden of Disease Series. 14: 66.

Campbell, K., 2009. Pesticide residue water quality report, Lower Boise River tributaries. Idaho State Department of Agriculture, Surface Water Quality Program, Boise, Idaho.

Carlson, A.R., 1971. Effects of long-term exposure to carbaryl (Sevin) on survival, growth, and reproduction of the fathead minnow (*Pimephales promelas*). Journal of the Fisheries Research Board of Canada 29, 583-587.

Carretta, J.V., Forney, K.A., Muto, M.M., Barlow, J., Baker, J., Lowry, M., 2005. U.S. Pacific Marine Mammal Assessments - 2004. U.S. Department of Commerce, p. 322.

CBD, 2001. Petition to list the southern resident killer whale (*Orcinus orca*) as an endangered species under the Endangered Species Act. Center for Biological Diversity, Berkeley, California.

CDFG, 1998. Report to the Fish and Game Commission: a status review of the spring-run Chinook salmon (*Oncorhynchus tshawytscha*) in the Sacramento River drainage. Candidate Species Status Report California Department of Fish and Game

CDFG, 2002. California Department of Fish and Game comments to NMFS regarding green sturgeon listing. California Department of Fish and Game.

Cech Jr., J.J., Doroshov, S.I., Moberg, G.P., May, B.P., Schaffter, R.G., Kohlhorst, D.M., 2000. Biological assessment of green sturgeon in the Sacramento-San Joaquin watershed (phase 1). Final Report. CALFED Bay-Delta Program.

Cederholm, C.J., Johnson, D.H., Bilby, R.E., Dominguez, L.G., Garrett, A.M., Graeber, W.H., Greda, E.L., Kunze, M.D., Marcot, B.G., Palmisano, J.F., Plotnikoff, R.W., Percy, W.G., Simenstad, C.A., Trotter, P.C., 2000. Pacific salmon and wildlife - Ecological contexts, relationships, and implications for management. Special Edition Technical Report. Prepared for D.H. Johnson and T.A. O'Neil, Wildlife-Habitat Relationships in Oregon and Washington. WDFW, Olympia.

Chapman, D., Hillman, G.T., Deppert, D., Erho, M., Hays, S., Peven, C., Suzumoto, B., Klinge, R., 1994. Status of summer/fall Chinook salmon in the mid-Columbia region. Report to Chelan, Douglas, and Grant County PUDs, Boise, Idaho.

Chapman, D., Witty, K., 1993. Habitat of weak salmon stocks in the Snake River basin and feasible recovery measures. Report to the Bonneville Power Administration, DOE/BP-99654-1, Portland, Oregon.

Chapman, D.W., Bjornn, T.C., 1969. Distribution of salmonids in streams, with special reference to food and feeding. In: Northcote, T.G. (Ed.), Symposium on salmon and trout in streams: H.R. MacMillan Lectures in Fisheries, . University of British Columbia, Institute of Fisheries, Vancouver, British Columbia, Canada, pp. 153-176.

Cheng, W., Farrell, A., 2007. Acute and Sublethal Toxicities of Rotenone in Juvenile Rainbow Trout (&lt;i>Oncorhynchus mykiss&lt;/i>): Swimming Performance and Oxygen Consumption. Archives of

Environmental Contamination and Toxicology 52, 388-396.

Christensen, I., Perrin, W., Brownell, R., Demaster, I., 1984. Growth and reproduction of killer whales, (*Orcinus orca*), in Norwegian coastal waters. Report, International Whaling Commission (special issue) 6, 253-258.

Christensen, J., Hewitson, B., Busuioc, A., Chen, A., Gao, X., Held, R., Jones, R., Kolli, R., Kwon, W., Laprise, R., 2007. Regional climate projections, Climate Change, 2007: The Physical Science Basis. Contribution of Working group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. University Press, Cambridge.

Clarke, A.D., Lewis, A., Telmer, K.H., Shrimpton, J.M., 2007. Life history and age at maturity of an anadromous smelt, the eulachon *Thaleichthys pacificus* (Richardson). Journal of Fish Biology 71, 1479-1493.

Clemens, W.A., Hart, J.L., Wilby, G.V., 1936. Analysis of stomach contents of fur seals taken off the west coast of Vancouver Island in April and May, 1935. Canadian Department of Fisheries, Ottawa, Canada.

Collins, M.R., Smith, T.I.J., 1993. Characteristics of the adult segment of the Savannah River population of shortnose sturgeon. Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies. 47, 485-491.

Colway, C., Stevenson, D.E., 2007. Confirmed records of two green sturgeon from the Bering Sea and Gulf of Alaska. Northwestern Naturalist 88, 188-192.

Connor, W.P., Sneva, J.G., Tiffan, K.F., Steinhorst, R.K., Ross, D., 2005. Two alternative juvenile life history types for fall Chinook salmon in the Snake River basin. Transactions of the American Fisheries Society 134.

COSEWIC, 2005. COSEWIC Assessment and update status report on the shortnose sturgeon *Acipenser brevirostrum* in Canada. COSEWIC, Committee on the Status of Endangered Wildlife in Canada, Ottawa, Canada, p. vi + 27.

Cox, K.W., 1960. Review of the abalone of California. California Fish and Game Bulletin 46, 381-406.

Cross, L.M., Duke, L.D., 2008. Regulating industrial stormwater: State permits, municipal implementation, and a protocol for prioritization. Journal of the American Water Resources Association 44, 86-106.

Crowley, T.J., Berner, R.A., 2001. CO<sub>2</sub> and climate change. Science 292, 870.

Cryan, J.F., 1985. Retreat in the barrens. Defenders Magazine 60, 18-29.

Cullon, D.L., Yunker, M.B., Alleyne, C., Dangerfield, N.J., O'Neill, S., Whitticar, M.J., Ross, P.S., 2009. Persistent organic pollutants in Chinook salmon (*Oncorhynchus tshawytscha*): Implications for resident killer whales of British Columbia and adjacent waters. (*Orcinus orca*). Environmental Toxicology and Chemistry 28, 148-161.

Dadswell, M.J., Rulifson, R.A., 1994. Macrotidal estuaries: a region of collision between migratory marine animals and tidal power development. Biological Journal of the Linnean Society 51, 93-113.

Dadswell, M.J., Taubert, B.D., Squiers, T.S., Marchette, D., Buckley, J., 1984a. Synopsis of biological data on shortnose sturgeon, *Acipenser brevirostrum* LeSueur 1818. NOAA Technical Report U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Silver Spring, Maryland.

Dadswell, M.J., Taubert, B.D., Squiers, T.S., Marchette, D., Buckley, J., 1984b. Synopsis of biological data on shortnose sturgeon, *Acipenser brevirostrum* LeSueur, 1818. NOAA Technical Report 14.

Dahl, T.E., 1990. Wetlands losses in the United States, 1780s to 1980s. U.S. Department of the Interior, U.S. Fish and Wildlife Service; Washington, D.C.

Dahl, T.E., 2006. Status and trends of wetlands in the conterminous United States, 1998 to 2004. U.S. Fish and Wildlife Service, Washington, D.C., p. 28.

Dahlheim, M.E., 1997. A photographic catalog of killer whales, *Orcinus orca*, from the Central Gulf of Alaska to the southeastern Bering Sea. NOAA Technical Report NMFS No. 131. 54p.

- Dahlheim, M.E., Ellifrit, D.K., Swenson, J.D., 1997. Killer whales of southeast Alaska: A catalogue of photo-identified individuals. (*Orcinus orca*). Marine Mammal Laboratory, Alaska Fisheries Center, NMFS, NOAA, Seattle, WA. 79p.
- Dahlheim, M.E., Heyning, J.E., 1999. Killer whale *Orcinus orca* (Linnaeus, 1758). Pp.281-322 *In*: S. Ridgway and R. Harrison, editors. Handbook of marine mammals. Academic Press, San Diego, California.
- Davidson, C., Knapp, R.A., 2007. Multiple stressors and amphibian declines: dual impacts of pesticides and fish on yellow-legged frogs. *Ecological Applications* 17, 587-597.
- Demko, D.B., Cramer, S.P., 2000. Effects of pulse flows on juvenile chinook migration in the Stanislaus River. Report of S.P. Cramer & Associates, Inc. to South San Joaquin Irrigation District, Manteca, California and Oakdale Irrigation District, Oakdale, California, p. 48.
- Deng, X., 2000. Artificial reproduction and early life stages of the green sturgeon (*Acipenser medirostris*). University of California, Davis.
- DeVries, R.J., 2006. Population dynamics, movements, and spawning habitat of the shortnose sturgeon, *Acipenser brevirostrum*, in the Altamaha River. University of Georgia.
- DFO, 2008. Eulachon integrated fisheries management plan April 1, 2008 to March 31, 2009. Department of Fisheries and Oceans, Canada.
- Dimick, R.E., Merryfield, F., 1945. The fishes of the Willamette River system in relation to pollution. Oregon State College Engineering Experiment Station. Bulletin Series No. 20.
- Dovel, W., Pekovitch, A., Berggren, T., 1992. Biology of the shortnose sturgeon (*Acipenser brevirostrum* Lesueur, 1818) in the Hudson River estuary, New York. *In*: Smith, C.L. (Ed.), *Estuarine Research in the 1980s*. State University of New York Press, Albany, New York, pp. 187-216.
- Drake, A., Wilson, L., 1991. Eulachon, a fish to cure humanity. UBC Museum of Anthropology, Museum Note 32.
- Duffield, D.A., Miller, K.W., 1988. Demographic features of killer whales in oceanaria in the United States and Canada, 1965-1987. *Rit Fiskideildar* 11, 297-306.
- Duffield, D.A., Odell, D.K., McBain, J.F., Andrews, B., 1995. Killer whale (*Orcinus orca*) reproduction at Sea World. *Zoo Biology* 14, 417-430.
- Duke, L.D., Augustenborg, C.A., 2006. Effectiveness of Self-Identified and Self-Reported Environmental Regulations for Industry: The Case of Storm Runoff in the U.S. *Journal of Environmental Planning and Management* 49, 385-411.
- Dwyer, F. James, Linda C. Sappington, Denny R. Buckler and Susan B. Jones. 1995. Use of Surrogate Species in Assessing Contaminant Risk to Endangered and Threatened Fishes. EPA/600/R-96/029. U.S. Environmental Protection Agency, Environmental Research Laboratory, Gulf Breeze, FL. 78 p. (EPA/600/X-92/139, Environmental Research Laboratory, Gulf Breeze, FL)
- Ehlke, R.D., Keller, K., 2003. 2002 Chum salmon spawnign ground surveys on the mainstem Columbia River and its Washington tributaries. Prepared for the Pacific States Marine Fisheries Commission, Vancouver, Washington by the Bonneville Power Administration, Portland, Oregon.
- Elsner, M.M., Hamlet, A.F., 2010. Macro-scale hydrologic model implementation. Chapter 5 in Final Report for the Columbia Basin Climate Change Scenarios Project.
- Climate Impacts Group, Center for Science in the Earth System, Joint Institute for the Study of the Atmosphere and Ocean, University of Washington, Seattle, Washington.
- Emmett, R.L., Stone, S.L., Hinton, S.A., Monaco, M.E., 1991. Distribution and abundance of fishes and invertebrates in West Coast estuaries. *Estuarine Living Marine Resources Program Report 8*. National Oceanic and Atmospheric Administration, National Ocean Service, Strategic Environmental Assessments Division, Rockville, Maryland.

- EPA, 1986. Ambient water quality criteria for chlorpyrifos-1986. Office of Water Regulations and Standards. Criteria and Standards Division. Washington, DC.
- EPA, 1989. Registration Standard (Second Round Review) for the Reregistration of Pesticide Products Containing Chlorpyrifos. Office of Pesticide Programs, US EPA, Washington, D.C.
- EPA, 2002. Columbia River Basin fish contaminant Survey 1996-1998. Environmental Protection Agency.
- EPA, 2006. Reregistration Eligibility Decision for Piperonyl Butoxide. Office of Pesticide Programs, US EPA, Washington, D.C.
- Erbe, C., 2002. Underwater noise of whale-watching boats and potential effects on killer whales (*Orcinus orca*), based on an acoustic impact model. *Marine Mammal Science* 18, 394-418.
- ERC, 2002. Contaminant analysis of tissues from two shortnose sturgeon (*Acipenser brevirostrum*) collected in the Delaware River. Environmental Research and Consulting, Inc., National Marine Fisheries Service, Gloucester, Massachusetts.
- ERC, 2003. Contaminant analysis of tissues from a shortnose sturgeon (*Acipenser brevirostrum*) from the Kennebec River, Maine. Environmental Research and Consulting, Inc., National Marine Fisheries Service, Gloucester, Massachusetts.
- Erickson, D., Webb, M., 2007. Spawning Periodicity, Spawning Migration, and Size at Maturity of Green Sturgeon, *Acipenser medirostris*, in the Rogue River, Oregon. *Environmental Biology of Fishes* 79, 255-268.
- Erickson, D.L., Hightower, J.E., 2007. Oceanic distribution and behavior of green sturgeon. *American Fisheries Society Symposium* 56, 197-211.
- Eschmeyer, W.N., Herald, E.S., Hammann, H., 1983. A field guide to Pacific coast fishes of North America. Houghton Mifflin Company, Boston, Massachusetts.
- Finlayson, B., Somer, W.L., Vinson, M.R., 2010. Rotenone toxicity to rainbow trout and several mountain stream insects. *North American Journal of Fisheries Management* 30, 102-111.
- Fisher, F.W., 1994. Past and present status of Central Valley Chinook salmon. *Conservation Biology* 8, 870-873.
- Flather, C.H., Knowles, M.S., Kendall, I.A., 1998. Threatened and endangered species geography. *Bioscience* 48, 365-376.
- Foerster, R.E., 1968. The sockeye salmon. *Bulletin of the Fisheries Research Board of Canada* 162.
- Ford, J.K.B., Ellis, G.M., 1999. Transients: Mammal-hunting killer whales of B.C., Washington State, and Southeast Alaska. (*Orcinus orca*). University of British Columbia Press, Vancouver, B.C.
- Ford, J.K.B., Ellis, G.M., 2006. Selective foraging by fish-eating killer whales *Orcinus orca* in British Columbia. *Mar. Ecol. Prog. Ser.* 316, 185-199.
- Ford, J.K.B., Ellis, G.M., Balcomb, K.C., 2000. Killer whales: the natural history and genealogy of *Orcinus orca* in British Columbia and Washington State. 2nd ed. UBC Press, Vancouver, British Columbia.
- Ford, J.K.B., Ellis, G.M., Barrett-Lennard, L.G., Morton, A.B., Palm, R.S., Balcomb III, K.C., 1998. Dietary specialization in two sympatric populations of killer whale (*Orcinus orca*) in coastal British Columbia and adjacent waters. *Canadian Journal of Zoology* 76, 1456-1471.
- Foster, E.P., Fitzpatrick, M.S., Feist, G.W., Schreck, C.B., Yates, J., 2001. Gonad organochlorine concentrations and plasma steroid levels in white sturgeon (*Acipenser transmontanus*) from the Columbia River, USA. *Bulletin of Environmental Contamination and Toxicology* 67, 239-245.
- French, R., Bilton, H., Osako, M., Hartt, A., 1976. Distribution and origin of sockeye salmon (*Oncorhynchus nerka*) in offshore waters of the North Pacific Ocean. *International North Pacific Fisheries Commission Bulletin* 34.
- Fry, D.H., Jr., 1961. King salmon spawning stocks of the California Central Valley, 1940-1959. *California Fish and Game* 47, 55-71.

- Fulton, L.A., 1968. Spawning areas and abundance of chinook salmon, *Oncorhynchus tshawytscha*, in the Columbia River Basin-Past and present. U.S. Fish and Wildlife Service Special Scientific Report on Fisheries 571:26.
- Fulton, L.A., 1970. Spawning areas and abundance of steelhead trout and coho, sockeye, and chum salmon in the Columbia River basin - past and present. NOAA Technical Report.
- Funk, D.W., Markowitz, T.M., (Eds.), R.R., 2005. Baseline studies of beluga whale habitat use in Knik Arm, Upper Cook Inlet, Alaska: July 2004 - July 2005. Final report prepared by LGL Alaska Research Associates, Inc., Anchorage, AK, for Knik Arm Bridge and Toll Authority (KABATA), Anchorage, AK. 232p.
- Futer, P., Nassichuk, M., 1983. Metals in eulachons from the Nass River and crabs from Alice Arm, B.C. Canadian Reports of Fisheries and Aquatic Sciences.
- Gaydos, J.K., Balcomb III, K.C., Osborne, R.W., Dierauf, L., 2004. Evaluating potential infectious disease threats for southern killer whales, *Orcinus orca*: a model for endangered species. *Biological Conservation* 117, 253-262.
- Geiger, D.L., 2004. AbMap: The abalone mapping project. <http://www.vetigastropoda.com/ABMAP/text/index.htm>.
- Geist, D.R., Murray, C.J., Hanrahan, T.P., Xie, Y., 2009. A model of the effects of flow fluctuations on fall Chinook salmon spawning habitat availability in the Columbia River. *North American Journal of Fisheries Management* 28, 1911-1927.
- Gibson, C., 1998. Population of the 100 largest cities and other urban places in the United States: 1790 to 1990. Population.
- Gilbert, C.R., 1989. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Mid-Atlantic Bight): Atlantic and shortnose sturgeons. U.S. Fish and Wildlife Service Biological Report. U.S. Department of the Interior, Fish and Wildlife Service and U.S. Army Corps of Engineers, Waterways Experiment Station, Washington, D.C.
- Gilliom, R.J., Barbash, J.E., Crawford, C.G., Hamilton, P.A., Martin, J.D., Nakagaki, N., Nowell, L.H., Scott, J.C., Stackelberg, P.E., Thelin, G.P., Wolock, D.M., 2006. The quality of our Nation's waters. Pesticides in the Nation's streams and groundwater, 1992 - 2001. U.S. Department of the Interior, Geological Survey, Reston, Virginia.
- Good, T.P., Waples, R.S., Adams, P., 2005. Updated status of federally listed ESUs of West Coast salmon and steelhead. NOAA Technical Memorandum. U.S. Department of Commerce, Seattle, WA, pp. 1-598.
- Gordon, J., Moscrop, A., 1996. Underwater noise pollution, and its significance for whales, and dolphins. In: Simmonds, M.P., Hutchinson, J.D. (Eds.), *The conservation of whales and dolphins: Science and practice*. John Wiley & Sons, Chichester, United Kingdom, pp. 281-319.
- Gregory, S.V., Bisson, P.A., 1997. Degradation and loss of anadromous salmonid habitat in the Pacific Northwest. In: Stouder, D.J., Bisson, P.A., Naiman, R.J. (Eds.), *Pacific salmon and their ecosystems*. Chapman and Hall, New York, pp. 277-314.
- Groot, C., Margolis, L., 1991. *Pacific salmon life histories*. University of British Columbia Press, Vancouver, Canada.
- Gross, M.R., Repka, J., Robertson, C.T., Secor, D.H., Winkle, W.V., 2002. Sturgeon conservation: insights from elasticity analysis. In: Webster, V.W. (Ed.), *Biology, management, and protection of North American sturgeon*, Symposium 28. American Fisheries Society, Bethesda, Maryland, pp. 13-30.
- Grunwald, C., Stabile, J., Waldman, J.R., Gross, R., Wirgin, I., 2002. Population genetics of shortnose sturgeon *Acipenser brevirostrum* based on mitochondrial DNA control region sequences. *Molecular Ecology* 11, 1885-1898.
- Hallock, R.J., Van Woert, W.F., Shapovalov, L., 1961. An evaluation of stocking hatchery-reared steelhead rainbow trout (*Salmo gairdneri gairdneri*) in the Sacramento River System. *Fish Bulletin* 114, 1-74.
- Hanazato, T., 1991. Effects of long- and short-term exposure to carbaryl on survival, growth and reproduction of *Daphnia ambigua*. *Environmental Pollution* 74, 139-148.
- Hanson, B., Baird, R.W., Schorr, G., 2005. Focal behavioral observations and fish-eating killer whales: improving

- our understanding of foraging behavior and prey selection. 16th Biennial Conference on the Biology of Marine Mammals, San Diego, California.
- Haraguchi, K., Hisamichi, Y., Endo, T., 2009. Accumulation and mother-to-calf transfer of anthropogenic and natural organohalogens in killer whales (*Orcinus orca*) stranded on the Pacific coast of Japan. *Science of the Total Environment* 407, 2853-2859.
- Hard, J.J., Myers, J.M., Ford, M.J., Kope, R.G., Pess, G.R., Waples, R.S., Winans, G.A., Berejikian, B.A., Waknitz, F.W., Adams, P.B., Bisson, P.A., Campton, D.E., Reisenbichle, R.R., 2007. Status review update of Puget Sound steelhead. Puget Sound biological review team. National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, Washington, p. 117.
- Hart, J., 1991. Our changing cities. Johns Hopkins Univ Pr.
- Hart, J.L., 1973. Pacific fishes of Canada. Fisheries Research Board of Canada Bulletin 180.
- Hart, J.L., McHugh, J.L., 1944. The smelts (*Osmeridae*) of British Columbia. Bulletin of the Fisheries Research Board of Canada 64.
- Hastings, R.W., O'Herron II, J.C., Schick, K., Lazzari, M.A., 1987. Occurrence and distribution of shortnose sturgeon, *Acipenser brevirostrum*, in the upper tidal Delaware River. *Estuaries* 10, 337-341.
- Hatten, J.R., Tiffan, K.F., 2009. A spatial model to assess the effects of hydropower operations on Columbia River fall Chinook salmon spawning habitat. *North American Journal of Fisheries Management* 29, 1379-1405.
- Hay, D.E., McCarter, P.B., 2000. Status of the eulachon *Thaleichthys pacificus* in Canada. Department of Fisheries and Oceans Canada. Canadian Stock Assessment Secretariat, Ottawa, Ontario.
- Hayes, S.A., Bond, M.H., Hanson, C.V., Freund, E.V., 2008. Steelhead growth in a small central California watershed: Upstream and estuarine rearing patterns. *Trans. Am. Fish. Soc.* 137, 114-128.
- Hayhoe, K., Wake, C.P., Huntington, T.G., Luo, L., Schwartz, M.D., Sheffield, J., Wood, E., Anderson, B., Bradbury, J., DeGaetano, A., 2007. Past and future changes in climate and hydrological indicators in the US Northeast. *Climate Dynamics* 28, 381-407.
- Hayman, R.A., Beamer, E.M., McClure, R.E., 1996. FY 1995 Skaig River Chinook restoration research. Report by Skagit System Cooperative, La Conner, Washington:54p
- Healey, M.C., 1991. Life history of chinook salmon (*Oncorhynchus tshawytscha*). Pacific salmon life histories. UBC Press, University of British Columbia, Vancouver, pp. Pages 311-393.
- Hebdon, J.L., Kline, P., Taki, D., Flagg, T.A., 2004. Evaluating reintroduction strategies for Redfish Lake sockeye salmon captive broodstock strategy. In: Nickum, M.J., Mazik, P.M., Nickum, J.G., MacKinlay, D.D. (Eds.), Propagated fish in resource management. American Fisheries Society, Symposium 44. American Fisheries Society, Bethesda, Maryland, pp. 401-413.
- Heppell, S., 2007. Elasticity Analysis of Green Sturgeon Life History. *Environmental Biology of Fishes* 79, 357-368.
- Herman, D.P., Burrows, D.G., Wade, P.R., Durban, J.W., Matkin, C.O., LeDuc, R.G., Barrett-Lennard, L.G., Krahn, M.M., 2005. Feeding ecology of eastern North Pacific killer whales *Orcinus orca* from fatty acid, stable isotope, and organochlorine analyses of blubber biopsies. *Mar. Ecol. Prog. Ser.* 302, 18.
- Heublein, J.C., Kelly, J.T., Crocker, C.E., Klimley, A.P., Lindley, S.T., 2009. Migration of green sturgeon, *Acipenser medirostris*, in the Sacramento River. *Environmental Biology of Fishes* 84, 245-258.
- Hicks, B.J., J.D Hall, P.A. Bisson, Sedell, J.R., 1991. Responses of salmonids to habitat changes. Pages 483-518 in W.R. Meehan (ed.), Influences of Forest and Rangeland Management on Salmonid Habitat. American Fisheries Society Special Publication 19.
- Hill, E.F., Camardese, M.B., 1986. Lethal dietary toxicities of environmental contaminants to coturnix. U.S. Department of Interior, Fish and Wildlife Service, Washington, D.C.

- Hobbs, F., Stoops, N., 2002. Demographic trends in the 20th century. <http://www.census.gov/prod/2002pubs/censr-4.pdf>
- Hobbs, R.C., Shelden, K.E.W., 2008. Supplemental status review and extinction assessment of Cook Inlet belugas (*Delphinapterus leucas*). AFSC Processed Rep. 2008-08, 76 pages. AFSC, NOAA, NMFS, Seattle, WA.
- Hobbs, R.C., Shelden, K.E.W., Rugh, D.J., Norman, S.A., 2008. 2008 status review and extinction risk assessment of Cook Inlet belugas (*Delphinapterus leucas*). NMFS, Alaska Fisheries Science Center. AFSC Processed Report 2008-02. 116pp.
- Hobday, A.J., Tegner, M.J., 2000. Status review of white abalone (*Haliotis sorenseni*) throughout its range in California and Mexico. NOAA Technical Memorandum NMFS-SWR-035.
- Holt, M.M., Noren, D.P., Veirs, V., Emmons, C.K., Veirs, S., 2009. Speaking up: Killer whales (*Orcinus orca*) increase their call amplitude in response to vessel noise. *Journal of the Acoustical Society of America* 125, E127-E132.
- Houghton, R., 1994. The worldwide extent of land-use change. *Bioscience* 44, 305-313.
- Houston, J.J., 1988. Status of green sturgeon, *Acipenser medirostris*, in Canada. *Canadian Field-Naturalist* 102, 286-290.
- Howard, P.H., 1991. Handbook of environmental fate and exposure data for organic chemicals: Pesticides. CRC.
- Howell, P., Jones, K., Scarnecchia, D., La Voy, L., Kendra, W., Ortmann, D., 1985a. Willamette River winter steelhead (wild). Stock assessment of Columbia River anadromous salmonids II: Steelhead stock summaries, stock transfer guidelines, and information needs. Bonneville Power Administration, Portland, Oregon, pp. 668-685.
- Howell, P., Jones, K., Scarnecchia, D., LaVoy, L., Kendra, W., Ortmann, D., 1985b. Stock assessment of Columbia River anadromous salmonids. Volume II: Steelhead stock summaries, stock transfer guidelines, and information needs. Final Report to the Bonneville Power Administration Bonneville Power Administration, Portland, Oregon.
- Hudson, R.H., Tucker, R.K., Haegele, M.A., 1984. Handbook of toxicity of pesticides to wildlife. U.S. Department of Interior, Fish and Wildlife Service, Washington, D.C.
- ICBTRT, 2003. Independent populations of chinook, steelhead, and sockeye for listed evolutionarily significant units within the Interior Columbia River Domain. Interior Columbia Basin Technical Recovery Team, Northwest Fisheries Science Center, Seattle, Washington.
- ICTRT, 2003. Independent populations of chinook, steelhead, and sockeye for listed evolutionarily significant units within the Interior Columbia River Domain. Recovery Document. Interior Columbia Basin Technical Recovery Team, National Marine Fisheries Service, Seattle, Washington.
- IPCC, 2001. Climate change 2001: The scientific basis, contribution of working group I to the third assessment report of the intergovernmental panel of climate change. In: Houghton, J., Ding, Y., Griggs, D., Noguer, M., vander Linden, P., Dai, X., Maskell, K., Johnson, C. (Eds.). Cambridge University Press, Cambridge, England.
- Israel, J.A., Bando, K.J., Anderson, E.C., May, B., 2009. Polyploid microsatellite data reveal stock complexity among estuarine North American green sturgeon (*Acipenser medirostris*). *Can. J. Fish. Aquat. Sci.* 66, 1491-1504.
- Jacobs, R., Larson, G., Meyer, J., Currence, N., Hinton, J., Adkinson, M., Burgner, R., Geiger, H., Lestelle, L., 1996. The sockeye salmon *Oncorhynchus nerka* population in Lake Ozette, Washington, USA. National Park Service Technical Report NPS/CCSOSU/NRTR-96/04. U.S. Department of the Interior.
- Jarvinen, A.W., Nordling, B.R., Henry, M.E., 1983. Chronic toxicity of Dursban (chlorpyrifos) to the fathead minnow (*Pimephales promelas*) and the resultant acetylcholinesterase inhibition. *Ecotoxicology and Environmental Safety* 7, 423-434.
- Jefferson, T.A., Webber, M.A., Pitman, R.L., 2008. Marine Mammals of the World: A Comprehensive Guide to their Identification. Academic Press, Elsevier. London, U.K.
- Jeffries, S., 1984. Marine mammals of the Columbia River Estuary. Washington State Department of Game,

Olympia, Washington.

Jennings, M.R., 1996. Past occurrence of eulachon, *Thaleichthys pacificus*, in streams tributary to Humboldt Bay, California. *California Fish and Game* 82, 147-148.

Johnson, O.W., Grant, W.S., Kope, R.G., Neely, K., Waknitz, F.W., Waples, R.S., 1997. Status review of chum salmon from Washington, Oregon, and California. NOAA Tech. Memo. U.S. Dept. of Commerce, p. 280 p.

Johnson, W.W., Finley, M.T., 1980. Handbook of acute toxicity of chemicals to fish and aquatic invertebrates. U.S. Department of Interior, Fish and Wildlife Service, Washington, D.C.

Kakuschke, A., Prange, A., 2007. The influence of metal pollution on the immune system a potential stressor for marine mammals in the North Sea. *International Journal of Comparative Psychology* 20, Retrieved from: <http://escholarship.org/uc/item/55p54w59tj>.

Karl, T.R., Melillo, J.M., Peterson, T.C. (Eds.), 2009. Global climate change impacts in the United States. Cambridge University Press, New York, New York.

Kemmerich, J., 1945. A review of the artificial propagation and transplantation of the sockeye salmon of the Puget Sound area in the State of Washington conducted by the federal government from 1896 to 1945. Report to the Regional Director. U.S. Fish and Wildlife Service.

Kidd, H., James, D.R. (Eds.), 1991. The agrochemicals handbook. Third Edition. Royal Society of Chemistry Information Services, Cambridge, United Kingdom.

Kieffer, M.C., Kynard, B., 1993. Annual movements of shortnose and Atlantic sturgeons in the Merrimack River, Massachusetts. *Transactions of the American Fisheries Society* 122, 1088-1103.

Kirshen, P., Ruth, M., Anderson, W., 2008. Interdependencies of urban climate change impacts and adaptation strategies: a case study of Metropolitan Boston USA. *Climatic Change* 86, 105-122.

Klinkhart, E.G., 1966. The beluga whale in Alaska. Alaska Department of Fish and Game. Federal Aid in Wildlife Restoration Project Report, Volume VII. Project W-6-R and W-14-R.

Klopatek, J.M., Olson, R.J., Emerson, C.J., Jones, J.L., 1979. Land-use conflicts with natural vegetation in the United States. *Environmental Conservation* 6, 191-199.

Knowles, N., Dettinger, M.D., Cayan, D.R., 2006. Trends in snowfall versus rainfall in the western United States. *Journal of Climate* 19, 4545-4559.

Koplin, D., Furlong, E., Meyer, M., EM, T., Zaugg, S., Barber, L., Buxton, H., 2002a. Pharmaceuticals, hormones, and other organic wastewater contaminants in 419 U.S. Streams, 1999-2000: A national reconnaissance. *Environmental Science and Technology* 36, 1202-1211.

Koplin, D.W., Furlong, E.T., Meyer, M.T., Thurman, E.M., Zaugg, S.D., Barber, L.B., Buxton, H.T., 2002b. Pharmaceuticals, hormones, and other organic wastewater contaminants in U.S. Streams, 1999-2000: A national reconnaissance. *Environmental Science and Technology* 36, 1202-1211.

Kostow, K., 1995. Biennial report on the status of wild fish in Oregon. Oregon Department of Fish and Wildlife.

Krahn, M.M., Ford, M.J., Perrin, W.F., Wade, P.R., Angliss, R.P., Hanson, M.B., Taylor, B.L., Ylitalo, G.M., Dahlheim, M.E., Stein, J.E., Waples, R.S., 2004. 2004 Status Review of Southern Resident Killer Whales (*Orcinus orca*) under the Endangered Species Act. NOAA Technical Memorandum NMFS-NWFSC-62, U.S. Department of Commerce, Seattle, Washington. 95p.

Krahn, M.M., Hanson, M.B., Schorr, G.S., Emmons, C.K., Burrows, D.G., Bolton, J.L., Baird, R.W., Ylitalo, G.M., 2009. Effects of age, sex and reproductive status on persistent organic pollutant concentrations in "Southern Resident" killer whales. *Marine Pollution Bulletin*. 58, 1522-1529.

Krahn, M.M., Wade, P.R., Kalinowski, S.T., Dahlheim, M.E., Taylor, B.L., Hanson, M.B., Ylitalo, G.M., Angliss, R.P., Stein, J.E., Waples, R.S., 2002. Status review of Southern Resident killer whales (*Orcinus orca*) under the Endangered Species Act. NOAA Technical Memorandum. U.S. Department of Commerce, p. 133.

- Kruse, G.O., Scarnecchia, D.L., 2001. Assessment of bioaccumulated metal and organochlorine compounds in relation to physiological biomarkers in Kootenai River white sturgeon. *Journal of Applied Ichthyology* 18, 430-438.
- Kynard, B., 1997. Life history, latitudinal patterns, and status of the shortnose sturgeon, *Acipenser brevirostrum*. *Environmental Biology of Fishes* 48, 319-334.
- Kynard, B., Horgan, M., Kieffer, M., Seibel, D., 2000. Habitats used by shortnose sturgeon in two Massachusetts rivers, with notes on estuarine Atlantic sturgeon: A hierarchical approach. *Transactions of the American Fisheries Society* 129, 487-503.
- Labenia, J.S., Baldwin, D.H., French, B.L., Davis, J.W., Scholz, N.L., 2007. Behavioral impairment and increased predation mortality in cutthroat trout exposed to carbaryl. *Mar. Ecol. Prog. Ser.* 329, 12.
- Lackey, R.T., 2003. Pacific Northwest salmon: Forecasting their status in 2100. *Reviews in Fisheries Science* 11, 35-88.
- Lackey, R.T., 2009. Challenges to sustaining diadromous fishes through 2100: lessons learned from western North America. In *Challenges for diadromous fishes in a dynamic global environment*. In: Haro, A., Smith, K.L., Rulifson, R.A., Moffitt, C.M., Klauda, R.J., Dadswell, M.J., Cunjak, R.A., Cooper, J.A., Beal, K.L., Avery, T.S. (Eds.), *American Fisheries Society Symposium* Bethesda, Maryland.
- Laetz, C.A., Baldwin, D.H., Collier, T.K., Hebert, V., Stark, J.D., Scholz, N.L., 2009. The synergistic toxicity of pesticide mixtures: implications for risk assessment and the conservation of endangered Pacific salmon. *Environmental Health Perspectives* 117, 6.
- Langenbuch, H., Pörtner, H.O., 2002. Changes in metabolic rate and N excretion in the marine invertebrate *Sipunculus nudus* under conditions of environmental hypercapnia: identifying effective acid–base variables. *Journal of Experimental Biology* 205, 1153-1160.
- Langenbuch, H., Pörtner, H.O., 2003. Energy budget of hepatocytes from Antarctic fish (*Pachycara brachycephalum* and *Lepidonotothen kempfi*) as a function of ambient CO<sub>2</sub>: pH-dependent limitations of cellular protein biosynthesis? *Journal of Experimental Biology* 206, 3895-3903.
- Larson, Z.S., Belchik, M.R., 2000. A preliminary status review of eulachon and Pacific lamprey in the Klamath River Basin. *Yurok Tribal Fisheries Program*, Klamath, California.
- Laufle, J.C., Pauley, G.B., Shepard, M.F., 1986. *Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (Pacific Northwest) - Coho Salmon* U.S. Fish and Wildlife Service Biological Report 82(11.48). U.S. Army Corps of Engineers, TR EL-82-4. 18p.
- Lenarz, W.H., Larson, R., Ralston, S., 1991. Depth distributions of late larvae and pelagic juveniles of some fishes of the California current. *CalCOFI Reports* 32, 41-46.
- Levermann, A., Mignot, J., Nawrath, S., Rahmstorf, S., 2007. The role of northern sea ice cover for the weakening of the thermohaline circulation under global warming. *Journal of Climate* 20, 4160-4171.
- Lichatowich, J.A., 1999. *Salmon without rivers. A history of the Pacific salmon crisis*. Island Press, Washington, D.C.
- Light, J.T., Harris, C.K., Burgner, R.L., 1989. Ocean distribution and migration of steelhead (*Oncorhynchus mykiss*). Document submitted to the International North Pacific Fisheries Commission. FRI-UW-89012. Fisheries Research Institute, University of Washington, Seattle, 50 pp.
- Littell, J.S., Elsner, M.M., Whitely Binder, L.C., Snover, A.K. (Eds.), 2009. *The Washington climate change impacts assessment: evaluating Washington's future in a changing climate*. University of Washington, Climate Impacts Group, Seattle, Washington.
- Little, E.E., Archeski, R.D., Flerov, B.A., Kozlovskaya, V.I., 1990. Behavioral indicators of sublethal toxicity in rainbow trout. *Archives of Environmental Contamination and Toxicology* 19, 380-385.
- Litzow, M., Bailey, K., Prahl, F., Heintz, R., 2006. Climate regime shifts and reorganization of fish communities: the essential fatty acid limitation hypothesis. *Mar Ecol Prog Ser* 315, 1-11.

- London, T.R.S.o., 2005. A guide to facts and fictions about climate change. [http://royalsociety.org/uploadedFiles/Royal\\_Society\\_Content/News\\_and\\_Issues/Science\\_Issues/Climate\\_change/climate\\_facts\\_and\\_fictions.pdf](http://royalsociety.org/uploadedFiles/Royal_Society_Content/News_and_Issues/Science_Issues/Climate_change/climate_facts_and_fictions.pdf).
- Lubowski, R.N., Vesterby, M., Bucholtz, S., Baez, A., Roberts, M.J., 2006. Major Uses of Land in the United States, 2002. U.S. Department of Agriculture, Economic Research Service, Economic Information Bulletin No. EIB-14, Washington, D.C.
- Macek, K.J., 1975. Acute toxicity of pesticide mixtures to bluegills. *Bulletin of Environmental Contamination and Toxicology* 14, 648-652.
- Mahoney, B.A., Shelden, K.E.W., 2000. Harvest history of beluga whale, *Delphinapterus leucas*, in Cook Inlet, Alaska. *Marine Fisheries Review* 62, 124-133.
- Mangum, F.A., Madrigal, J., 1999. Rotenone effects on aquatic macroinvertebrates of the Strawberry River, Utah: a five-year summary. *Journal of Freshwater Ecology* 14, 125-135.
- Mantua, N.J., Hare, S.R., Zhang, Y., Wallace, J.M., Francis, R.C., 1997. A Pacific interdecadal climate oscillation with impacts on salmon production. *Bulletin of the American Meteorological Society* 78, 1069-1079.
- Marr, J.C., 1943. Age, length, and weight studies of three species of Columbia River salmon (*Oncorhynchus keta*, *O. gorbuscha*, and *O. kisutch*). *Stanford Ichthyology Bulletin* 2, 157-197.
- Martineau, D., 2007. Potential synergism between stress and contaminants in free-ranging cetaceans. *International Journal of Comparative Psychology* 20, 194-216.
- Matkin, C., Ellis, G., Saulitis, E., Barrett-Lennard, L., Matkin., D., 1999. Killer whales of southern Alaska. (*Orcinus orca*). North Gulf Oceanic Society, Homer, Alaska. 96pp. ISBN 0-9633467-9-2.
- Matkin, C.O., Ellis, G., Barrett-Lennard, L., Yurk, H., Saulitis, E., Scheel, D., Olesiuk, P., Ylitalo, G., 2003. Photographic and acoustic monitoring of killer whales in Prince William Sound and Kenai Fjords. Restoration Project 030012 Final Report, Exxon Valdes Oil Spill Restoration Project. North Gulf Oceanic Society, Homer, Alaska.
- Matkin, C.O., Matkin, D.R., Ellis, G.M., Saulitis, E., McSweeney, D., 1997. Movements of resident killer whales in southeastern Alaska and Prince William Sound, Alaska. *Marine Mammal Science* 13, 469-475.
- Matlack, G.R., 1997. Four centuries of forest clearance and regeneration in the hinterland of a large city. *Journal of Biogeography* 24, 281-295.
- Matthews, G.M., Waples, R.S., 1991. Status review for Snake River spring and summer Chinook salmon. NOAA Technical Memorandum NMFS F/NWC-200. U.S. Department of Commerce.
- McCarthy, J.J., Canziani, O., Leary, N.A., Dokken, D.J., White, K.S. (Eds.), 2001. Climate change 2001: Impacts, adaptation, and vulnerability. Contribution of working group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom.
- McCarthy, S.G., Duda, J.J., Emlen, J.M., Hodgson, G.R., Beauchamp, D.A., 2009. Linking Habitat Quality with Trophic Performance of Steelhead along Forest Gradients in the South Fork Trinity River Watershed, California. *Transactions of the American Fisheries Society* 138, 506-521.
- McDonald, M.A., Hildebrand, J.A., Wiggins, S.M., 2006. Increases in deep ocean ambient noise in the northeast Pacific west of San Nicolas Island, California. *Journal of the Acoustical Society of America* 120, 711-718.
- McElhany, P., Chilcote, M., Myers, J., Beamesderfer, R., 2007. Viability status of Oregon salmon and steelhead populations in the Willamette and lower Columbia basins. Willamette/Lower Columbia Technical Recovery Team Report. NMFS and Oregon Department of Fish and Wildlife, Seattle, Washington.
- McEwan, D., Jackson, T.A., 1996. Steelhead restoration and management plan for California. California Department of Fish and Game, Sacramento, California.
- McEwan, D.R., 2001. Central valley steelhead. In: Brown, R.L. (Ed.), *Contributions to the biology of the central*

- valley salmonids. California Department of Fish and Game, Sacramento, California, pp. 1-43.
- McLean, J.E., Hay, D.E., Taylor, E.B., 1999. Marine population structure in an anadromous fish: Life history influences patterns of mitochondrial DNA variation in the eulachon, *Thaleichthys pacificus*. *Molecular Ecology* 8, S143-S158.
- McLean, J.E., Taylor, E.B., 2001. Resolution of population structure in a species with high gene flow: microsatellite variation in the eulachon (Osmeridae: *Thaleichthys pacificus*). *Marine Biology* 139, 411-420.
- Meehan, W.R., Bjornn, T.R., 1991. Salmonid distributions and life histories: Cutthroat trout. Influence of forest and rangeland management on salmonid fishes and their habitats. Bethesda, American Fisheries Society Special Publication 19, 66-67.
- Merz, J.E., 1994. A dietary analysis of juvenile Sacramento squawfish (*Ptychocheilus grandis*), Chinook salmon (*Oncorhynchus tshawytscha*), and steelhead trout (*O. mykiss*) in the Lower American River, Sacramento County, California. California State University, Sacramento, CA.
- Meyers, J.M., Kope, R.G., Bryant, G.J., Teel, D.J., Lierheimer, L.J., Wainwright, T.C., Grand, W.S., Waknitz, F.W., Neely, K., Lindley, S.T., Waples, R.S., 1998. Status review of Chinook salmon from Washington, Idaho, Oregon, and California. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-F/NWC-195 NMFS-NWFSC-35.
- Miller, M.J., 2004. The ecology and functional morphology of North American sturgeon and paddlefish. In: LeBreton, G.T.O. (Ed.), *Sturgeon and paddlefish of North America*. Kluwer Academic Publishers, Netherlands, pp. 87-102.
- Mills, S.K., Beatty, J.H., 1979. The propensity interpretation of fitness. *Philosophy of Science* 46, 263-286.
- Minckley, W.L., Hendrickson, D.A., Bond, C.E., 1986. Geography of western North American freshwater fishes: Description and relationship to intercontinental tectonism. In: Hocutt, C.H., Wiley, E.O. (Eds.), *The zoogeography of North American freshwater fishes*. John Wiley and Sons, New York, New York, pp. 519-613.
- Moffett, J.W., 1949. The first four years of king salmon maintenance below Shasta Dam, Sacramento River, California. *California Fish and Game* 35, 77-102.
- Moore, M.E., Berejikian, B.A., Tezak, E.P., 2010. Early marine survival and behavior of steelhead smolts through Hood Canal and the Strait of Juan de Fuca. *Transactions of American Fisheries Society* 139, 49-61.
- Morgan, D.S., Jones, J.L., 1999. Numerical model analysis of the effects of ground-water withdrawals on discharge to streams and springs in small basins typical of the Puget Sound Lowland, Washington. US Geological Survey water-supply paper, 1-73.
- Moser, H.G., Boehlert, G.W., 1991. Ecology of pelagic larvae and juveniles of the genus *Sebastes*. *Environmental Biology of Fishes* 30, 203-224.
- Moser, M.L., Bain, M., Collins, M.R., Haley, N., Kynard, B., O'Herron Ii, J.C., Rogers, G., Squiers, T.S., 2000. A Protocol for Use of Shortnose and Atlantic Sturgeons. NOAA Technical Memorandum. U.S. Department of Commerce p. 18 pp.
- Moser, M.L., Lindley, S.T., 2007. Use of Washington estuaries by subadult and adult green sturgeon. *Environ. Biol. Fishes* 79, 243-253.
- Moser, M.L., Ross, S.W., 1995. Habitat Use and Movements of Shortnose and Atlantic Sturgeons in the Lower Cape Fear River, North Carolina. *Transactions of the American Fisheries Society* 124, 225.
- Mote, P., Hamlet, A., Salathé, E., 2008. Has spring snowpack declined in the Washington Cascades? *Hydrology and Earth System Sciences* 12, 193-206.
- Moyle, P.B., 1976a. The decline of anadromous fishes in California. *Conservation Biology* 8, 869-870.
- Moyle, P.B., 1976b. *Inland fishes of California*. University of California Press, Berkeley, California.
- Moyle, P.B., 2002. *Inland fishes of California. Revised and Expanded*. University of California Press, Berkeley,

California.

Moyle, P.B., Foley, P.J., Yoshiyama, R.M., 1992. Status of green sturgeon, *Acipenser medirostris*, in California. Final Report submitted to National Marine Fisheries Service. University of California, Davis, California.

Moyle, P.B., Yoshiyama, R.M., Williams, J.E., Wikramanayake, E.D., 1995. Fish species of special concern in California. Second edition. Final report to California Department of Fish and Game, contract 2128IF.

Musick, J.A., Harbin, M.M., Berkeley, S.A., Burgess, G.H., Eklund, A.M., Findley, L., Gilmore, R.G., Golden, J.T., Ha, D.S., Huntsman, G.R., McGovern, J.C., Parker, S.J., Poss, S.G., Sala, E., Schmidt, T.W., Sedbeny, G.R., Weeks, H., Wright, S.G., 2000. Marine, estuarine, and diadromous fish stocks at risk of extinction in North America (exclusive of Pacific salmonids). *Fisheries* 25, 6-30.

Nakamoto, R.J., Kisanuki, T.T., Goldsmith, G.H., 1995. Age and growth of Klamath River green sturgeon (*Acipenser medirostris*). Project #93-FP-13. U.S. Fish and Wildlife Service.

National Research Council, 2003. Ocean noise and marine mammals. National Academies Press, Washington, D.C.

Neave, F., Yonemori, T., Bakkala, R., 1976. Distribution and origin of chum salmon in offshore waters of the North Pacific Ocean. *Int. North Pac. Fish. Comm. Bull.* 35, 1-79.

Nickelson, T.E., Nicholas, J.W., McGie, A.M., Lindsay, R.B., Bottom, D.L., Kaiser, R.J., Jacobs, S.E., 1992. Status of anadromous salmonids in Oregon coastal basins. Oregon Department of Fish and Wildlife, Resource Development Section and Ocean Salmon Management, Oregon Department of Fish and Wildlife, Portland, Oregon.

NMFS, 1996. Status review update for coho salmon from Washington, Oregon, and California.

NMFS, 1997a. Status review update for coho salmon from the Oregon and Northern California coasts. West coast coho salmon biological review team.

NMFS, 1997b. Status review update for West Coast steelhead from Washington, Idaho, Oregon, and California. Memorandum date 7 July 1997 from the biological review team to the National Marine Fisheries Service Northwest Regional Office.

NMFS, 1998. Final Recovery Plan for the Shortnose Sturgeon *Acipenser brevirostrum*. In: Prepared by the Shortnose Sturgeon Recovery Team for the National Marine Fisheries Service (Ed.), Silver Spring, Maryland, p. 104.

NMFS, 1998d. Status review update for sockeye salmon from Ozette Lake and Baker River, Washington. West coast sockeye biological review team. Northwest Fisheries Science Center, Seattle, Washington.

NMFS, 2000. Status Review of the Smalltooth Sawfish (*Pristis pectinata*).

NMFS, 2005a. Assessment of acoustic exposures on marine mammals in conjunction with USS Shoup active sonar transmissions in the eastern Strait of Juan de Fuca and Haro Strait, Washington ~ 5 May 2003 ~. NMFS, Office of Protected Resources, Silver Spring, Maryland.

NMFS, 2005b. Final assessment of NOAA Fisheries' critical habitat analytical review teams for 12 evolutionarily significant units of West Coast salmon and steelhead. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Protected Resources Division.

NMFS, 2005c. Green sturgeon (*Acipenser medirostris*) status review update. Biological review team, Southwest Fisheries Science Center. February 2005.

NMFS, 2006. Supplement to the draft Snake River salmon recovery plan for Southeast Washington. National Marine Fisheries Service, Northwest Region, Seattle, Washington.

NMFS, 2008a. Biological opinion on the Environmental Protection Agency registration of pesticides containing chlorpyrifos, diazinon, and malathion. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Protected Resources, Silver Spring, Maryland.

NMFS, 2008b. Conservation Plan for the Cook Inlet beluga whale (*Delphinapterus leucas*). Alaska Region, Juneau, AK, p. 122.

- NMFS, 2008c. Listing endangered and threatened species: Notification of finding on a petition to list Pacific eulachon as an endangered or threatened species under the Endangered Species Act. National Marine Fisheries Service.
- NMFS, 2008d. Recovery Plan for Southern Resident Killer Whales (*Orcinus orca*). National Marine Fisheries Service, Northwest Region, Seattle, Washington, p. 251.
- NMFS, 2009a. Biological opinion on the Environmental Protection Agency registration of pesticides containing carbaryl, carbofuran, and methomyl. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Protected Resources, Silver Spring, Maryland.
- NMFS, 2009b. Final recovery plan for Lake Ozette sockeye salmon (*Oncorhynchus nerka*). National Marine Fisheries Service, Northwest Regional Office, Salmon Recovery Division.
- Noss, R.F., Murphy, D.D., 1995. Editorial: Endangered Species Left Homeless in Sweet Home. JSTOR, pp. 229-231.
- NRC, 1996. Habitat Management and Rehabilitation. In: National Research Council (Ed.), Upstream: salmon and society in the Pacific Northwest. National Academy Press, Washington, DC, pp. 204-225.
- O'Corry-Crowe, G., 2008. Climate change and the molecular ecology of Arctic marine mammals. Ecological Applications 18, S56-S76.
- O'Corry-Crowe, G., Suydam, R., Orr, J., Lowry, L., Frost, K., Litovka, D., Hobbs, R., 2007. Combination of satellite telemetry and molecular genetic analysis in the study of beluga whales in the Western Nearctic., NOAA NMFS Technical Memorandum NMFS-F/SPO-82. vi + 82pp. p.37. Report of the National Marine Fisheries Service Workshop on Advancing Electronic Tag Technologies and Their Use in Stock Assessments.
- O'Herron II, J.C., Able, K.W., Hastings, R.W., 1993. Movements of shortnose sturgeon (*Acipenser brevirostrum*) in the Delaware River. Estuaries 16, 235-240.
- Odemar, M.W., 1964. Southern range extension of the eulachon, *Thaleichthys pacificus*. California Fish and Game 50, 305-307.
- Olesiuk, P.F., Bigg, M.A., Ellis, G.M., 1990. Life history and population dynamics of resident killer whales (*Orcinus orca*) in the coastal waters of British Columbia and Washington State. Report of the International Whaling Commission Special Issue 12, 209-243.
- Olesiuk, P.F., Ellis, G.M., Ford, J.K., 2005. Life history and population dynamics of northern resident killer whales (*Orcinus orca*) in British Columbia. DFO Canadian Science Advisory Secretariat Research Document 2005/045. 81.
- Paragamian, V.L., Beamesderfer, R.C.P., Ireland, S.C., 2005. Status, population dynamics, and future prospects of the endangered Kootenai River white sturgeon population with and without hatchery intervention. Transactions of the American Fisheries Society 134.
- Parry, M., Canziani, O., Palutikof, J., van der Linden, P.J. (Eds.), 2007. Climate change 2001: Impacts, adaptation, and vulnerability. Contribution of working group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom.
- Parsons, K.M., III, K.C.B., Ford, J.K.B., Durban, J.W., 2009. The social dynamics of southern resident killer whales and conservation implications for this endangered population. (*Orcinus orca*). Animal Behaviour 77, 963-971.
- Paul, E.A., Simonin, H.A., Tomajer, T.M., 2005. A comparison of the toxicity of synergized and technical formulations of permethrin, sumithrin, and resmethrin to trout. Archives of Environmental Contamination and Toxicology 48, 251-259.
- Payne, J.T., Wood, A.W., Hamlet, A.F., Palmer, R.N., Lettenmaier, D.P., 2004. Mitigating the effects of climate change on the water resources of the Columbia River basin. Climatic Change 62, 233-256.
- Pennington, J.T., Mahoney, K.L., Kuwahara, V.S., Kolber, D.D., Calienes, R., Chavez, F.P., 2006. Primary production in the eastern tropical Pacific: A review. Progress in Oceanography 69, 285-317.

- Perrin, W.F., Reilly, S.B., 1984. Reproductive parameters of dolphins and small whales of the family Delphinidae. Pages 97-134 in: Perrin, W.G., R.L. Brownell, Jr., and D.P. DeMaster, editors. *Reproduction in whales, dolphins, and porpoises*. International Whaling Commission (Special Issue 6), Cambridge, U.K.
- Pess, G.R., Montgomery, D.R., Beechie, T.J., Holsinger, L., 2003. Anthropogenic alterations to the biogeography of Puget Sound salmon. Pages 129-154 in: Montgomery, D.R., S. Bolton, D.B. Booth, and L. Wall, editors. *Restoration of Puget Sound rivers*. University of Washington Press, Seattle, Washington.
- Pörtner, H.O., Bock, C., Reipschläger, A., 2000. Modulation of the cost of pHi regulation during metabolic depression: a <sup>31</sup>P-NMR study in invertebrate (*Sipunculus nudus*) isolated muscle. *Journal of Experimental Biology* 2003, 2417-2428.
- Pörtner, H.O., Langenbuch, M., Reipschläger, A., 2004. Biological impact of elevated ocean CO<sub>2</sub> concentrations: lessons from animal physiology and Earth history. *Journal of Oceanography* 60, 705-718.
- Protection, C.f.W., 2003. *Impacts of Impervious Cover on Aquatic Systems*. Center for Watershed Protection.
- Puget Sound Action Team, 2007. *State of the Sound 2007*. Office of the Governor, State of Washington. Olympia, Washington.
- Radtke, L.D., 1966. Distribution of smelt, juvenile sturgeon, and starry flounder in the Sacramento-San Joaquin Delta with observations on food of sturgeon. Pages 115-119 in: J.L. Turner and D.W. Kelly, eds. *Ecological studies of the Sacramento-San Joaquin Estuary. Part II*; California Department of Fish and Game, Fish Bulletin, 136.
- Ramesh, H., David, M., 2009. Respiratory performance and behavioral responses of the freshwater fish, *Cyprinus carpio* (Linnaeus) under sublethal chlorpyrifos exposure. *Journal of Basic and Clinical Physiology and Pharmacology* 20, 127-139.
- Randall, R.G., Healey, M.C., Dempson, J.B., 1987. Variability in length of freshwater residence of salmon, trout, and char. In: Dodswell, M.J., et al. (Ed.), *Common strategies of anadromous and catadromous fishes*. Am. Fish. Soc. Symp, pp. 27-41.
- Rauscher, S.A., Pal, J.S., Diffenbaugh, N.S., Benedetti, M.M., 2008. Future changes in snowmelt-driven runoff timing over the western US. *Geophysical Research Letters* 35.
- Rawson, K., Sands, N.J., Currens, K.P., Graeber, W.H., Ruckelshaus, M.H., Fuerstenberg, R.R., Scott, J., B., 2009. Viability criteria for the Lake Ozette sockeye salmon evolutionarily significant unit. NOAA Technical Memorandum. Department of Commerce, Seattle, Washington, p. 38.
- Reisenbichler, R.R., 1997. Genetic factors contributing to declines of anadromous salmonids in the Pacific Northwest. In: Stouder, D.J., Bisson, P.A., Naiman, R.J. (Eds.), *Pacific salmon and their ecosystems: status and future options*. Chapman and Hall, New York, pp. 223-244.
- Relyea, R.A., 2004. Growth and survival of five amphibian species exposed to combinations of pesticides. *Environmental Toxicology and Chemistry* 23, 6.
- Relyea, R.A., Mills, N., 2001. Predator-induced stress makes the pesticide carbaryl more deadly to gray treefrog tadpoles (*Hyla versicolor*). *Proceedings of the National Academy of Sciences of the United States of America* 98, 2491 - 2496.
- Reynolds, F.L., Mills, T.J., Benthin, R., Low, A., 1993. Restoring central valley streams: A plan for action. Calif. Dep. Fish Game, Sacramento, CA, p. 184.
- Rhatigan, M., 2004. Legislation overlap: should the Clean Water Act or the Federal Insecticide, Fungicide and Rodenticide Act prevail when pesticides end up in US waters? *The Notre Dame Law Review* 79, 30.
- Rich, W.H., 1942. The salmon runs of the Columbia River in 1938. *Fishery Bulletin* 50, 103-147.
- Richardson, S.L., Laroche, J.L., Richardson, M.D., 1980. Larval fish assemblages and associations in the north-east Pacific Ocean along the Oregon coast, winter-spring 1972-1975. *Estuarine and Coastal Marine Science* 11, 671-699.
- Richardson, W.J., Greene Jr, C.R., Malme, C.I., Thomson, D.H., 1995. *Marine mammals and noise*. Academic

Press, Inc., San Diego, California.

Rien, T.A., Burner, L.C., Farr, R.A., Howell, M.D., North, J.A., 2001. Green sturgeon population characteristics in Oregon. Annual Progress Report. Sportfish Restoration Project F-178-R.

Rogers, I.H., Birtwell, I.K., Kruzynski, G.M., 1990. The Pacific eulachon (*Thaleichthys pacificus*) as a pollution indicator organism in the Fraser River estuary, Vancouver, British Columbia. *Science of the Total Environment* 97-98, 713-727.

Ross, P.S., 2006. Fireproof killer whales (*Orcinus orca*): flame-retardant chemicals and the conservation imperative in the charismatic icon of British Columbia, Canada. *Canadian Journal of Fisheries and Aquatic Sciences* 63.

Ross, P.S., Ellis, G.M., Ikonomou, M.G., Barrett-Lennard, L.G., Addison, R.F., 2000. High PCB concentrations in free-ranging Pacific killer whales, *Orcinus orca*: effects of age, sex, and dietary preference. *Mar. Pollut. Bull.* 40, 504-515.

Royce, W.F., Smith, L.S., Hartt, A.C., 1968. Models of oceanic migrations of Pacific salmon and comments on guidance mechanisms. *Fisheries Bulletin* 66, 441-462.

Rugh, D.J., Shelden, K.E.W., Hobbs, R.C., 2010. Range contraction in a beluga whale population. *Endangered Species Research* 12, 69-75.

Salo, E.O., 1991. Life history of chum salmon (*Oncorhynchus keta*). In: Groot, C., Margolis, L. (Eds.), *Pacific salmon life histories*. University of British Columbia Press, Edmonton, Alberta., pp. 231-309.

Sandercock, F., 1991. The History of Coho Salmon (*Oncorhynchus kisutch*). In: Groot, C., Margolis, L. (Eds.), *Pacific Salmon Life History*. University of British Columbia Press, Vancouver.

Saulitis, E., Matkin, C., Barrett-Lennard, L., Heise, K., Ellis, G., 2000. Foraging strategies of sympatric killer whale (*Orcinus orca*) populations in Prince William Sound, Alaska. *Mar. Mamm. Sci.* 16, 16.

Scheffer, V.B., Slipp, J.W., 1948. The whales and dolphins of Washington state - with a key to the cetaceans of the West Coast of North America. *American Midland Naturalist* 39, 257-337.

Schmittner, A., Latif, M., Schneider, B., 2005. Model projections of the North Atlantic thermohaline circulation for the 21st century assessed by observations. *Geophysical Research Letters* 32, L23710.

Scholz, N.L., Truelove, N.K., French, B.L., Berejikian, B.A., Quinn, T.P., Casillas, E., Collier, T.K., 2000. Diazinon disrupts antipredator and homing behaviors in chinook salmon (*Oncorhynchus tshawytscha*). *Canadian Journal of Fisheries and Aquatic Sciences* 57, 1911-1918.

Schoonmaker, P.K., Gresh, T., Lichatowich, J., Radtke, H.D., 2003. Past and present salmon abundance: Bioregional estimates for key life history stages. Pages 33-40 in: J.G. Stockner, editor. *Nutrients in salmonid ecosystems: Sustaining production and biodiversity*. American Fisheries Society, Symposium 34, Bethesda, Maryland.

Scott, W.B., Crossman, E.J., 1973. Freshwater fishes of Canada. *Bulletin of the Fisheries Research Board of Canada* 184, 1-966.

Secor, D., Anders, P., Webster, V.W., Dixon, D., 2002. Can we study sturgeon to extinction? What we do and don't know about the conservation of North American sturgeon. Pages 3-9 in: Webster, V.W., editor. *Biology, management, and protection of North American sturgeon*, Symposium 28. American Fisheries Society, Bethesda, Maryland.

Shapovalov, L., Taft, A.C., 1954. The life histories of the steelhead rainbow trout (*Salmo gairdneri gairdneri*) and silver salmon (*Oncorhynchus kisutch*) with special reference to Waddell Creek, California, and recommendations regarding their management. California Department of Fish Game Bulletin 98. Available: [http://content.cdlib.org/xtf/view?docId=kt9x0nb3v6&brand=calisphere&doc.view=entire\\_text](http://content.cdlib.org/xtf/view?docId=kt9x0nb3v6&brand=calisphere&doc.view=entire_text).

Sharma, B., Gopal, K., Khanna, Y.P., 1993. Interaction of carbaryl with acetylcholinesterase of the teleost, *Clarias batrachus*. *Toxicological and Environmental Chemistry* 39, 147-152.

- Shea, K., Mangel, M., 2001. Detection of population trends in threatened coho salmon. *Can. J. Fish. Aquat. Sci* 58, 375-385.
- Shea, T.B., Berry, E.S., 1983. Toxicity of carbaryl and 1-naphthol to goldfish (*Carassius auratus*) and killifish (*Fundulus heteroclitus*). *Bulletin of Environmental Contamination and Toxicology* 31, 526-529.
- Sih, A., Bell, A.M., Kerby, J.L., 2004. Two stressors are far deadlier than one. *Trends in Ecology and Evolution* 19, 274-276.
- Simenstad, C.A., Salo, E.O., 1982. Foraging success as a determinant of estuarine and nearshore carrying capacity of juvenile chum salmon (*Oncorhynchus keta*) in Hood Canal, Washington. *Proceedings of the North Pacific Aquaculture Symposium, Alaska Sea Grant* 82, 21-37.
- Sinclair, C.J., Boxall, A.B.A., 2003. Assessment of the environmental properties and effects of pesticide transformation products. *Cranfield University, Center for EcoChemistry, Bedfordshire, United Kingdom.*
- Slaney, T.L., Hyatt, K.D., Northcote, T.G., Fielden, R.J., 1996. Status of anadromous salmon and trout in British Columbia and Yukon. *Fisheries* 21, 20-35.
- Smith, E., Baker, J., 2008. Pacific Island Ecosystem Complex chapter, *Climate Impacts on U.S. Living Marine Resources: National Marine Fisheries Service Concerns, Activities and Needs*. U.S. Dept. Commerce, NOAA Tech. Memo. NMFS-F/SPO-89, 118 p.
- Smith, W.E., Saalfeld, R.W., 1955. Studies on Columbia River smelt *Thaleichthys pacificus* (Richardson). *Washington Department of Fisheries, Fisheries Research Paper* 1, 3-26.
- Sogard, S.M., Williams, T.H., Fish, H., 2009. Seasonal Patterns of Abundance, Growth, and Site Fidelity of Juvenile Steelhead in a Small Coastal California Stream. *Trans. Am. Fish. Soc.* 138, 549-563.
- Speckman, S.G., Piatt, J.F., 2000. Historic and current use of Lower Cook Inlet, Alaska, by belugas, *Delphinapterus leucas*. *Marine Fisheries Review* 62, 22-26.
- Squiers, T.S., 2003. Completion report Kennebec River shortnose sturgeon population study (1997-2001). *National Marine Fisheries Service.*
- Staubitz, W.W., Bortleson, G., Semans, S., Tesoriero, A., Black, R., 1997. *Water-Quality Assessment of the Puget Sound Basin, Washington, Environmental Setting and Its Implications for Water Quality and Aquatic Biota*. USGS Water-Resources Investigations Report, 1997, 86.
- Stearns, S.C., 1977. The evolution of life history traits: a critique of the theory and a review of the data. *Annual Review of Ecology and Systematics* 8, 145-171.
- Stearns, S.C., 1992. *The evolution of life histories*. Oxford University Press, New York, New York.
- Stephen, C., Research, U.S.E.P.A.O.o., Development, 1985. *Guidelines for deriving numerical national water quality criteria for the protection of aquatic organisms and their uses*. United States Environmental Protection Agency, Office of Research and Development.
- Stewart, I.T., Cayan, D.R., Dettinger, M.D., *Changes toward earlier streamflow timing across western North America.*
- Stewart, I.T., Cayan, D.R., Dettinger, M.D., 2004. Changes in snowmelt runoff timing in western North America under abusiness as usual/climate change scenario. *Climatic Change* 62, 217-232.
- Sturdevant, M.V., Willette, T.M., Jewett, S., Deberec, E., 1999. Diet composition, diet overlap, and size of 14 species of forage fish collected monthly in PWS, Alaska, 1994-1995. In: Sturdevant, M.V. (Ed.), pp. 12-36.
- Tierney, K.B., Sampson, J.L., Ross, P.S., Sekela, M.A., Kennedy, C.J., 2008. Salmon olfaction is impaired by an environmentally realistic pesticide mixture. *Environmental Science & Technology* 42, 4996-5001.
- Tiffan, K.F., Kock, T.J., Haskell, C.A., Connor, W.P., Steinhorst, R.K., 2009. Water velocity, turbulence, and migration rate of subyearling fall Chinook salmon in the free-flowing and impounded Snake River. *Transactions of the American Fisheries Society* 138, 373-384.

- Tutschulte, T.C., 1976. The comparative ecology of three sympatric abalones. Doctoral dissertation. University of California, San Diego.
- Van Eenennaam, J.P., Linares, J., Doroshov, S.I., Hillemeier, D.C., Willson, T.E., Nova, A.A., 2006. Reproductive conditions of the Klamath River green sturgeon. *Trans. Am. Fish. Soc.* 135, 151-163.
- Varanasi, U., E., Casillas, M.R., Arkoosh, T., Hom, D.A., Misitano, D.W., Brown, S.-L., Chan, T.K.C., McCain, B.B., Stein, J.E., 1993. Contaminant exposure and associated biological effects in juvenile Chinook salmon (*Oncorhynchus tshawytscha*) from urban and nonurban estuaries of Puget Sound. NOAA Technical Memorandum NMFS-NWFSC-8. Seattle, Washington.
- Walker, L.A., Cornell, L., Dahl, K.D., Czekala, N.M., Dargen, C.M., Joseph, B., Hsueh, A.J.W., Lasley\*, B.L., 1988. Urinary concentrations of ovarian steroid hormone metabolites and bioactive follicle-stimulating hormone in killer whales (*Orcinus orca*) during ovarian cycles and pregnancy. *Biology of Reproduction* 39, 1013-1020.
- Waples, R.S., Aegersold, P.B., Winans, G.A., 1997. Population genetic structure and life history variability in *Oncorhynchus nerka* from the Snake River basin. Report to Bonneville Power Administration, Contract No. 1993BP05326, Project No. 199306800. BPA Report DOE/BP-05326-1.
- Waples, R.S., Johnson, O.W., R.P. Jones, Jr., 1991. Status review for Snake River sockeye salmon. U.S. Department of Commerce, NOAA Technical Memorandum NMFS F/NWC-195.
- Ward, E., Holmes, E., Balcomb, K., 2009a. Quantifying the effects of prey abundance on killer whale reproduction. *Journal of Applied Ecology* 46, 632-640.
- Ward, E.J., Parsons, K., Holmes, E.E., III, K.C.B., Ford, J.K.B., 2009b. The role of menopause and reproductive senescence in a long-lived social mammal. *Frontiers in Zoology* 6, 4.
- WDF, 1993. Washington Department of Fisheries 1992 Washington State salmon and steelhead stock inventory (SASSI). Washington Department of Fisheries, Washington Department of Wildlife, Western Washington Treaty Indian Tribes, Olympia, Washington.
- WDFW, ODFW, 2001. Washington and Oregon eulachon management plan. Washington Department of Fish and Wildlife and Oregon Department of Fish and Wildlife.
- Webb, M.A., Feist, H.G.W., Fitzpatrick, M.S., Foster, E.P., Schreck, C.B., Plumlee, M., Wong, C., Gundersen, D.T., 2006. Mercury concentrations in gonad, liver, and muscle of white sturgeon *Acipenser transmontanus* in the Lower Columbia River. *Archives of Environmental Contamination and Toxicology* 50, 443-451.
- Wedemeyer, G.A., Saunders, R.L., Clarke, W.C., 1980. Environmental factors affecting smoltification and early marine survival of anadromous salmonids. *Mar.Fish.Rev.*, 1-14.
- Williams, J.E., Haak, A.L., Neville, H.M., Colyer, W.T., 2009. Potential consequences of climate change to persistence of cutthroat trout populations. *North American Journal of Fisheries Management* 29, 533-548.
- Williams, R., Bain, D.E., Ford, J.K.B., Trites, A.W., 2002a. Behavioural responses of male killer whales to a 'leapfrogging' vessel. *Journal of Cetacean Research, and Management* 4, 305-310.
- Williams, R., Trites, A.W., Bain, D.E., 2002b. Behavioural responses of killer whales (*Orcinus orca*) to whale-watching boats: opportunistic observations and experimental approaches. *Journal of Zoology* 256, 255-270.
- Willson, M.F., Armstrong, R.H., Hermans, M.C., Koski, K., 2006. Eulachon: a review of biology and an annotated bibliography. Auke Bay Laboratory, Alaska Fisheries Science Center, Juneau, Alaska.
- Wing, B.L., 1977. Salmon food observations. Pages 20-27 in: Southeast Alaska troll log book program: 1976 scientific report. Alaska Sea Grant Report 77-11.
- Wirgin, I., Grunwald, C., Carlson, E., Stabile, J., Peterson, D.L., Waldman, J., 2005. Range-wide population structure of shortnose sturgeon *Acipenser brevirostrum* based on sequence analysis of the mitochondrial DNA control region. *Estuaries* 28, 16.
- Wright, S., 1999. Petition to list eulachon *Thaleichthys pacificus* as threatened or endangered under the Endangered

Species Act.

Wydoski, R., Whitney, R., 1979. Inland fishes of Washington. University of Washington Press.

Yang, M.S., Nelson, M.W., 1999. Food habits of the commercially important groundfishes in the Gulf of Alaska in 1990, 1993, and 1996. NOAA.

Ylitalo, G.M., Myers, M., Stewart, B.S., Yochem, P.K., Braun, R., Kashinsky, L., Boyd, D., Antonelis, G.A., Atkinson, S., Aguirre, A.A., Krahn, M.M., 2008. Organochlorine contaminants in endangered Hawaiian monk seals from four subpopulations in the Northwestern Hawaiian Islands. *Marine Pollution Bulletin* 56, 231-244.

Yoshiyama, R.M., Gerstung, E.R., Fisher, F.W., Moyle, P.B., 1996. Historical and present distribution of chinook salmon in the Central Valley drainage of California. Department of Wildlife, Fish, and Conservation Biology, University of California, Davis California.

Zabel, R.W., Achord, S., 2004. Relating size of individuals to juvenile survival within and among closely-related populations of chinook salmon. *Ecology* 85, 795-806.

Zabel, R.W., Williams, J.G., 2002. Selective mortality in Chinook salmon: What is the role of human disturbance? *Ecological Applications* 12, 173-183.

Zimmerman, C.E., Edwards, G.W., Perry, K., 2009. Maternal Origin and Migratory History of Steelhead and Rainbow Trout Captured in Rivers of the Central Valley, California. *Transactions of the American Fisheries Society* 138, 280-291.

Zinkl, J.G., Shea, P.J., Nakamoto, R.J., Callman, J., 1987. Brain cholinesterase activity of rainbow trout poisoned by carbaryl. *Bulletin of environmental contamination and toxicology* 38, 29-35.

## APPENDIX A: Definition of Adverse Incidents in the PGP

From the Draft PGP Appendix A:

**Adverse Incident** – means an unusual or unexpected incident that an Operator has observed upon inspection or of which the Operator otherwise become aware, in which:

- (1) There is evidence that a person or non-target organism has likely been exposed to a pesticide residue, and
- (2) The person or non-target organism suffered a toxic or adverse effect. The phrase toxic or adverse effects includes effects that occur within waters of the United States on non-target plants, fish or wildlife that are unusual or unexpected (e.g., effects are to organisms not otherwise described on the pesticide product label or otherwise not expected to be present) as a result of exposure to a pesticide residue, and may include:

- Distressed or dead juvenile and small fishes
- Washed up or floating fish
- Fish swimming abnormally or erratically
- Fish lying lethargically at water surface or in shallow water
- Fish that are listless or nonresponsive to disturbance
- Stunting, wilting, or desiccation of non-target submerged or emergent aquatic plants
- Other dead or visibly distressed non-target aquatic organisms (amphibians, turtles, invertebrates, etc.)

**The phrase, toxic or adverse effects, also includes any adverse effects to humans (e.g., skin rashes) or domesticated animals that occur either from direct contact with or as a secondary effect from a discharge (e.g., sickness from consumption of plants or animals containing pesticides) to Waters of the United States that are temporally and spatially related to exposure to a pesticide residue (e.g., vomiting, lethargy).**