Chapter 9
Southern Resident Killer Whales

This Page Intentionally Left Blank

Chapter 9
Southern Resident Killer Whales

9.1 Current Rangewide Status

The Southern Resident killer whale DPS consists of three pods, identified as J, K, and L pods. In this section, the status of the Southern Resident killer whales throughout their range is summarized. Although the entire Southern Resident DPS has potential to occur in the coastal waters at any time during the year, occurrence is more likely during November to May when Southern Residents are only occasionally found in the inland waters of Washington State. The information on the rangewide status of the species is generally representative of the status of the species in coastal waters. The final recovery plan for Southern Residents was issued in January 2008 (NMFS 2008j). This section summarizes information taken largely from the recovery plan, as well as new data that became available more recently. For more detailed information about this population, please refer to the Final Recovery Plan for Southern Resident Killer Whales, which can be found on the internet at www.nwr.noaa.gov.

9.1.1 Status and Trends

Although there is little information available regarding the historical abundance of Southern Resident killer whales, two methods have been used to estimate a historical population size of 140 to 200. The minimum estimate (~140) is the number of whales killed or removed for public display in the 1960s and 1970s added to the remaining population at the time of the captures. The maximum estimate (~200) is based on a recent genetic analysis of microsatellite DNA (NMFS 2003e).

At present, the Southern Resident population has declined to essentially the same size that was estimated during the early 1960s, when it was considered as likely depleted (Olesiuk et al. 1990) (Figure 9.1-1). Since censuses began in 1974, J and K pods have steadily increased their sizes. However, the population suffered approximately a 20% decline from 1996-2001, largely driven by declines in L pod. There have been recent increases in the population from 2002-2006 indicating that L pod’s decline may have ended, however such a conclusion is premature. The 2007 census counted 87 Southern Resident killer whales, 25 in J pod, 19 in K pod and 43 in L pod.

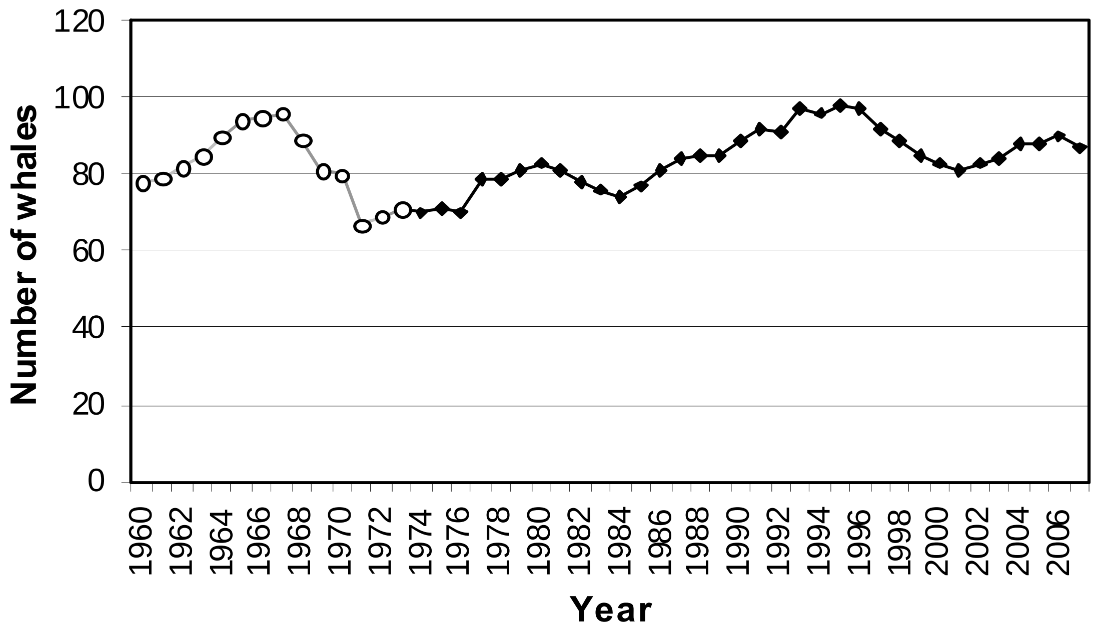

Figure 9.1-1. Population size and trend of Southern Resident killer whales, 1960-2007. Data from 1960-1973 (open circles, gray line) are number projections from the matrix model of Olesiuk et al. (1990). Data from 1974-2007 (diamonds, black line) were obtained through photo-identification surveys of the three pods (J, K, and L) in this community and were provided by the Center for Whale Research (unpubl. data) and NMFS (2008j). Data for these years represent the number of whales present at the end of each calendar year except for 2007, when data extend only through October.

9.1.2 Listing status

The Southern Resident killer whale Distinct Population Segment (DPS) was listed as endangered under the ESA on November 18, 2005 (NMFS 2005d). The final rule included information on the population decline in the 1990s and identified several potential factors that may have caused the decline or may be limiting recovery. These are: quantity and quality of prey, toxic chemicals which accumulate in top predators, and disturbance from sound and vessel traffic. The rule also identified oil spills as a potential risk factor for this species. Southern Residents are designated as “depleted” and “strategic” under the Marine Mammal Protection Act (MMPA) (NMFS 2003e). Critical habitat for the Southern Resident killer whale DPS was proposed on June 15, 2006 (NMFS 2006l) and the final designation of critical habitat was published November 29, 2006 (NMFS 2006c). Critical habitat includes approximately 2,560 square miles of inland waters in three specific areas: 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. Southern Resident critical habitat does not occur in the coastal waters, and is therefore not considered further in this consultation.

9.1.3 Range and Distribution

Southern Residents are found throughout the coastal waters off Washington, Oregon, and Vancouver Island and are known to travel as far south as central California and as far north as the Queen Charlotte Islands, British Columbia (Figure 9.1-2).

Figure 9.1-2. Geographic Range (light shading) of the Southern Resident Killer Whale Population. Reprinted from Wiles (2004).

Southern Residents are highly mobile and can travel up to 86 miles (160 km) in a single day (Erickson 1978, Baird 2000). To date, there is no evidence that Southern Residents travel further than 50 km offshore (Ford et al. 2005). Although the entire Southern Resident DPS has potential to occur in coastal waters at any time during the year, occurrence is more likely during November to May.

Southern Residents spend the majority of their time from late spring to early autumn in inland waterways of Washington State and British Columbia (Strait of Georgia, Strait of Juan de Fuca, and Puget Sound) (Bigg 1982, Ford et al. 2000, Krahn et al. 2002) (Figure 9.1-3). Typically, J, K and L pods arrive in May or June and spend most of their time in the core area of Georgia Basin and Puget Sound until departing in October. K and L pods also make frequent trips to the outer coasts of Washington and southern Vancouver Island during this time, which generally last a few days (Ford et al. 2000).

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1976				J,K								
1977												
1978			J,K									
1979											J,K	
1980												
1981				J,K								
1982						J,K				J,K		
1983										J,K	J,K	
1984						J,K						
1985						J,K						
1986					J,K							
1987										J,K	J,K	J,K
1988					J,K							
1989			J,K							J,K	J,K	J,K
1990												
1991					J,K					J,K		
1992												
1993					J,K							
1994										J,L		
1995												
1996										J,K	J,K	
1997										J,L	J,L	J,K
1998											J,K	
1999												
2000												
2001												
2002			J,K,L?									
2003												J,K
2004					J,L	J,L						J,K
2005		J?			J,L							
2006	J?											
2007	none					J,L						

Only J Pod present		Two pods present, as indicated		J, K, and L pods present		Data not available	

Figure 9.1-3. Monthly occurrence of the three Southern Resident killer whale pods (J, K, and L) in the inland waters of Washington and British Columbia, 1976-2005. This geographic area is defined as the region east of Race Rocks at the southern end of Vancouver Island and Port Angeles on the Olympic Peninsula. Pods were recorded as present during a month if they were sighted on at least one day (Hanson 2008).

Late summer and early fall movements of Southern Residents in the Georgia Basin have remained fairly consistent since the early 1970s, with strong site fidelity shown to the region as a whole. However, presence in inland waters in the fall has increased in recent years (NMFS 2008j). It is uncertain whether potential variability in sighting effort over time has contributed to this trend. During early autumn, Southern Residents, and J pod in particular, expand their routine movements into Puget Sound, likely to take advantage of chum and Chinook salmon runs (Osborne 1999). During late fall, winter, and early spring, the ranges and movements of the Southern Residents are less well known.

Sightings through the Strait of Juan de Fuca in late fall suggest that activity shifts to the outer coasts of Vancouver Island and Washington (Krahn et al. 2002).

The Southern Residents were formerly thought to range southward along the coast to about Grays Harbor (Bigg et al. 1990) or the mouth of the Columbia River (Ford et al. 2000). However, recent sightings of members of K and L pods in Oregon (in 1999 and 2000) and California (in 2000, 2003, 2005, 2006 and 2008) have considerably extended the southern limit of their known range (NMFS 2008j). There have been 40 verified sightings or strandings of J, K or L pods along the outer coast from 1975 to present with most made from January to May. These include 16 records off Vancouver Island and the Queen Charlottes, 11 off Washington, four off Oregon, and nine off central California. Most records have occurred since 1996, but this is more likely because of increased viewing effort along the coast for this time of year. Sightings in Monterey Bay, California coincided with large runs of salmon, with feeding witnessed in 2000 (Black et al. 2001). L pod was also seen feeding on unidentified salmon off Westport, Washington, in March 2004 during the spring Chinook run in the Columbia River (M. B. Hanson, personal observation, as cited in Krahn et al. 2004).

9.1.4 Life history

Southern Resident killer whales are a long lived species, with late onset of sexual maturity (review in NMFS 2008j). Females produce a low number of surviving calves over the course of their reproductive life span (5.4 surviving calves over 25 years) (Olesiuk et al. 1990, Bain 1990). Mothers and offspring maintain highly stable social bonds throughout their lives, which is the basis for the matrilineal social structure in the Southern Resident population (Bigg et al. 1990, Baird 2000, Ford et al. 2000). Groups of related matrilines form pods. Three pods – J, K, and L, make up the Southern Resident community. Clans are composed of pods with similar vocal dialects and all three pods of the Southern Residents are part of J clan.

Southern Resident killer whales are known to consume 22 species of fish and one species of squid (Scheffer and Slipp 1948, Ford et al. 1998, 2000, Ford and Ellis 2006, Saulitis et al. 2000). A long-term study of resident killer whale diet identified salmon as their preferred prey (97 percent of prey consumed during spring, summer and fall) (Ford and Ellis 2006). Feeding records for Southern Residents suggest that diet resembles that of the Northern Residents, with a strong preference for Chinook salmon (78 percent of identified prey) during late spring to fall (Hanson et al. 2005, Ford and Ellis 2006). Chum salmon (11 percent) are also taken in significant amounts, especially in autumn. Other species eaten include coho (5 percent), steelhead (*O. mykiss*, 2 percent), sockeye (*O. nerka*, 1 percent), and non salmonids (e.g., Pacific herring and quillback rockfish [*Sebastes maliger*] 3 percent combined). Chinook were preferred despite the much lower abundance of Chinook in the study area in comparison to other salmonids (such as sockeye), presumably because of the species' large size, high fat and energy content, and year-round occurrence in the area. Killer whales also captured older (i.e., larger) than average Chinook (Ford and Ellis 2006).

Researchers are expanding the sample size for Southern Residents and collecting additional fecal samples for analysis to address the potential biases of scale sampling. In inland waters from May to September, Southern Residents' diet consists of approximately 88% Chinook (Hanson et al. 2007a). These studies also confirmed a shift to chum salmon in fall. Little is known about the winter and early spring diet of Southern Residents. Early results from genetic analysis of fecal and prey samples indicate that Southern Residents consume Fraser River-origin Chinook, as well as salmon from Puget Sound, Washington and Oregon coasts, the Columbia River, and Central Valley California (Hanson et al. 2007b). As further data are analyzed, they will provide information on which specific runs of salmon the whales are consuming in certain locations and seasons.

There are no fecal or prey samples or direct observations of predation events (where the prey was identified to the species) when the whales are in coastal waters. Although less is known about diet preferences of Southern Residents off the Pacific coast, it is likely that salmon are also important during late fall and winter when Southern Residents more predictably occur in coastal waters. Chemical analyses support the importance of salmon in the year round diet of Southern Residents (Krahn et al. 2002, 2007). Krahn et al. (2002), examined the ratios of DDT (and its metabolites) to various PCB compounds in the whales, and concluded that the whales feed primarily on salmon throughout the year rather than other fish species. Krahn et al. (2007) analyzed stable isotopes from tissue samples collected in 1996 and 2004/2006. Carbon and nitrogen stable isotopes indicated that J and L pods consumed prey from similar trophic levels in 2004/2006 and showed no evidence of a large shift in the trophic level of prey consumed by L pod between 1996 and 2004/2006.

Researchers have estimated the energy requirements of killer whales and caloric values for salmon to calculate the number of fish needed per day. Salmon differ significantly in size across species and runs, and prey preference among salmon would affect annual consumption rates. Fewer salmon per day would be required from a larger preferred prey species such as Chinook salmon. NOAA Fisheries provides an estimate of the biological requirements of Southern Residents using the best available information on metabolic needs of the Southern Resident population and the caloric content of salmon (NMFS 2008k).

9.2 Environmental Baseline

Because the entire listed entity is found in the coastal waters during some portion of the year, the status of the species in this area is the same as the range-wide status of the species, described above. The following discussion summarizes the conditions in coastal waters that are known to affect the likelihood that Southern Resident killer whales will survive and recover in the wild. The small size of the population increases the level of concern about any risks to Southern Resident killer whales (NMFS 2008j).

Natural Mortality

Seasonal mortality rates among Southern and Northern Resident whales are believed to be highest during the winter and early spring, based on the numbers of animals missing from pods returning to inland waters each spring. Olesiuk et al. (2005) identified high neonate mortality that occurred outside of the summer field research seasons. At least 12 newborn calves (9 in southern community and 3 in northern community) were seen outside the summer field season and disappeared by the next field season. Additionally, stranding rates are higher in winter and spring for all killer whale eco-types in Washington and Oregon (Norman et al. 2004). Southern Resident strandings in coastal waters include three separate events (1995 and 1996 off of Northern Vancouver Island and the Queen Charlotte Islands, and 2002 offshore of Long Beach, Washington State), and the causes of death are unknown (NMFS 2008j).

In recent years, sighting reports indicate anecdotal evidence of thin killer whales returning to inland waters in the spring. For example, in March 2006 a thin female from the Southern Resident population (L54) with a nursing calf was sighted off Westport, WA. The sighting report indicated she had lost so much blubber that her ribs were showing under the skin (Cascadia Research 2008).

Prey Availability

Salmon, particularly Chinook salmon, are the preferred prey of Southern Resident killer whales in inland waters of Washington State during spring, summer and early fall. Chemical analyses support the importance of salmon in the year round diet of Southern Residents. Based on the best available information, Southern Residents may equally prefer Chinook salmon in inland and coastal waters. This analysis therefore focuses on effects of the Prospective Actions on Chinook abundance in coastal waters. Focusing on Chinook provides a conservative estimate of potential effects of the Prospective Action on Southern Residents within coastal waters. The total abundance of all salmon and other potential prey species is difficult to quantify, but is orders of magnitude larger than the total abundance of Chinook in coastal waters.

When prey abundance is low, killer whales may spend more time and energy foraging than when prey abundance is high, with the potential for fitness consequences including reduced reproductive rates and higher mortality rates. Ford and Ellis (2006) correlated coastwide reduction in Chinook abundance (Alaska, British Columbia, and Washington) with decreased survival of resident whales (Northern and Southern Residents), but changes in killer whale abundance have not been linked to changes in salmon stock groups.

The availability of prey to Southern Resident killer whales is affected by a number of natural and human actions. Details regarding baseline conditions of those Chinook salmon in the Columbia River basin that are listed under the Endangered Species Act are described in Chapters 8.2 (Snake River fall Chinook), 8.3 (Snake River spring/summer Chinook), 8.6 (Upper Columbia River spring Chinook), 8.10 (Lower Columbia River Chinook), and 8.13 (Upper Willamette River Chinook) sections of the SCA. The baseline also includes Chinook ESUs that are not ESA-listed, notably the typically abundant Hanford Reach fall Chinook ESU and the Mid-Columbia spring Chinook ESU. Adult salmon are also affected by fisheries harvest in fresh and marine waters. In addition, climate effects from Pacific decadal oscillation and El Nino/Southern oscillation conditions and events cause changes in ocean productivity which can affect natural mortality of salmon, as described in more detail in Chapter 5 (5.7 Large-scale Environmental Variation). Predation in the ocean also contributes to natural mortality of salmon. Salmonids are prey for pelagic fishes, birds, and marine mammals.

Based on the best available information regarding diet composition for Southern Residents killer whales (which suggests that Chinook salmon are their preferred prey), their metabolic needs, and the caloric content of salmon, NOAA Fisheries estimates that the Southern Resident population (based on 2007 population size and structure) could need approximately 221,000 Chinook on an annual basis in coastal waters of their range (NMFS 2008k). Based on estimates derived from fisheries catch and escapement data over the past decade, there may be approximately 3.5 million adult Chinook salmon available in the coastal range of Southern Residents (NMFS 2008k). This estimate includes estimated annual reductions in prey availability from fisheries harvest in coastal waters. However, this estimate is likely to vary on an annual basis due to a combination of factors including ocean conditions and harvest management decisions (implementing the regulations for ocean salmon fisheries include ESA section 7 consultation).

Another factor that could affect the number of salmon required is the size of individual Chinook. NOAA Fisheries is not able to assess the potential differences in biomass of individual Chinook available to Southern Residents, and thus relies on abundance estimates as a proxy measure (as in past consultation, i.e., NMFS 2006m). Southern Resident killer whales consume both natural and hatchery salmon (DFO unpubl. data). There is no information available suggesting that Southern Residents would be affected differently by consuming natural or hatchery salmon (i.e., no known differences in size, energy content, contaminant level, or behavior or location in the ocean).

Prey Quality

Contaminants enter fresh and marine waters and sediments from numerous sources, but are typically concentrated near populated areas of high human activity and industrialization. As discussed in the Status of the Species section above, recent studies have documented high concentrations of PCBs, DDTs, and PBDEs in killer whales (Ross et al. 2000, Ylitalo et al. 2001, Reijnders and Aguilar 2002, Krahn et al. 2004). Harmful contaminants are stored in blubber; however, organochlorines can be released from the blubber and become redistributed to other tissues increasing risk of immune or reproductive effects during weight loss from reductions in prey (Krahn et al. 2002).

As top predators, when killer whales consume contaminated prey they accumulate the contaminants in their blubber. When prey is scarce, killer whales metabolize their blubber and the contaminants are mobilized. In addition, nursing females transmit large quantities of contaminants to their offspring. Chinook salmon contain higher levels of some contaminants (i.e., PCBs) than other salmon species (O'Neill et al. 2005). Only limited information is available for contaminant levels of Chinook along the west coast (i.e., higher PCB and PBDE levels may distinguish Puget Sound-origin stocks, whereas higher DDT-signature may distinguish California origin stocks; Krahn et al. 2007). Adult Chinook that originate from the Columbia River may accumulate contaminants through development and growth in the freshwater and marine environment, and become a source of contaminant loading if consumed by Southern Residents.

Vessel Activities and Sound

Commercial shipping, ferry operations, military vessels and recreational vessels occur in the coastal range of Southern Residents; however, the density of traffic is lower in the coastal compared to inland waters of Washington State and British Columbia. Several studies in the inland waters of Washington State and British Columbia have linked interactions of vessels and Northern and Southern Resident killer whales with short-term behavioral changes (Kruse 1991; Williams et al. 2002a, b; Foote et al. 2004, Bain et al. 2006). Although the potential impacts from vessels and the sounds they generate are poorly understood, these activities may affect foraging efficiency, communication, and/or energy expenditure through their physical presence, increased underwater sound level, or both. Collisions of killer whales with vessels are rare, but remain a potential source of serious injury and mortality. There are no known incidents of Southern Resident collisions with vessels in coastal waters, however, very few stranded killer whales are recovered and there are stretches of unpopulated coastline where stranded whales would not be reported.

Vessel sounds in coastal waters are most likely from large ships, tankers and tugs. Most sound generated by large vessels is a source of low frequency (5 to 500 Hz) human-generated sound in the world's oceans (NRC 2003). While ships generate some broadband noise in the hearing range of whales, the majority of energy is below their peak hearing sensitivity. Such vessels do not target whales, move at relatively slow speed and are likely detected and avoided by Southern Residents. It is difficult to precisely quantify or estimate the magnitude of the risks posed by commercial whale watching and recreational vessels in coastal waters; however, weather conditions in the Pacific Ocean in winter limit these activities. The risk to Southern Residents is less in coastal waters than within the inland waters of Washington State and British Columbia, where traffic levels are higher and a greater proportion of traffic may target whales (whale watching and recreational vessels).

Non-Vessel Sound

Anthropogenic (human-generated) sound in coastal waters within the range of Southern Residents is generated by other sources besides vessels, including oil and gas exploration, construction activities, and military operations. Natural sounds in the marine environment include wind, waves, surf noise, precipitation, thunder, and biological noise from other marine species. The intensity and persistence of certain sounds (both natural and anthropogenic) in the vicinity of marine mammals vary by time and location and have the potential to interfere with important biological functions (e.g., hearing, echolocation, communication).

Sound from in-water construction activities could potentially occur through permits issued by the Army Corps of Engineers under section 404 of the Clean Water Act and section 10 of the Rivers and Harbors Act of 1899 and by the State of Washington under its Hydraulic Project Approval (HPA) program. Several consultations on federal projects in the coastal range of Southern Residents have been conducted and conservation measures have been included to minimize or eliminate potential effects to marine mammals. Sound, such as sonar generated by military vessels also has the potential to disturb killer whales in coastal waters.

Oil spills

Oil spills have occurred in the coastal range of Southern Residents in the past, and there is potential for spills in the future. Oil can be discharged into the marine environment in any number of ways, including shipping accidents, refineries and associated production facilities, and pipelines. Despite many improvements in spill prevention since the late 1980s, much of the region inhabited by Southern Residents remains at risk from serious spills because of the heavy volume of shipping traffic and proximity to petroleum refining centers in inland waters. Numerous oil tankers transit through the coastal range of Southern Residents throughout the year. The magnitude of the risks posed by oil discharges in this area is difficult to precisely quantify or estimate.

The long-term effects of repeated ingestion of sub-lethal quantities of petroleum hydrocarbons on killer whales are not well understood. In marine mammals, acute exposure to petroleum products can cause changes in behavior and reduced activity, inflammation of the mucous membranes, lung congestion, pneumonia, liver disorders, and neurological damage (Wursig 1990 and Geraci 1990). In addition, oil spills have the potential to adversely impact habitat and prey populations, and, therefore, may adversely affect Southern Residents by reducing food availability.

Scientific Research

Most of the scientific research conducted on Southern Resident killer whales occurs in inland waters of Washington State and British Columbia. In general, the primary objective of this research is population monitoring or data gathering for behavioral and ecological studies. In 2006, NOAA Fisheries issued scientific research permits to seven investigators who intend to study Southern Resident killer whales. Research activities are typically conducted between May and October in inland waters. However, some permits include authorization to conduct research in coastal waters.

In the biological opinion NOAA Fisheries prepared to assess the impact of issuing the permits, we determined that the effects of these disturbances on Southern Residents were likely to adversely affect, but not jeopardize the continued existence of, the Southern Resident killer whales (NMFS 2006n). The annual authorized takes by harassment of Southern Residents under these permits totaled 1,935 non-invasive takes (e.g., surveys and photo-identification); 70 takes from biopsying, tagging, or breath sampling; and 820 takes due to unintentional harassment, although actual anticipated takes are substantially lower. While most of the authorized takes would occur in inland waters, a small portion of this disturbance is part of the baseline in the coastal range of Southern Residents.

Activities Outside U.S. Jurisdiction

The Southern Resident killer whales are highly migratory and may transit in and out of the waters of the United States and the high seas. NOAA Fisheries does not presently have information to assess the impact on Southern Residents of scientific research or boating activities within Canadian jurisdictional waters. NOAA Fisheries included information on Canadian fisheries within the coastal range of Southern Residents using the same methods to quantify U.S. fisheries in this area (NMFS 2008k).

Summary of the Environmental Baseline

Southern Resident killer whales are exposed to a wide variety of past and present state, federal or private actions and other human activities in their coastal range as well as federal projects in this area that have already undergone formal section 7 consultation, and state or private actions that are contemporaneous with this consultation. All of the following activities discussed in the above section are likely to have some level of impact on Southern Residents when they are in coastal waters of their range.

Reductions in food availability, increased exposure to pollutants, and human disturbance have all been identified as potential threats to killer whales in Washington and British Columbia (Ford and Ellis 1999, 2005; Ford et al. 2000; Baird 2001; Krahn et al. 2002, 2004; Taylor 2004, Wiles 2004). Researchers are unsure about which threats are most significant to the Southern Resident population. Although the three primary factors are identified as prey availability, environmental contaminants, and vessel effects and sound, none have been directly linked to or identified as the cause of the recent decline of the Southern Resident killer whales (Krahn et al. 2002). There is limited information on how these factors or additional unknown factors may be affecting Southern Resident killer whales when in coastal waters in winter. For reasons discussed earlier, it is possible that two or more of these factors may act together to harm the whales. The small size of the population increases the level of concern about all of these risks (NMFS 2008j).

9.3 Effects of the Prospective Actions on Southern Resident Killer Whales

The potential effects of the Prospective Actions on Southern Resident killer whales relate to prey availability. Contamination (prey quality) is not an issue because the effects of the Prospective Actions do not include the introduction of contaminants into freshwater. Chapter 2 of the SCA defines the federal actions aggregated in the SCA, or Prospective Actions, which include:

- Operation and configuration of the Federal Columbia River Power System (FCRPS) as described in the 2007 FCRPS Biological Assessment (Corps et al. 2007b) and the mainstem effects of 11 Reclamation irrigation projects (Corps et al. 2007b, Appendix B-1-7), as modified by NOAA Fisheries' RPA for the FCRPS (described in Chapter 4 of the FCRPS Biological Opinion (NMFS 2008a).

- Operation and Maintenance of 12 Irrigation Projects in the Upper Snake (described in Reclamation's 2007 Upper Snake Biological Assessment (USBR 2007).

- NOAA Fisheries' § 10(a)(1)(A) Transportation Permit issued as part of NOAA Fisheries' FCRPS Opinion.

- NOAA Fisheries' participation in the 2008-2017 *U.S. v. Oregon* Management Agreement (hereafter, "2008 *U.S. v. Oregon* Agreement") concerning particular Columbia River fisheries related activities as described in Chapter 2 of NOAA Fisheries' Biological Opinion for that Agreement.

- Federal Action Agencies' funding of all FCRPS mitigation hatchery programs.

Most of the direct effects of the Prospective Actions occur within the freshwater system and plume of the Columbia River; effects experienced by Southern Residents in the coastal area are indirect. The Prospective Actions may affect the abundance of killer whale prey in the ocean. Changes in prey abundance would affect the entire population of Southern Resident killer whales. The best available information indicates that salmon are the preferred prey of killer whales year round, including in coastal waters (Status of the Species), and that Chinook are the preferred salmon species. Prey abundance is a concern for killer whales both in the near and long term. To survive in the near term, killer whales require regular supplies of adult Chinook prey in the ocean, and to recover over the longer term, killer whales require abundant Chinook stocks coast-wide, likely including stocks from the Columbia River (Status of the Species). This analysis considers the short-term (less than ten years) and long-term (ten years and longer) effects of the Prospective Actions described above.

9.3.1 Effects of Hydro and Associated Actions on Southern Resident Killer Whales

Short-Term Effects

The hydro and associated actions combined include operation and configuration of the FCRPS, federal water management in the Upper Snake, and federal actions to improve habitat, reduce predation and fund hatcheries. Included in the hatchery funding is a commitment to review and reform (as needed) future hatchery operations. No details are proposed regarding hatchery reform, and NOAA Fisheries expects that future hatchery production, including reforms, will be subject to additional future consultation when detailed actions are proposed. In the interim, the Prospective Action is to continue funding hatchery operations at current levels.

Effects of Artificial Production

The Prospective Actions include continued funding for artificial propagation of Chinook salmon, which produces killer whale prey. Action agency (BPA, Corps and Reclamation) funding accounts for approximately 50 percent of the Chinook smolts released above Bonneville Dam (Jones 2008). This analysis also assumes that current levels of funding and production will continue over the short term.

For returns prior to 2007, the proportion of hatchery-origin Chinook passing Bonneville Dam ranged between 50 and 80 percent for individual stocks of Chinook from the Columbia River (PCSRF 2007). Since 2000, Chinook hatchery returns to Bonneville Dam represented approximately 70 percent of the total Chinook run, on average (Turner 2008). If the Prospective Actions produce approximately 50% of all returning hatchery Chinook above Bonneville Dam, and all hatchery Chinook combined represent approximately 70% of the Chinook returns at Bonneville, approximately 35% of the total annual return of Chinook above Bonneville Dam can be attributed to the Prospective Actions.

Effects of Hydrosystem Operations

The operation and configuration of the FCRPS causes mortality of migrating juvenile Chinook, which in turn results in fewer adult Chinook in the ocean and reduced prey availability, compared to an absence of dam-related juvenile mortality. For purposes of determining whether the Chinook prey base for killer whales is adversely affected by the proposed action, it is not necessary to precisely quantify the mortality resulting from the hydrosystem operations (as distinguished from other causes), so long as it can be reasonably concluded that the decrease in the prey base for killer whales resulting from hydrosystem operations is less than the increase in the prey base resulting from the hatchery programs funded by the action agencies.

The effect of the hatchery programs is to increase by 35% the number of Columbia and Snake River Chinook originating above Bonneville Dam and available to the killer whales. In order for any decrease caused by the hydrosystem to exceed this increase, the hydrosystem would have to cause a 35% or greater reduction in the total number of Columbia and Snake River Chinook available to killer whales. For the reasons discussed below, it is unlikely that the hydrosystem results in a 35% or greater reduction in the killer whale prey base.

Many factors cause mortality to juvenile salmon as they migrate to the ocean. Natural mortality occurs from predators, competition for food, and disease. Human actions unrelated to the hydrosystem, such as the diking and filling of wetlands, road construction and maintenance, and introduction of pollutants can increase mortality in that part of the migration corridor that is within the hydrosystem. And the "bare existence" of the dams, as well as the operation of the dams, also causes juvenile mortality.

Although we have relatively good estimates of the overall level of mortality experienced by juvenile Chinook as they move through the hydrosystem, available information does not enable us to partition the overall level of mortality among the various potential causes. Attempts to allocate mortality have not been notably successful. Most recently, in *National Wildlife Federation v. NMFS*, CV 01-640-RE (D. OR. May 26, 2005) the Court rejected NOAA Fisheries' attempt to partition the sources of mortality. The Court directed the federal agencies to focus instead on the actions needed to bring ESA-listed salmon to recovery. Thus, the analysis in other parts of this opinion does not attempt to estimate how many fewer ESA-listed salmon are present as a result of the operating the hydrosystem.

To assure that the effects of the hydro operations in the Prospective Action on the killer whale prey base will not outweigh the benefits to that prey base resulting from the hatchery programs funded as part of that action, NOAA Fisheries compared the percent increase in adult Chinook from the hatchery actions to the total mortality rate for juvenile Chinook passing through the hydrosystem, regardless of cause. This comparison is a very conservative approach since only a portion of these mortalities are, in fact, the result of the hydro operations being consulted upon.

As further described in other portions of this biological opinion dealing with ESA-listed salmon (SCA, Hydro Modeling Appendix), the estimated average survival for spring/summer Chinook passing through the area of the hydrosystem under the proposed action varies from about 67% (for both in-river migrating and transported juveniles from

Lower Granite to Bonneville Dams, assuming a "D" value of 0.709) to more than 95% (passing 1 dam). More than 85% of adult spring/summer Chinook returning to the Columbia and Snake Rivers come from fish that pass 4 dams or fewer dams, which have a survival rate of 73 to over 95%. Thus, for spring/summer Chinook, the total mortality, regardless of cause, is less than 35% (That is, the total survival through the hydrosystem is greater than 65%).

Spring/summer Chinook primarily spawn and rear in tributaries and enter the Snake and Columbia Rivers as yearling smolts that use the area of the hydrosystem primarily as a migratory corridor. Thus, the high level of natural mortality that occurs to all salmon in the egg-to-smolt stage has already taken place before the spring Chinook enter the hydrosystem. For fall Chinook, the reverse is true.

Fall Chinook spawn and rear principally in the mainstem of the Snake and Columbia Rivers. Regardless of whether they originate in the wild or from a hatchery, fall Chinook move through the system primarily as smaller, sub-yearling fish. Due to their size, such fish are more vulnerable to predation and other natural mortalities. This loss is exacerbated by the increased time that sub-yearlings spend rearing in shallow-water habitat as they move through the migratory corridor. Many of these losses would occur regardless of whether the fall Chinook were migrating through a hydrosystem or in a natural river.

Since fall Chinook losses from natural causes are considerably greater than the spring/summer Chinook losses during the downstream migration, it is no surprise that the estimated survival rates for fall Chinook passing through the hydrosystem are considerably lower than those for spring/summer Chinook, but combined these rates exceed 65%. The survival rate[1] for those passing through 8 dams is approximately 33%; for 4 dams survival is about 54%; and for 1 dam survival is approximately 85%.[2] Less than 3% of the fall Chinook adults originate from locations that are above more than 8 dams. About 29% (primarily the Hanford Reach run) pass through 4 dams, and about 68% of the fall Chinook adults (primarily hatchery production) originate above only 1 dam. When the survival rate is weighted based on the percentage of the fall Chinook found in each group, the overall weighted average survival of fall Chinook passing through the hydrosystem is approximately 74% [(3%*33%)+(29%*54%)+(68%*85%)].

[1] The implementation of the Prospective Actions should substantially improve the survival of migrating fall Chinook salmon. However, NOAA Fisheries does not attempt to estimate quantitative improvements for fall Chinook salmon from these actions due to complications arising from the expression of multiple life-history strategies.

[2] Juvenile fall Chinook survival estimates are calculated based on per km survival estimates from McNary tailrace to John Day tailrace (1999 – 2002 migrations, June 19 to July 23 releases) using information presented in Williams et al. 2005 (Table 39). The average of these data is 76.7% over a 123 km reach, or a survival rate of nearly 0.998 / km. The entire FCRPS reach is about 512 km, the Bonneville to McNary reach is about 287 km, and Bonneville dam and reservoir is about 73 km in length.

Because the overall losses occurring within the area of the hydrosystem to both spring/summer and fall Chinook are less than 35%, the hatchery production contained in the Prospective Actions more than mitigates for losses to the killer whale prey base, regardless of the source of loss.

The above assessment does not take into account the increased productivity and survival due to habitat and predator programs, which, if included, would show a further increase in the prey base for killer whales. Additionally, there are more hatchery and natural Chinook salmon available to Southern Resident killer whales from Columbia River stocks than is apparent from returns to Bonneville Dam. Recent estimates of ocean abundance (estimated by extrapolation from fisheries catch data) indicate approximately 1,000,000 adult Chinook originate from Columbia River stocks (NMFS 2008k, CTC 2007, ODFW and WDFW 2007). Although there is large annual variability in adult Chinook returns to the mouth of the Columbia River, returns from 1980 to 2007 indicate a slight positive trend, with average abundance of approximately 800,000 Chinook (Corps et al. 2008a).

Long-Term Effects

Salmon analyses presented in the SCA indicate that Prospective Actions including actions that affect the operation of the hydrosystem, tributary and estuary habitat, harvest, predation (tern, pike minnow and marine mammal), hatcheries, and RM&E overall have positively affected and will continue to positively affect the survival and recovery of the listed entities of salmon and steelhead. These analyses consider whether a sufficient number of populations within specific Major Population Groups (MPGs) will survive (i.e., low 24-year extinction risk) and trend toward recovery (i.e., improved average returns-per-spawner, median population growth rate, and abundance trend) to indicate that a specific MPG trends toward recovery (more details available in SCA, Chapter 7).

As discussed in SCA Section 8.1.5 (Effects of Hatchery Programs), while hatchery Prospective Actions (the Action Agencies' obligation to fund hatcheries) are important steps to reducing risk and assuring the long-term viability of these ESUs, at present the hatchery reform process is underway and it is not possible to quantify results or expect that benefits of these reforms are "reasonably certain to occur," and therefore was not part of the basis for conclusions. The Prospective Actions include implementation of hatchery reform (described in RPA 39) pending completion of separate ESA consultations (target completion dates: November 2009 to June 2010; SCA Section 5.5.1). Thus, hatchery effects from the Prospective Actions were assumed as constant from present until future adoption of hatchery reforms as the result of these separate consultations.

Over the long term, the abundance of Columbia River Chinook, and thus of Southern Resident killer whale prey, may be affected by climate change. The Prospective Actions include monitoring of climate effects on salmonids and mechanisms to synthesize, update, and modify implementation to respond to new information regarding the effects of climate change on listed salmonids (SCA Section 7.1.2.1).

The analysis in the SCA concludes that listed Chinook ESUs, and all other listed salmonid ESUs/DPSs in the Columbia River Basin, are expected to survive with an adequate potential for recovery, and the Prospective Actions are not likely to jeopardize the continued existence of these ESUs. Additionally, the Prospective Actions will not adversely modify the designated critical habitat of these and all other listed ESUs/DPSs addressed, and critical habitat is expected to remain functional (or retain the ability to become functional) to serve the intended conservation role in the near and long term. These conclusions were derived after reviewing the effects of the Prospective Actions, the effects of the environmental baseline, and any cumulative effects presented in the salmon analyses. The long-term recovery of listed Columbia River salmon is a benefit for Southern Resident killer whales in the long term.

The potential harmful effects of artificial production on long-term fitness of salmon populations are discussed in the SCA Appendix, Hatchery Effects Report. Specifically, hatcheries can negatively affect population viability by reducing abundance, productivity, spatial distribution and/or diversity of natural-origin fish (described in McElhany et al. 2000). Table 3 of the SCA Appendix, Hatchery Effects Report, identified risks or threats to population viability for Chinook ESUs, including isolated hatchery practices or non-indigenous hatchery broodstock and/or the influence of strays, in combination with a high proportion of hatchery fish in the population can increase the risks to productivity and diversity. The Prospective Actions contemplate future hatchery reforms intended to address harmful effects of hatchery production on the long-term fitness of the naturally spawning fish. Detailed information is not presently available to evaluate long-term effects of a continuation of current hatchery production on Chinook availability, or of reforms to hatchery operations. Thus, an analysis of long-term effects of the hatchery funding contemplated in the Prospective Actions is not possible at this time and will be considered in separate future consultations when detailed information is available.

9.3.2 Effects of Harvest Actions on Southern Resident Killer Whales

Prospective Actions include the 2008 *U.S. v. Oregon* Agreement, which includes some take of hatchery- and natural-origin Chinook salmon. The terminal fisheries do not directly affect Southern Residents, as the fisheries occur after the fish have returned to the river and are no longer available to the whales in the ocean.

Short-Term Effects

Since the majority of fish available for in-river harvest are hatchery fish, the majority of salmon caught will be hatchery salmon. Although the harvest action is constrained by take limitations on natural-origin salmon, some are incidentally caught. Even with the proposed harvest levels on Chinook, most hatchery programs are expected to meet or exceed escapement goals (SCA Chapter 8), and thus will continue to operate at full production with no effect on the future availability of hatchery Chinook in the ocean. In-river harvest of natural-origin fish reduces the number of adults returning to the spawning grounds, and consequently could reduce the number of offspring in the following generation. Such a reduction could in turn reduce the number of adult Chinook available as prey to killer whales in the ocean.

Spring and fall run Chinook are likely to be affected differently by the prospective harvest actions because of differences in their life histories. Spawning habitat for natural-origin Snake River fall Chinook is fully seeded, and Upper River Brights are above escapement goals. Spawning habitat for fall stocks below Bonneville dam, with few exceptions, is also fully seeded, because of stray hatchery fish. Thus harvest of fall run Chinook is not expected to result in a decrease in the number of offspring in the subsequent generation. In contrast, spring returns of natural-origin Chinook, particularly for upriver stocks, tend to be under-seeded. The prospective harvest action manages take of natural-origin upriver Chinook using a sliding scale, and can result in take levels from 5.5 to 17 percent of natural-origin Chinook. Generally, the level of take can be characterized as 10 percent natural-origin from these ESUs. This analysis makes the conservative assumption that in some cases available spawning habitat will be under-seeded, and that a further reduction may occur as a result of the harvest of natural-origin Chinook. That reduction would be proportional to the allowable harvest rate.

Overall, Chinook returns are approximately 30 percent natural-origin fish (70 percent hatchery), whereas upriver spring Chinook are approximately 12 and 32 percent natural-origin for runs returning to spawn above Priest Rapids Dam on the Columbia River and to the Snake River, respectively (average return, 2003 to 2007). On average, the return of natural-origin Chinook to the mouth of the Columbia River from these stocks combined is approximately 30,000 (average return, 2003 to 2007). The 10 percent take that can be expected from the harvest action is therefore approximately 3,000 natural-origin Chinook.

A conservative assumption is that spawner-to-spawner rates are on the order of one-to-one. Given this assumption, the annual return to the river mouth would be 3,000 additional Chinook had there been no fishing. Approximately 3,000 Chinook represents less than 1 percent of the Chinook stocks available to Southern Residents in the ocean that originate from the Columbia River (~1,000,000 Chinook; NMFS 2008k, CTC 2007, ODFW and WDFW 2007) or that return to the mouth of the Columbia River annually (~800,000 Chinook; Corps et al. 2008a).

Long-Term Effects

Over the long term, reductions in naturally spawning spring Chinook could compound. This could reduce Chinook available for killer whale prey in the year in which the reduction was realized and over the long term if it increased the extinction risk of the listed Chinook stocks. As discussed above, the SCA concludes that the combination of Prospective Actions in all areas is likely to ensure the survival, and maintain the long-term potential for recovery, of the listed Chinook ESUs.

9.4 Cumulative Effects

Cumulative effects are those effects of future tribal, state, local or private activities, not involving Federal activities, reasonably certain to occur within the action area (50 CFR 402.02). For the purpose of the Southern Resident killer whale analysis, this area is the coastal range of the species. Future Federal actions will be reviewed through separate section 7 consultation processes.

Future tribal, state and local government actions will likely be in the form of legislation, administrative rules, or policy initiatives and fishing permits. Activities are primarily those conducted under state, tribal or federal government management. These actions may include changes in ocean policy and increases and decreases in the types of activities that currently occur, including changes in the types of fishing activities, resource extraction, or designation of marine protected areas, any of which could impact listed species or their habitat. Government actions are subject to political, legislative and fiscal uncertainties. These realities, added to the geographic scope, which encompasses several government entities exercising various authorities, and the changing economies of the region, make analysis of cumulative effects speculative. A Final Recovery Plan for Southern Resident Killer Whales was published January 24, 2008 (NMFS 2008l). Although state, tribal and local governments have developed plans and initiatives to benefit marine fish species, ESA listed salmon, and the listed Southern Residents, they must be applied and sustained in a comprehensive way before NOAA Fisheries can consider them “reasonably certain to occur” in its analysis of cumulative effects. Details regarding cumulative effects of Chinook salmon in the Columbia River are described in Chapter 8 sections of the SCA for each ESU affected.

Private activities are primarily associated with commercial and sport fisheries, construction, and marine pollution. These potential factors are ongoing and expected to continue in the future, and the level of their impact is uncertain. For these reasons, it is not possible to predict beyond what is included in SCA Chapter 8 whether future non-Federal actions will lead to an increase or decrease in prey available to Southern Resident killer whales, or have other effects on their survival and recovery.

This Page Intentionally Left Blank

Chapter 10
Green Sturgeon of the Southern DPS

This Page Intentionally Left Blank

Chapter 10
Green Sturgeon of the Southern DPS

Purpose

This Chapter provides discusses the status of green sturgeon (*Acipenser medirostris*) and estimates the effects of the proposed action on them. Much of this information was provided by the Action Agencies in the form of a biological assessment on April 18, 2008 (Corps et al. 2008).

10.1 Status of the Species

10.1.1 Listing

Upon completion of a status review, NOAA Fisheries determined that green sturgeon comprise two DPSs that qualify as species under ESA: 1) a northern DPS, consisting of populations in coastal systems from the Eel River, California northward, that was determined to not warrant listing; and 2) a southern DPS consisting of coastal and Central Valley populations south of the Eel River, with the only known spawning population in the Sacramento River (Adams et al. 2002). The southern distinct population segment (DPS) of green sturgeon was listed as threatened under the ESA by NOAA Fisheries on April 7, 2006 (NMFS 2006d). Take prohibitions via section 4(d) of the ESA have not yet been promulgated, nor has critical habitat yet been designated for the southern DPS, although both actions are expected to occur in 2008.

10.1.2 Life history

Green sturgeon are the most marine-oriented of the North American sturgeon species. Juveniles of this species are able to enter estuarine waters after only one year in freshwater. During this time, they are believed to feed on benthic invertebrates, although little is known about rearing habitats and feeding requirements. Green sturgeon are known to range in nearshore marine waters from Mexico to the Bering Sea, and are commonly observed in bays and estuaries along the west coast of North America, including the Columbia River (NMFS 2008m). McLain (2006) noted that Southern DPS green sturgeon were first determined to occur in Oregon and Washington waters in the late 1950s when tagged San Pablo Bay green sturgeon were recovered in the Columbia River estuary. The proportion of the Southern relative to Northern DPS is high (~ 67-82%, or 121 fish, of 155 fish sampled) (Israel and May 2007). Aggregations of adults occupy the lower Columbia River and estuary, up to the Bonneville Dam, primarily during summer months (WDFW and ODFW 2002, Moser and Lindley 2007). Beamis and Kynard (1997) suggested that green sturgeon move into estuaries of non-natal rivers to feed. Information from fisheries-dependent sampling suggests that green sturgeon only occupy large estuaries during the summer and early fall in the northwestern United States. Green sturgeon are known to enter Washington estuaries during summer (Moser and Lindley 2007). There is no evidence of spawning in the Lower Columbia. Green sturgeon in the Lower Columbia River are most likely feeding, but, to date, all stomachs examined (n>50) have been empty (Rien as cited in Grimaldo and Zeug 2001).

10.1.3 Status/Population Trend

Quality data on current population sizes and trends for green sturgeon is non-existent. Lacking any empirical abundance information, Beamesderfer et al. (2007) recently attempted to characterize the relative size of the Sacramento-San Joaquin green sturgeon population (Southern DPS) by comparison with the Klamath River population (Northern DPS). Using Klamath River tribal fishery harvest rate data and assuming adults represent 10% of the population at equilibrium, they roughly estimate the Klamath population at 19,000 fish with an annual recruitment of 1,800 age-1 fish. Given the relative abundance of the two stocks in the Columbia River estuary based on genetic samples, they speculate abundance of the Sacramento population may equal, or exceed the Klamath population estimate. Collectively, Beamesderfer et al. (2007) estimate abundances of the various green sturgeon populations may be larger than previously thought due to seasonal high abundances in the Columbia River, Willapa Bay, and Grays River estuaries and other coastal tributaries, historical high harvest in different areas at different times, and a significant portion of each population likely remains in the ocean at any given time.

10.1.4 Key Limiting Factors for Green Sturgeon

The principal factor in the decline of the Southern DPS is the reduction of the spawning habitat to a limited section of the Sacramento River (NMFS 2006d). The potential for catastrophic events to affect such a limited spawning area increases the risk of the green sturgeon’s extirpation. Insufficient freshwater flow rates in spawning areas, contaminants (e.g., pesticides), bycatch of green sturgeon in fisheries, potential poaching (e.g., for caviar), entrainment of juveniles by water projects, influence of exotic species, small population size, impassable migration barriers, and elevated water temperatures in the spawning and rearing habitat likely also pose threats to this species (NMFS 2006d).

10.1.5 Harvest Effects

In the past, take of green sturgeon may have occurred from direct harvest in sport and commercial fisheries and from catch and release mortality in commercial fisheries. In the more recent years, the take of green sturgeon in the Columbia River was incidental to fisheries directed at white sturgeon. The numerous management actions implemented by the states of Oregon and Washington since 1994 to control white sturgeon harvest also reduced harvest of green sturgeon, including a reduction of impacts to the listed Southern DPS. The reduced catch of green sturgeon in recent years is believed to be the result of these collective management actions by the states resulting in lower catch, and is not considered indicative of lower abundance of the stock (TAC 2008).

Incidental take of green sturgeon primarily occurs during the early-fall (August) and late-fall (September-November) seasons, concurrent with peak abundance of green sturgeon in the lower Columbia River. Sturgeon angler effort and catch in the estuary increased steadily during the 1990s and peaked in 1998 when anglers made 86,400 trips and caught 30,300 white sturgeon, or 73% of the total catch below Bonneville Dam (TAC 2008). Since 1989, all fisheries affecting lower Columbia River white sturgeon have been managed for Optimum Sustainable Yield (OSY) to provide sustainable broodstock recruitment and ensure the overall health of the white sturgeon population. Beginning in 1996, the states formally adopted a three-year Joint State management agreement based on OSY to guide Columbia River sturgeon fisheries and management decisions. Although the majority of the tenets within the current Joint State sturgeon management agreement focus on white sturgeon, a few objectives specific to benefit green sturgeon management were also included. Beginning July 7, 2006, and in response to the ESA listing of the Southern DPS, retention of green sturgeon in the commercial fisheries was disallowed (TAC 2008). Beginning in January 2007, the states changed the regulations in the recreational fishery to also disallow retention of green sturgeon (TAC 2008). The delay in the implementation of non-retention requirements in the recreational fishery were related to the prescribed process for changing sport regulations and the need for a concurrent public education process.

Harvest of green sturgeon has declined from an average of 1,388 fish annually during 1991-2000 to 154 fish per year since 2001 due to changes in regulations and season structure (Table 10.1-1). During 1996-2006, an average of 61 green sturgeon were harvested in the recreational fishery (Table 10.1-1). During 1996-2006, anglers released an average of 7 green sturgeon annually (2.7 sub-legal, 3.1 legal, and 1.3 over legal-sized) (TAC 2008). With the listing of the Southern green sturgeon DPS, the states took additional emergency action to disallow retention of green sturgeon during commercial fisheries beginning in July 2006, when the ESA listing became effective. During the remainder of 2006, the states started a public awareness and education process so that the sport fishing community would be better able to recognize the differences between white and green sturgeon. The states also disallowed retention of green sturgeon in the recreational fishery starting in 2007 (TAC 2008).

Table 10.1-1. Lower Columbia River Green Sturgeon Catch, 1991-2007

Green Sturgeon						
Year	Sport	Commercial				
		Winter	Summer	Early Fall	Late Fall	Total
1991	22	4	--	2	3,180	3,208
1992	73	10	--	1,750	400	2,233
1993	15	1	--	--	2,220	2,236
1994	132	1	--	--	240	373
1995	21	--	--	--	390	411
1996	63	1	--	--	610	674
1997	41	2	--	1,474	138	1,655
1998	73	0	--	743	151	967
1999	93	2	--	508	279	882
2000	32	0	--	568	636	1,236
2001	50	4	--	338	--	392
2002	51	7	--	--	156	214
2003	52	1	--	11	27	91
2004	29	1	--	6	51	87
2005	119	0	38	32	21	210
2006	70	16	0	--	--	86
2007						0

10.1.6 Other Effects in the Environmental Baseline

In addition to these harvest effects on green sturgeon, the general discussion of the environmental baseline in Chapter 5 of the SCA, and in the further discussions in Chapters 8.2 through 8.14, also apply and inform these decisions.

10.2 Effects of the Prospective Actions

10.2.1 Effect of Prospective Harvest

Prospective take of green sturgeon would occur from catch and release mortalities in non-Indian recreational and commercial fisheries. Green sturgeon are not known to occur upstream of Bonneville Dam and would not be impacted by treaty Indian fisheries (TAC 2008). Prospective fishing regulations in Washington and Oregon for commercial and recreational fisheries would prohibit retention of green sturgeon. However, there may be a minor level of green sturgeon retained in recreational fisheries due to misidentification by anglers.

The estimated total prospective take of green sturgeon associated with recreational fisheries is expected to be less than those of past years (due to the implementation of non-retention regulations put into effect in January 2007) (TAC 2008). Take would be limited to post-release mortalities and a few fish retained due to misidentification. Post release mortality from hook and line recreational fisheries is unknown, but it is reasonable to expect hook and line mortality to be something less than the post-release mortality assigned to commercial fisheries (i.e. 5.2%). Because the prospective fisheries are similar than for the period of 1996-2006, it is estimated that a total of 67 (1995-2006 average handled + average released) green sturgeon will be handled annually in recreational fisheries conducted in the Columbia River. Of the fish handled, 80% (54) will be from the Southern DPS (TAC 2008). Of those released, some (5.2%) may suffer post- release mortality. Therefore, the total annual take of Southern DPS green sturgeon associated with prospective recreational fisheries in the lower Columbia River is estimated to be 3 fish (TAC 2008, Table 31).

Similarly, it is estimated that a total of 74 green sturgeon will be handled annually in commercial fisheries conducted in the Columbia River (TAC 2008). Of the handled fish, 80% (59) will be from the Southern DPS. Of those released, an estimated 5.2% may suffer post-release mortality. Therefore, the total annual take of Southern DPS green sturgeon associated with future lower Columbia River commercial fisheries is estimated to be 3 fish (59 * 0.52= 3) (TAC 2008). Overall, the estimated total lethal take of green sturgeon of the Southern DPS associated with harvest under the Prospective Action would be approximately 6 fish annually (TAC 2008).

10.2.2 Hydrosystem Effects

- Green sturgeon only encounter the effects of the FCRPS between Bonneville Dam and the Columbia River plume, including the Columbia River estuary.

- Adults are known to be found in this portion of the action area only during late summer and fall. At this time, operation of the FCRPS has a small effect on streamflow (e.g. flows are decreased about 15 kcfs (9%) in August and are increased 5 kcfs or about 5% in September. Such minor flow effects would have unmeasurable effects on benthic fish species such as green sturgeon.

- Larger effects of the FCRPS in the occupied portion of the action area, such as changes in the habitat characteristics of the Columbia River estuary, are unlikely to have substantial effects on green sturgeon because adult green sturgeon tend to use deepwater habitats. No spawning or juvenile rearing is known to occur in the Columbia basin.

- Green sturgeon are bottom (benthic) feeders and are not known to rely on salmonids as a prey base.

Chapter 11
Memoranda of Agreement

This Page Intentionally Left Blank

Chapter 11 Memoranda of Agreement

11.1 Effects of the Memoranda of Agreement with Tribes and States

A two-year collaboration between the federal agencies, tribes, and states was an integral part of the remand process. The Action Agencies used the results of this collaboration extensively in the development of their Biological Assessment and Comprehensive Analysis. After those documents were prepared and submitted to NOAA Fisheries on August 21, 2007, discussions between the Action Agencies and individual tribes and states continued. As the result of these continued discussions, Memoranda of Agreement (MOAs) were developed between the three federal action agencies, four tribes, and two states in the time period between the release of the draft Biological Opinion and the completion of this final Biological Opinion.[1]

Since these MOAs were finalized rather late in the process, there has not been sufficient time to fully describe and numerically quantify the effect of the measures proposed in them, nor to insert each of the measures contained within these MOAs into the appropriate specific sections of this opinion so that they could be considered in context. However, there has been adequate opportunity to review the proposed measures to determine the effects, whether they are consistent with the requirements of the Endangered Species Act, and to provide at least a qualitative characterization of the benefit likely to result from their implementation.

The Action Agencies developed an addendum to their FCRPS and Upper Snake BAs and Comprehensive Analysis (Corps et al. 2008b), including updating the description of the proposed action and biological effects analysis, to reflect the actions and commitments made in the MOAs. This assessment is based on that addendum.

The MOAs provide a ten year commitment to specific actions selected because of their targeted fishery benefits. Some actions provide additional survival benefits for listed fish beyond what was considered in the draft Biological Opinion, both to aid in gap filling and

---

[1] There are separate Agreements between the Action Agencies and:

1. Three Treaty Tribes and the Columbia River Intertribal Fish Commission
   - Confederated Tribes of the Umatilla Indian Reservation
   - Confederated Tribes of the Warm Springs Reservation
   - Confederated Tribes and Bands of the Yakama Nation
   - Columbia River Inter-Tribal Fish Commission
2. Confederated Tribes of the Colville Indian Reservation
3. State of Idaho
4. State of Montana

to provide an additional survival cushion. Some are new actions or clarifications of actions in the draft Biological Opinion that provide additional provisions for implementation of fish and wildlife actions over the ten years of the RPA. All are specific and binding commitments. The MOAs focus especially on ESA-listed salmon and steelhead, but proposed actions for non-listed fish, such as lamprey and non-listed salmon, are also included.

The MOAs also include future actions that will need to undergo additional, site-specific environmental compliance/reviews, prior to their implementation. As those actions are better defined, NOAA Fisheries will provide ESA reviews as appropriate for these future projects.

We note that all of the agreements specifically provide that all activities undertaken pursuant to the MOAs must be in compliance with the Endangered Species Act. Although NOAA Fisheries does not now have sufficient information to quantitatively determine the specific effect of such future actions, by virtue of this express provision, none of these future actions will be implemented unless and until it has been determined, after due consultation, that the particular action will be carried out in such as manner as to not jeopardize ESA-listed species and not adversely modify critical habitat.

Further, the MOAs represent the commitment of the particular tribes, states and CRITFC for their active participation in the work of implementing the FCRPS RPA. This has the potential to contribute to the efficiency, effectiveness and success of the actions called for in the RPA and these MOAs. The non-federal partners each have significant knowledge and experience with the listed salmon and steelhead species that will augment the federal implementation actions.

Overall, we conclude that the actions contained in the proposed MOAs are consistent with the requirements of the Endangered Species Act, that many of them will have a beneficial effect on the ESA-listed species that are the focus of this opinion. In some instances, the benefits are substantial. In some instances the benefits are either difficult to quantify at this point or are likely to be positive but not likely to be substantial, and in some instances the proposed action is not likely to affect the listed species.

NOAA Fisheries' specific findings are as follows:

Hydrosystem Actions

- Measure: Clarification of performance standards and metrics, including the use of the 96%/93% performance standards for spill/bypass operations and the consideration of delay and spill passage efficiency as part of performance.

  Finding
  Beneficial effect. These provisions are consistent with other requirements of this opinion and will further assure compliance with the performance standards.

- Measure: The identification of John Day operation at MOP (minimum operating pool) as a potential contingency action if performance is not on track as part of the 2016 comprehensive review.

  Finding
  No biological effect likely during the term of this opinion.

- Measure: Revised transportation operations to increase survival benefits for Snake River steelhead compared to the BA, as modified by the draft BiOp, subject to continued performance review.

  Finding
  Significant beneficial effect. This provision has been incorporated in the proposed FCRPS operations analyzed in this opinion and its benefits are reflected in the analysis.

- Measure: A more conservative fish trigger for cessation and re-initiation of summer spill during August at Snake River Projects. This includes dropping from 1000 fish collected to 300 fish collected for spill cessation and 1000 fish collected to 500 fish collected for re-initiation of spill.

  Finding
  No adverse effect, potential for beneficial effect. This provision has been incorporated in the proposed FCRPS operations analyzed in this opinion and its benefits are reflected in the analysis.

- Measure: Additional details on the parties' efforts to evaluate and improve dry-year operations.

  Finding
  No adverse effect, potential for beneficial effect. This provision will improve adaptive management under this opinion and may lead to better flow management in dry years.

- Measure: Additional details on the parties' efforts to evaluate summer draft at Lake Roosevelt.

  Finding
  No adverse effect. This measure may lead to better use of available storage to benefit migrating juveniles of all ESUs and to benefit resident fish.

- Measure: Additional details on the parties' efforts to improve water management flexibility through improved forecasting.

  Finding
  No adverse effect, potential for beneficial effect. This measure may lead to additional flow management options to benefit listed ESUs.

- Measure: Additional details regarding coordination on Canadian water negotiations.

  Finding
  No adverse effect.

- Measure: An expanded lamprey program, with dam operations and actions consistent with the needs of listed fish.

  Finding
  No adverse effect. Potentially beneficial to pacific lamprey, a species that is currently in low abundance.

- Measure: Reasonable operations for non-listed fish, with priority for ESA-listed fish in case of conflicts.

  Finding
  No adverse effect. Some potential benefit for listed ESUs by reducing conflict and increasing regional support for hydro operations needed to protect ESA-listed fish.

Habitat Actions

As identified in the Revised Addendum, the MOAs specify 84 individual habitat projects designed to address limiting factors for salmon and steelhead. All of these habitat actions are consistent with RPA 35 of this Opinion. NOAA Fisheries is unable to determine at this time which of these projects are in addition to actions that the Action Agencies might otherwise have taken. At this stage, we also do not have full details regarding the proposed projects. NOAA Fisheries therefore is unable to characterize the incremental benefit of these actions but have determined that they will address factors limiting the survival and recovery of listed ESUs.

All of these actions have beneficial effect. They are relatively widely distributed in the Columbia River Basin, and target some of the most important limiting factors for individual populations. Some of these projects have the potential to have significant beneficial effect for specific populations and would be expected to contribute measurably to the survival and recovery of that population.

Hatchery Actions

Hatchery actions numbered 1-9 in Attachment C will have beneficial effects for specific ESUs. Actions 2, 3, and 7 will have significant beneficial effects. These actions were already identified in the Draft Biological Opinion and those benefits are reflected in the analysis in the opinion. Action 1, reconditioning of Snake River steelhead kelts, was not included in prior analyses and will have a significant beneficial effect on that ESU. The proposed action and analysis in this opinion has been modified to reflect this action, and its benefits are assumed in the analysis.

Hatchery actions 10-17 are not directed toward ESA-listed ESUs. Because of the conditions that the parties have placed on their implementation, they are not expected to have adverse effects on the listed ESUs. They are likely to have a significant beneficial effect on the fulfillment of federal trust and treaty obligations, which is an appropriate and important factor so long as ESA requirements are met.

Tribal Conservation Law Enforcement Actions

While these actions have been characterized in the Revised Addendum as a means of reducing potential illegal take of ESA-listed salmon and steelhead, we believe that the benefits are likely to be more extensive. Based on our experience with the NOAA Fisheries Enforcement officers, we believe that effective conservation law enforcement helps reduce certain types of habitat degradation and increases public awareness and encourages voluntary conservation efforts in addition to deterring harvest violations.

This action will have beneficial effect, and may have substantial beneficial effect, for all upper river and mid-Columbia ESUs: Snake River steelhead; Snake River Spring Chinook; Snake River Fall Chinook; Upper Columbia Spring Chinook; Upper Columbia steelhead; Mid-Columbia River steelhead. A selective fisheries pilot project will also be implemented in the Upper Columbia.

Research, Monitoring and Evaluation

The MOAs include actions to address Biological Opinion priorities and to monitor on-the-ground implementation effectiveness and to address critical uncertainties. Items 1-4 are already included in this opinion. Items 5-12 are in addition to the research, monitoring, and evaluation specifically indentified in this opinion. Those items are expected to have a beneficial effect by furthering understanding and implementation effectiveness. No attempt has been made to quantify the extent of this effect.

Conclusion

The Tribal and State MOAs make commitments of operations and funding that, in general, will have beneficial effects for ESA-listed fish and, in some instances will have significant beneficial effects. They will also provide benefits to non-listed fish.

NOAA Fisheries concurs with the Summary of Effects found in Part IV of the Revised Addendum. NOAA Fisheries agrees that the hydro, habitat, and hatchery actions contained in the MOAs, as described and conditioned, are expected to be positive or neutral to the listed salmon and steelhead that are the subject of this consultation. The MOAs provide a commitment of resources for these future improvements. Collectively, the effect of the MOA actions is to provide additional biological benefits compared to the draft BiOp for the affected ESUs, particularly for Upper Columbia spring Chinook and steelhead; Snake River spring/summer Chinook fall Chinook, and steelhead; and Mid-Columbia steelhead.

Chapter 12
Literature Cited

This Page Intentionally Left Blank

Chapter 12 Literature Cited

Adams, P.B., C.B. Grimes, S.T. Lindley, and M.L. Moser. 2002. Status review for the North American green sturgeon. National Marine Fisheries Service, Southwest Fisheries Science Center, Santa Cruz, California.

Ainslie, B.J., J.R. Post, and A.J. Paul. 1998. Effects of pulsed and continuous DC electrofishing on juvenile rainbow trout. North American Journal of Fisheries Management 18(4):905-918.

American Rivers. 2006. Lower Snake River dam removal scenario for consideration. Memorandum to the Hydro Remand Workgroup from Nicole Cordan and Michael Garrity, American Rivers, Seattle, Washington. May 8.

Anderson, J.J., R.A. Hinrichesen, C. Van Holmes, K.D. Ham. 2004. Historical analysis of PIT tag data for transportation of fish at Lower Granite, Little Goose, Lower Monumental, and McNary Dams. May 21 draft report to the U.S. Army Corps of Engineers, Walla Walla, Washington.

Antolos, M., D.D. Roby, D.E. Lyons, K. Collis, A.F. Evans, M. Hawbecker and B.A Ryan. 2005. Caspian tern predation on juvenile salmonids in the mid-Columbia River. Transactions of the American Fisheries Society 134:466-480.

Araki, H., W.R. Arden, E. Olsen, B. Cooper, and M.S. Blouin. 2007a. Reproductive success of captive-bred steelhead trout in the wild: evaluation of three hatchery programs in the Hood River. Conservation Biology 21(1):181-190.

Araki, H., B. Cooper, and M.S. Blouin. 2007b. Genetic effects of captive breeding cause a rapid, cumulative fitness decline in the wild. Science 318:100-103.

Arkoosh, M.R., E. Casillas, E. Clemons, B. McCain, and U. Varanasi. 1991. Suppression of immunological memory in juvenile Chinook salmon (*Oncorhynchus tshawytscha*) from an urban estuary. Fish and Shellfish Immunology 1:261-277.

Arkoosh, M.R., E. Clemons, M. Myers, and E. Casillas. 1994. Suppression of B-cell mediated immunity in juvenile Chinook salmon (*Oncorhynchus tshawytscha*) after exposure to either a polycyclic aromatic hydrocarbon or to a polychlorinated biphenyls. Immunopharmocology and Immunotoxicology 16(2):293-314.

Arkoosh, M.R., E. Casillas, E. Clemons, J. Evered, J.E. Stein, and U. Varanasi. 1998. Increased susceptibility of juvenile Chinook salmon (*Oncorhynchus tshawytscha*) from a contaminated estuary to the pathogen *Vibrio anguillarum*. Transactions of the American Fisheries Society 127:360-374.

Arthaud, D., K. Kratz, C. Vandemoer, J. Morrow, M. Grady. 2004. Streamflow and salmon production in the interior Columbia Basin. National Marine Fisheries Service, Idaho State Habitat Office, Boise.

Axel, G.A., E.E. Hockersmith, D.A. Ogden, B.J. Burke, K.E. Frick, and B.P. Sandford. 2007. Passage behavior and survival for radio-tagged yearling Chinook salmon and steelhead at Ice Harbor Dam, 2005. Report to the U.S. Army Corps of Engineers by the National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, Washington.

Axel, G.A., E.E. Hockersmith, M.B. Eppard, B.P. Sandford, S.G. Smith, and D.B. Dey. 2003. Passage behavior and survival of hatchery yearling Chinook salmon passing Ice Harbor and McNary Dams during a low flow year, 2001. Report to the U.S. Army Corps of Engineers by the National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, Washington.

Bain, D. 1990. Examining the validity of inferences drawn from photo-identification data, with special reference to studies of the killer whale (*Orincus orca*) in British Columbia. Report of the International Whaling Commission, Special Issue 12:93-100.

Bain, D.E., J.C. Smith, R. Williams, and D. Lusseau. 2006. Effects of vessels on behavior of Southern Resident killer whales (*Orcinus* spp.) Contract Report for the National Marine Fisheries Service, Seattle, Washington.

Baird, R.W. 2001. The killer whale: foraging specialization and group hunting. Pages 127-153 *in* J. Mann, R.C. Connor, P.L. Tyack, and H. Whitehead, editors. Cetacean societies: field studies of dolphins and whales. The University of Chicago Press, Chicago, Illinois.

Baird. R.W. 2001. Status of killer whales, *Orcinus orca*, in Canada. The Canadian Field-Naturalist 115:676-701.

Battin, J., M.W. Wiley, M.H. Ruckelshaus, R.N. Palmer, E. Korb, K.K. Bartz, H. Imaki. 2007. Projected impacts of climate change on salmon habitat restoration. Proceedings of the National Academy of Sciences 104(16):6720-6725.

Beamesderfer, R.C., B.E. Rieman, L.J. Bledsoe, and S.Vigg. 1990. Management implications of a model of predation by a resident fish on juvenile salmonids migrating through a Columbia River reservoir. North American Journal of Fisheries Management 10:290-304

Beamesderfer, R.C. 1992. Reproduction and early life history of northern squawfish, *Ptychocheilus oregonenesis*, in Idaho's St. Joe River. Environmental Biology of Fishes 35:231-241.

Beamesderfer, R.C., D.L. Ward, and A.A. Nigro. 1996. Evaluation of the biological basis for a predator control program on northern squawfish (*Ptychocheilus oregonensis*) in the Columbia and Snake Rivers. Canadian Journal of Fisheries and Aquatic Sciences 53:2898-2908.

Beamesderfer, R.C., M.L. Simpson, and G.J. Kopp. 2007. Use of life history information in a population model for Sacramento green sturgeon. Environmental Biology of Fishes 79:315-337.

Beamis, W.E. and B. Kynard. 1997. Sturgeon rivers: An introduction to acipensiform biogeography and life history. Environmental Biology of Fishes 48:167-183.

Beechie, T.J., E.A. Steel, P. Roni, and E. Quimby (editors). 2003. Ecosystem recovery planning for listed salmon: an integrated assessment approach for salmon habitat. U.S. Dept. of Commerce, NOAA Tech. Memo., NMFS-NWFSC-58, 183 p.

Bendock, T. and M. Alexandersdottir. 1993. Hooking mortality of Chinook salmon released in the Kenai River, Alaska. North American Journal of Fisheries Management 13:540-549.

Bennett, D. and C. Peery. 2003. Biological effects of Snake River thermal regimes on endangered species in the lower Snake River. Report prepared for the U.S. Army Corps of Engineers by Normandeau Associates, Bedford, New Hampshire.

Bennett, D.H. and Naughton, G.P. 1999. Predator abundance and salmonid prey consumption in tailrace and forebay of Lower Granite Dam. Completion report to U.S. Army Corps of Engineers by the Department of Fish and Wildlife Resources, University of Idaho, Moscow.

Bentley, W.W., and H.L. Raymond. 1976. Delayed migration of yearling Chinook salmon since completion of Lower Monumental and Little Goose Dams on the Snake River. Transactions of the American Fisheries Society 105(3):422-424.

Berejikian, B.A. and M.J. Ford. 2004. Review of relative fitness of hatchery and natural salmon. U.S. Dept. of Commerce, NOAA Tech. Memo., NMFS-NWFSC-61, 28p.

Berejikian, B.A., M.D. Scheuerell, and W.W. Dickhoff. 2007. Emerging issues paper: hatchery fish effects on density-dependent growth and survival. National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, Washington.

Bergman, P.K., K.B. Jefferts, H.F. Fiscus, and R.C. Hager. 1968. A preliminary evaluation of an implanted, coded wire fish tag. Washington Department of Fisheries, Fisheries Research Papers 3(1): 63-84.

Beyer, J.M., G. Lucchetti, and G. Gray. 1988. Digestive tract evacuation in northern squawfish (*Ptychocheilus oregonenesis*). Canada Journal of Fisheries and Aquatic Sciences 45:548-553.

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.

Bigg, M.A., P.F. Olesiuk, G.M. Ellis, J.K.B. Ford, and K.C. Balcomb. 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 12:383-398.

Bilby, R.E., B.R. Fransen, J.K. Walter, C.J. Cederholm, and W.J. Scarlett. 2001. Preliminary evaluation of the use of nitrogen stable isotope ratios to establish escapement levels for Pacific salmon. Fisheries 26(1):6-14.

Bilby R.E., T. Bennett, and P. Roni. 2002. Utilization of nitrogen from spawning salmon by juvenile Chinook salmon and steelhead from two tributaries of the Columbia River. Final Report to Bonneville Power Administration by the National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, Washington.

Bjornn, T., D. Craddock, and D. Corley. 1968. Migration and survival of Redfish Lake, Idaho, sockeye salmon, *Oncorhynchus nerka*. Transactions of the American Fisheries Society. 97(4):360- 373.

Black, N., R. Ternullo, A. Schulman-Jangier, A.M. Hammers, and P. Stap. Occurrence, behavior, and photo-identification of killer whales in Monterey Bay, California. Proceedings of the Biennial Conference on the Biology of Marine Mammals 14:26.

Boggs, C.T. and C. A. Peery. 2004. Steelhead (*Oncorhynchus mykiss*) kelt abundance, condition, passage and survival in the lower Snake and Columbia Rivers, 2003. Report to the U. S. Army Corps of Engineers by the Idaho Cooperative Fish and Wildlife Research Unit, University of Idaho, Moscow.

Bordner, C.E., S.I. Doroshov, D.E. Hinton, R.E. Pipkin, R.B. Fridley, and F. Haw. 1990. Evaluation of marking techniques for juvenile and adult white sturgeons reared in captivity. Pages 293-303 *in* N. C. Parker, A.E. Giorgi, R.C. Heidinger, D.B. Jester, Jr., E.D. Prince, and G.A. Winans, editors. Fish-marking techniques. American Fisheries Society, Symposium 7, Bethesda, Maryland.

Bottom, D.L., C.A. Simenstad, J. Burke, A.M. Baptista, D.A. Jay, K.K. Jones, E. Casillas, and M.H. Schiewe. 2005. Salmon at river's end: the role of the estuary in the decline and recovery of Columbia River salmon. U.S. Dept. of Commerce, NOAA Tech. Memo., NMFS-NWFSC-68, 246p.

BPA (Bonneville Power Administration). 1997. Hydro system simulator (HYDROSIM). User Manual January 1997. Portland, Oregon.

BPA (Bonneville Power Administration). 2004. 2000 level modified streamflow, 1928-1999. Diversion and return flow patterns, summation of depletion adjustments, evaporation adjustments, 2000 level modified streamflow. Columbia River and coastal basins. BPA, Portland, Oregon.

BPA (Bonneville Power Administration). 2007. BPA analysis: replacing lower Snake River dams would cost Northwest $413 million to $565 million annually. BPA, Portland, Oregon.

BPA (Bonneville Power Administration), Corps (U.S. Army Corps of Engineers), USBR (U.S. Bureau of Reclamation, Confederated Tribes of the Warm Springs Reservation of Oregon, Confederated Tribes of the Umatilla Indian Reservation, Confederated Tribes of the Yakama Nation, and the Columbia River Inter-Tribal Fish Commission. 2008. Memorandum of agreement among the Umatilla, Warm Springs, and Yakama Tribes, Bonneville Power Administration, U.S. Army Corps of Engineers, and U.S. Bureau of Reclamation. Three Treaty Tribes – Action Agency Agreement. April 4.

Brannon, E., M. Powell, T. Quinn, and A. Talbot. 2002. Population structure of Columbia River basin Chinook salmon and steelhead trout. National Science Foundation and Bonneville Power Administration. Center for Salmonid and Freshwater Species at Risk, University of Idaho, Moscow.

Branstetter, R., J. Whiteaker, D.R. Hatch, S-Y Hyun, J. Blodgett, B. Bosch, D. Fast, and T. Newsome. 2006. Kelt reconditioning: a research project to enhance iteroparity in Columbia Basin steelhead (*Oncorhynchus mykiss*). 2006 Annual Report. Columbia River Inter-Tribal Fish Commission, Technical Report 06-06, Portland, Oregon.

Brink, S.R. and J.A. Chandler. 2006. Juvenile fall Chinook entrapment management plan for the Hells Canyon Reach of the Snake River. Idaho Power Company, Boise.

Bruesewitz, S.L. 1995. Hook placement in steelhead. Technical Report No. AF95-01. Washington Department of Fish and Wildlife, Olympia.

Brynildson, O.M. and C.L. Brynildson. 1967. The effect of pectoral and ventral fin removal on survival and growth of wild brown trout in a Wisconsin stream. Transactions of the American Fisheries Society 96:353-355.

Budy, P., and H. Schaller. 2007. Evaluating tributary restoration potential for Pacific salmon recovery. Ecological Applications 17(4):1068-1086.

Budy, P., G.P. Thiede, N. Bouwes, C.E. Petrosky, H. Schaller. 2002. Evidence linking delayed mortality of Snake River salmon to their earlier hydrosystem experience. North American Journal of Fisheries Management 22(1):35-51.

Busby, P.J., T.C. Wainwright, G.J. Bryant, L.J. Lierheimer, R.S. Waples, F.W. Waknitz, and I.V. Lagomarsino. 1996. Status review of West Coast steelhead from Washington, Idaho, Oregon, and California. U.S. Dept. of Commerce, NOAA Tech. Memo., NMFS-NWFSC-27, 261 p.

Cascadia Research Collective. 2008. Sighting of thin Southern Resident killer whale off Washington coast. Communication to Lynn Barre, National Marine Fisheries Service from Erin Falcone, Cascadia Research Collective, Olympia, Washington. March 4.

Casillas E., M.R. Arkoosh, E. Clemons, T. Hom, D. Misitano, T.K. Collier, J.E. Stein, and U. Varanasi. 1995a. Chemical contaminant exposure and physiological effects in out-migrant juvenile Chinook salmon from urban estuaries of Puget Sound, Washington. Proceedings of Puget Sound Research '95. Puget Sound Water Quality Authority, Olympia, Washington.

Casillas E., M.R. Arkoosh, E. Clemons, T. Hom, D. Misitano, T.K. Collier, J.E. Stein, and U. Varanasi. 1995b. Estuaries chemical contaminant exposure and physiological effects in out-migrant juvenile Chinook salmon from selected urban estuaries of Puget Sound, Washington. Proceedings of the 1994 Northeast Pacific Chinook and Coho Salmon Workshop: Salmon Ecosystem Restoration: Myth and Reality edited by M. Keefe. American Fisheries Society, Oregon Chapter, Corvallis, Oregon.

Casillas, E. B-T. L. Eberhard, T.K. Collier, M.M. Krahn, and J.E. Stein. 1998a. Hylebos fish injury study: round 2, part 3: exposure of juvenile Chinook salmon to chemical contaminants specific to the Hylebos Waterway: Tissue concentrations and biochemical responses. National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, Washington.

Casillas, E., L. Crockett, Y. deReynier, J. Glock, M. Helvey, B. Meyer, C. Schmitt, M. Yoklavich, A. Bailey, B. Chao, B. Johnson, and T. Pepperell. 1998b. Essential fish habitat, west coast groundfish appendix. National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, Washington.

Casillas, E. 1999. Role of the Columbia River estuary and plume in salmon productivity. Proceedings of the Northwest Power Planning Council Ocean Symposium. National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, Washington.

CBFWA (Columbia Basin Fish and Wildlife Authority). 1990. Review of the history, development, and management of anadromous fish production facilities in the Columbia River Basin. CBFWA, Portland, Oregon.

CBFWA (Columbia Basin Fish and Wildlife Authority). 1991. Integrated system plan. CBFWA, Portland, Oregon.

Center for Whale Research. Unpublished data. The historical status of the Southern Resident killer whales, southern Resident population 1976-2006. Center for Whale Research, Friday Harbor, Washington.

Chapman, D.A., A. Giorgi, T. Hillman, D. Deppert, M. Erho, S. Hays C. Peven, B. Suzumoto, and R. Klinge. 1994. Status of summer/fall Chinook salmon in the mid-Columbia region. Don Chapman Consultants, Boise, Idaho.

Chapman, D.W. and K.L. Witty. 1993. Habitats of weak salmon stocks of the Snake River basin and feasible recovery measures. Recovery issues for threatened and endangered Snake River salmon. Technical report 1 of 11. Project No. 93-013. Prepared for Bonneville Power Administration, Portland, Oregon.

Chisholm, I.M. and W.A. Hubert. 1985. Expulsion of dummy transmitters by rainbow trout. Transactions of the American Fisheries Society 114:766-767.

Chittenden, C., K.G. Butterworth, K.F. Cubitt, M.C. Jacobs, A. Ladouceur, D.W. Welch, and R.S. McKinley. 2008. Growth, survival, tag retention, swimming performance and condition of coho salmon (*O. kisutch*) presmolts surgically implanted with 6, 7 and 9mm acoustic tags. Environmental Biology of Fishes (submitted).

Clabough, T. and C. Peery. 2004. Removable Spillway Weir (RSW) fallback evaluation 2002 and 2003. Memorandum to M. Shutters and D. Clugston, U.S. Army Corps of Engineers by T. Clabough and C. Peery, Idaho Cooperative Fish and Wildlife Research Unit, Moscow. December.

Clugston, D. 2008. Sea lion marks and escapement 2002. Communication to G. Fredricks, National Marine Fisheries Service, from D. Clugston, U.S. Army Corps of Engineers, Portland, Oregon. April 17.

Coble, D.W. 1967. Effects of fin-clipping on mortality and growth of yellow perch with a review of similar investigations. Journal of Wildlife Management 31(1):173-180.

Collis, K. D.D. Roby, C. Couch, G. Dorsey, K. Fisher, D.E. Lyons, A.M. Myers, S.K. Nelson, R.M. Suryan, A. Evans, and M. Hawbecker. 2003. Caspian tern research on the lower Columbia River. Draft 2003 season summary. Prepared for the Bonneville Power Administration and the Interagency Caspian Tern Working Group, Portland, Oregon.

Collis, K. D.D. Roby, D.P. Craig, B.A. Ryan, and R.D. Ledgerwod. 2001. Colonial waterbird predation on juvenile salmonids tagged with passive integrated transponders in the Columbia River estuary: vulnerability of different salmonid species, stocks, and rearing types. Transactions of the American Fisheries Society 130:385-396.

Collis, K., D.D. Roby, D.P. Craig, S. Adamany, J. Adkins, and D.E. Lyons. 2002. Colony size and diet composition of piscivorous waterbirds on the lower Columbia River: Implications for losses of juvenile salmonids to avian predation. Transactions of the American Fisheries Society 131:537-550.

Collis, K., D.D. Roby, D.E. Lyons, Y. Suzuki, J.Y. Adkins, L. Reinalda, C. Hand, N. Hostetter, A. Evans, and M. Hawbecker. 2007. Research, monitoring, and evaluation of avian predation on salmonid smolts in the lower and mid-Columbia River. Draft 2006 season summary report to the Bonneville Power Administration and U.S. Army Corps of Engineers, Portland, Oregon.

Colville Tribes (Confederated Tribes of the Colville Reservation), BPA (Bonneville Power Administration), Corps (U.S. Army Corps of Engineers), and USBR (U.S. Bureau of Reclamation). 2008. Draft memorandum of agreement between the Confederated Tribes of the Colville Reservation, the Bonneville Power Administration, the U.S. Army Corps of Engineers, and the U.S. Bureau of Reclamation. March 25.

Connor, W.P., H.L. Burge, and R. Waitt. 2001. Snake River fall Chinook salmon early life history, condition, and growth as affected by dams. Unpublished report. U.S. Fish and Wildlife Service and University of Idaho, Moscow.

Connor, W.P., J.G. Sneva, K.F. Tiffan, R.K. Steinhorst, and D. Ross. 2005. Two alternative juvenile life history types for fall Chinook salmon in the Snake River Basin. Transactions of the American fisheries Society 134:291-304.

Cook, C., G. McMichael, J. Vucelick, B. Dibrani, I. Welch, C. Duberstein, E. Hockersmith, D. Ogden, and B. Sandford. 2006. Lower Monumental reservoir juvenile fall Chinook salmon behavior studies. PowerPoint presentation to AFEP, November 13-16, 2006.

Cooney, T. 2007. Current spawner abundance data sets for Interior Columbia Chinook populations. Attachment: Spreadsheet “Chinook datasets 11_14_07 for dist.xls.” Communication C. Toole, R. Hinrichsen, and M. Garrity from T. Cooney, National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, Washington. November 14.

Cooney, T. 2008a. Current population data sets for Interior Columbia steelhead. Attachment: Spreadsheet “Sthd datasets 1_22_08 for dist.xls.” Communication to C. Toole, National Marine Fisheries Service, from T. Cooney, National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, Washington. February 26.

Cooney, T. 2008b. Spreadsheets with updated probability lambda for Chinook and correction for Yakima Upper Columbia steelhead. Attachments: Spreadsheets “Chinook lambdas Feb08 with probcalc.xls” and “Sthd trend summaries feb08 with probcalc.xls.” Communication to C. Toole, National Marine Fisheries Service, from T. Cooney, National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, Washington. March 3.

Cooney, T. 2008c. Chinook lambda and trends with 1990 added. Attachment: Spreadsheets "Chinook lambdas Feb08 with probcalc.xls.” Communication to C. Toole, National Marine Fisheries Service, from T. Cooney, National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, Washington. March 3.

Cooney, T. 2008d. Lambda and BRT trend for fall Chinook. Attachment: Spreadsheets "snkfalloutputmar08.xls.” Communication to C. Toole, National Marine Fisheries Service, from T. Cooney, National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, Washington. March 24.

Cooney, T., and D. Matheson. 2006. Notes on productivity/abundance metrics table. Memorandum to C. Toole, National Marine Fisheries Service, from T. Cooney and D. Matheson, National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, Washington. October 31.

Cooney, T., and M. Ford. 2007. Snake River Fall Chinook: Summary of Status and Hatchery Considerations. National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, Washington.

Corps (U.S. Army Corps of Engineers). 1999. Columbia and lower Willamette Rivers navigation channel, Oregon and Washington. Final integrated feasibility report and environmental impact statement. Corps, Portland, Oregon.

Corps (U.S. Army Corps of Engineers). 2002. Lower Snake River juvenile salmon migration feasibility report and environmental impact statement. Appendix A - anadromous fish modeling. Corps, Walla Walla, Washington.

Corps (U.S. Army Corps of Engineers). 2006a. Application for a permit to enhance the survival of listed species under the Endangered Species Act of 1973 for the purpose of a juvenile transportation program to protect sockeye, Chinook, and coho salmon, and steelhead from adverse environmental conditions created by Corps dams and reservoirs on the lower Snake and Columbia Rivers. Corps, Portland, Oregon.

Corps (U.S. Army Corps of Engineers). 2006b. Response to memorandum regarding lower Snake River dam removal scenario. Letter to Nicole Cardon, Save Our Wild Salmon, and Michael Garrity, American Rivers, from Witt Anderson, U.S. Army Corps of Engineers, Portland, Oregon. June 5.

Corps (U.S. Army Corps of Engineers), BPA (Bonneville Power Administration), and USBR (U.S. Bureau of Reclamation). 2007a. Comprehensive analysis of the Federal Columbia River Power System and mainstem effects of Upper Snake and other tributary actions. Corps, Portland, Oregon.

Corps (U.S. Army Corps of Engineers), BPA (Bonneville Power Administration), and USBR (U.S. Bureau of Reclamation). 2007b. Biological assessment for effects of Federal Columbia River Power System and 18 Bureau of Reclamation projects in the Columbia Basin on anadromous salmonid species listed under the Endangered Species Act. Corps, Portland, Oregon.

Corps (U.S. Army Corps of Engineers), BPA (Bonneville Power Administration), and USBR (U.S. Bureau of Reclamation. 2008a. Addendum to "comprehensive analysis of the Federal Columbia River Power System and mainstem effects of Upper Snake and other tributary actions." Analysis of effects on listed Killer Whale and Green Sturgeon distinct population segments. Corps, Portland, Oregon.

Corps (U.S. Army Corps of Engineers), BPA (Bonneville Power Administration), and USBR (U.S. Bureau of Reclamation. 2008b. Revised Addendum to the Biological Assessments and Comprehensive Analysis of the Federal Columbia River Power System and Mainstem Effects of Upper Snake and Other Tributary Actions. Analysis of Effects on Listed Columbia River Basin Salmon and Steelhead Populations from Proposed Memorandum of Agreement Actions. Corps, Portland, Oregon.

Cramer, S.P., C.F. Willis, S.C. Vigg, J.T. Hawksworth, R. Montagne, D. Cramer, F. Shrier, C. Phillips, J. Welty, and K. Reininga. 1997. Synthesis and analysis of the Lower Columbia River Steelhead Initiative. Special Report. S.P. Cramer and Associates, Gresham, Oregon.

Cramer, S.P., J. Norris, P. Mundy, G. Grette, K. O'Neal, J. Hogle, C. Steward, and P. Bahls. 1999. Status of Chinook salmon and their habitat in Puget Sound, volume 2. Final report. S.P. Cramer and Associates, Gresham, Oregon.

CREDDP (Columbia River Estuary Data Development Program). 1980. A literature survey of the Columbia River estuary, volume 1. Pacific Northwest River Basins Commission, Vancouver, Washington.

CRITFC (Columbia River Inter-Tribal Fish Commission). 2008. Comments on October 2007 Draft FCRPS Biological Opinion. CRITFC, Portland, Oregon.

Crozier, L., R. Zabel, and A. Hamlet. 2008. Predicting differential effects of climate change at the population level with life-cycle models of spring Chinook salmon. Global Change Biology 14:236-249.

CTC (Pacific Salmon Commission Joint Chinook Technical Committee). 2007. Annual report on catch, escapement, exploitation rate analysis and model calibration of Chinook salmon under Pacific salmon commission jurisdiction, 2006.

Cudaback, C.N. and D.A. Jay. 1996. Formation of the Columbia River plume - hydraulic control in action? Pages 139-154 *in* D.G. Aubrey and C.T. Friedrichs, editors. Coastal and estuarine studies 53: buoyance effects on coastal and estuarine dynamics. American Geophysical Union, Washington, D.C.

Dalbey, S.R., T.E. McMahon, and W. Fredenberg. 1996. Effect of electrofishing pulse shape and electrofishing-induced spinal injury to long-term growth and survival of wild rainbow trout. North American Journal of Fisheries Management 16:560-569.

DART (Columbia River Data Access in Real Time). 2007a. Adult passage at Bonneville Dam, 1983-2007. Columbia River DART, School of Aquatics and Fishery Sciences, University of Washington, Seattle.

DART (Columbia River Data Access in Real Time). 2007b. Wild trapped Snake subyearling Chinook PIT-tag detections at Lower Granite Dam 1993-2007. Columbia River DART, School of Aquatics and Fishery Sciences, University of Washington, Seattle.

Dauble, D.D., T.P. Hanrahan, D.R. Geist, and M.J. Parsley. 2003. Impacts of the Columbia River hydroelectric system on mainstem habitats of fall Chinook salmon. North American Journal of Fisheries Management 23:641-659.

Dawley, E.M., R.D. Ledgerwood, T.H. Blhm, C.W. Sims, J.T. Durkin, R.A. Kirn, A.E. Rankis, G.E. Moran, and F.J. Ossiander. 1986. Migrational characteristics, biological observations, and relative survival of juvenile salmonids entering the Columbia River estuary, 1966-2983. Final report of research funded by the Bonneville Power Administration, Portland, Oregon, and the National Marine Fisheries Service, Northwest and Alaska Fisheries Science Center, Seattle, Washington.

Dimick, R. E., and F. Merryfield. 1945. The fishes of the Willamette River system in relation to pollution. Oregon State College, Engineering Experiment Station, Corvallis, Oregon, Bulletin 19:7-55.

Dwyer, W.P. and R.G. White. 1997. Effect of electroshock on juvenile Arctic grayling and Yellowstone cutthroat trout growth 100 days after treatment. North American Journal of Fisheries Management 17:174-177.

Dygert, P. 2007. Preliminary analysis of the survival benefits associated with a kelt reconditioning program directed at b-run steelhead. Memorandum to U.S. vs. Oregon Parties from P. Dygert, National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, Washington. August 10.

Ebel, W., D. Park, and R. Johnsen. 1973. Effects of transportation on survival and homing of Snake River Chinook salmon and steelhead trout. Fisheries Bulletin 72:549-563.

Ebel, W.J., H.L. Raymond, G.E. Monan, W.E. Faff, and G.K. Tanonaka. 1975. Effects of atmospheric gas supersaturation caused by dams on salmon and steelhead trout of the Snake and Columbia Rivers, (a review of the problem and progress toward a solution, 1974). National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, Washington.

Ehlke, R.D. and K. Keller. 2003. 2002 chum salmon spawning ground surveys on the mainstem Columbia River and its Washington tributaries. Annual report prepared for Bonneville Power Administration by the Pacific States Marine Fish Commission, Portland, Oregon.

Ebel, W. 1980. Transportation of Chinook salmon, *Oncorhynchus tshawytscha*, and steelhead, *Salmo gaurdneri*, smolts in the Columbia River and effects on adult returns. Fisheries Bulletin 78:491-505

Elliot, D.G., R.J. Pascho. 1994. Juvenile fish transportation: impact of bacterial kidney disease on survival of spring/summer Chinook salmon stocks, 1992. Prepared for the U.S. Army Corps of Engineers by the Northwest Biological Science Center, National Biological Survey, Seattle, Washington.

Emmett, R. L., S. L. Stone, S.A. Hinton, and M.E. Monaco. 1991. Distribution and abundance of fishes and invertebrates in west coast estuaries, volume II: species life history summaries. National Oceanic and Atmospheric Administration, National Ocean Service ELMR Report No. 8, Rockville, Maryland.

EPA (Environmental Protection Agency). 1999. A review of synthesis of effects of alterations to the water temperature regime on freshwater life stages of salmonids with special reference to Chinook salmon. EPA, Region 10, Seattle, Washington.

EPA (Environmental Protection Agency). 2001. Technical synthesis: scientific issues relating to temperature criteria for salmon, trout, and char native to the Pacific Northwest. Final draft. A summary report submitted to the Policy Workgroup of the Temperature Criteria Guidance Project. EPA, Region 10, Seattle, Washington.

EPA (Environmental Protection Agency). 2003. Guidance for Pacific Northwest state and tribal water quality standards. EPA, Region 10, Seattle, Washington.

Erickson, A. W. 1978. Population studies of killer whales (*Orcinus orca*) in the Pacific Northwest: a radio-marking and tracking study of killer whales. U.S. Marine Mammal Commission, Washington, D.C.

Evermann, B.W. 1895. A preliminary report upon salmon investigations in Idaho in 1894. U.S. Fishery Commission Bulletin 15:253-284.

Faler, M.P., L.M. Miller, and K.I. Welke. 1988. Effects of variation in flow on distribution of northern squawfish in the Columbia River below McNary Dam. North American Journal of Fisheries Management 8:30-35.

Falter, C.M. 1969. Digestive rates and daily rations of northern squawfish in the St. Joe River, Idaho. Doctoral dissertation, University of Idaho, Moscow.

FERC (Federal Energy Regulatory Commission). 2007. Final environmental impact statement, Hells Canyon Hydroelectric Project Idaho/Oregon. FERC, Washington, D.C.

Ferguson, J.W., G.M. Matthews, R.L. McComas, R.F. Absolon, D.A. Brege, M.H. Gessel, and L.G. Gilbreath. 2005. Passage of adult and juvenile salmonids through Federal Columbia River Power System dams. U.S. Dept. of Commerce, NOAA Tech. Memo., NMFS-NWFSC-64, 160 p.

Ferguson, J.W. 2006. Estimation of percentages for listed Pacific salmon and steelhead smolts arriving at various locations in the Columbia River basin in 2006. Memorandum to James H. Lecky, National Marine Fisheries Service, from J.W. Ferguson, National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, Washington. June 13.

Ferguson, J.W., B.P. Sandford, R.E. Reagan, L.G. Gilbreath, E.B. Meyer, R.D. Ledgerwood, and N.S. Adams. 2007. Bypass system modification at Bonneville Dam on the Columbia River improved the survival of juvenile salmon. Transactions of the American Fisheries Society 136:1487-1510.

Fieberg, J. and S.P. Ellner. 2000. When is it meaningful to estimate an extinction probability? Ecology 81(7):2040-2047.

Fisher, T., and R. Hinrichsen. 2006. Abundance-based trend results for Columbia basin salmon and steelhead ESUs. Appendix F. Prepared for Bonneville Power Administration, Portland, Oregon.

Flagg, T.A., F.W. Waknitz, D.J. Maynard, G.B Milner, and C.V.W. Mahnken. 1995. The effect of hatcheries on native coho salmon populations in the lower Columbia River. In Proceedings of the of the American Fisheries Society Symposium 15:366-375.

Flagg, T.A., W.C. McAuley, P.A. Kline, M.S. Powell, D. Taki, and J.C. Gislason. 2004. Application of captive broodstocks to preservation of ESA-listed stocks of Pacific Salmon: Redfish Lake sockeye salmon case example. Pages 387-400 *in* M.J. Nickum, P.M. Mazik, J.G. Nickum, and D.D. MacKinlay, editors. Propagated fish in resource management. American Fisheries Society, Symposium 44, American Fisheries Society, Bethesda, Maryland.

Flagg, T.A. 2007. Snake River sockeye hatchery program. Communication to L. Krasnow, National Marine Fisheries Service from T.A. Flagg, National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, Washington. September 14.

Flagg, T.A. 2008. Snake River sockeye - genetic diversity. Communication to L. Krasnow, National Marine Fisheries Service, from T.A. Flagg, National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, Washington. April 3.

Fletcher, D.H., F. Haw, and P.K. Bergman. 1987. Retention of coded-wire tags implanted into cheek musculature of largemouth bass. North American Journal of Fisheries Management 7:436-469.

Foote, A.D., R.W. Osborne, and A.R. Hoelzel. 2004. Whale-call response to masking boat noise. Nature 428:910.

Ford, J.K.B., G.M. Ellis, L.G. Barrett-Lennard, A.B. Morton, R.S. Palm, and K.C. Balcomb. 1998. Dietary specialization in two sympatric population of killer whales (*Orcinus orca*) in coastal British Columbia and adjacent waters. Canadian Journal of Zoology 76:1456-1471

Ford, J.K.B., and G.M. Ellis. 1999. Transients: mammal-hunting killer whales of British Columbia, Washington, and southeastern Alaska. UBC Press, Vancouver, British Columbia

Ford, J.K.B., G.M. Ellis, and K.C. Balcomb. 2000. Killer whales: the natural history and genealogy of *Orcinus orca* in British Columbia and Washington State, 2nd edition. UBC Press, Vancouver, British Columbia.

Ford, M.J. 2002. Selection in captivity during supportive breeding may reduce fitness in the wild. Conservation Biology 16(3):815-825.

Ford, J.K.B, G.M. Ellis. 2005. Prey selection and food sharing by fish-eating 'resident' killer whales (*Orcinus orca*) in British Columbia. Fisheries and Oceans Canada, Nanaimo, British Columbia.

Ford, J.K.B., G.M. Ellis, and P.F. Olesiuk. 2005. Linking prey and population dynamics: did food limitation cause recent declines of 'resident' killer whales (*Orcinus orca*) in British Columbia? Fisheries and Oceans Canada, Nanaimo, British Columbia.

Ford, J.K.B. and G.M. Ellis. 2006. Selective foraging by fish-eating killer whales *Orcinus orca* in British Columbia. Marine Ecology Progress Series 316:185-199.

Fox, D.S., S. Bell, W. Nehlsen, J. Damron, and E. Krebill. 1984. The Columbia River estuary atlas of physical and biological characteristics. Columbia River Estuary Data Development Program, Portland, Oregon.

FPC (Fish Passage Center). 2006. Fish Passage Center annual report 2005. Fish Passage Center of the Columbia Basin Fish and Wildlife Authority, Portland, Oregon.

FPC (Fish Passage Center). 2007. Fish Passage Center annual report 2006. Fish Passage Center of the Columbia Basin Fish and Wildlife Authority, Portland, Oregon.

Framework Work Group (Framework Work Group of the *NWF v. NMFS* Collaboration Process). 2006. Relative magnitude of human-related mortality factors affecting listed salmon and steelhead in the interior Columbia River basin. Interim report. Framework Work Group, Portland, Oregon.

Fredenberg, W.A. 1992. Evaluation of electrofishing-induced spinal injuries resulting from field electrofishing surveys in Montana. Montana Department of Fish, Wildlife, and Parks, Helena.

Fresh, K. 2004. Question regarding use of plume. Communication to L. Krasnow, National Marine Fisheries Service, from K. Fresh, National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, Washington. June 25.

Fresh, K.L., E. Casillas, L.L. Johnson, and D.L. Bottom. 2005. Role of the estuary in the recovery of Columbia River Basin salmon and steelhead: an evaluation of the effects of selected factors on salmonid population viability. U.S. Dept. of Commerce, NOAA Tech. Memo., NMFS-NWFSC-69, 105p.

Friesen, T.A., and D.L. Ward. 1999. Management of northern pikeminnow and implications for juvenile salmonid survival in the lower Columbia and Snake Rivers. North American Journal of Fisheries Management 19:406-420.

Friesen, T.A., J.S. Vile, and A.L. Pribyl. 2004. Migratory behavior, timing rearing, and habitat use of juvenile salmonids in the lower Willamette River. Pages 63-138 *in* Friesen, T, editor. Biology, behavior, and resources of resident and anadromous fish in the lower Willamette River. Oregon Department of Fish and Wildlife, Clackamas.

Fulton, L.A. 1968. Spawning areas and abundance of Chinook salmon (*Oncorhynchus tshawytscha*) in the Columbia River basin – past and present. Special scientific report, Fisheries No. 571. U.S. Fish and Wildlife Service, Bureau of Commercial Fisheries, Washington, D.C.

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. Special scientific report, Fisheries No. 618. National Marine Fisheries Service, Washington, D.C.

Gadomski, D.M., M.G. Mesa, and T.M. Olson. 1994. Vulnerability to predation and physiological stress responses of experimentally descaled juvenile Chinook salmon, *Oncorhynchus tshawytscha*. Environmental Biology of Fishes 39:191-199.

Garcia, A.P., S. Bradbury, B.D. Arnsberg, and P.A. Groves. 2007. Fall Chinook salmon spawning ground surveys in the Snake River basin upriver of Lower Granite Dam, 2006. Annual report. Prepared for Bonneville Power Administration, Portland, Oregon.

Geraci, J.R. 1990. Physiologic and toxic effects on cetaceans. Pages 167-198 *in* J.R. Geraci and D.J. St. Aubin, editors. Sea mammals and oil: confronting the risks. Academic Press, New York.

Gilbert, C.H. and B.W. Evermann. 1894. A report upon investigations in the Columbia River Basin, with descriptions of four new species of fishes. Bulletin of the United States Fisheries Commission 14:169-204.

Good, T.P., R.S. Waples, and P. Adams (editors). 2005. Updated status of federally listed ESUs of West Coast salmon and steelhead. U.S. Dept. Commerce, NOAA Tech. Memo., NMFS-NWFSC-66, 598p.

Goodman, D. 1987. The minimum viable population problem. The demography of chance extinction. Administrative report LJ-84-44C. National Marine Fisheries Service, Southwest Fisheries Science Center, La Jolla, California.

Gray, G.A. and D.W. Rondorf. 1986. Predation on juvenile salmonids in Columbia Basin reservoirs. Pages 178-185 *in* G.E. Hall and M.J. Van Den Avyle, editors. Reservoir fisheries management strategies from the '80s. American Fisheries Society, Southern Division, Bethesda, Maryland.

Gresh, T., J. Lichatowich, and P. Schoonmaker. 2000. An estimation of historic and current levels of salmon production in the Northeast Pacific ecosystem: evidence of a nutrient deficit in the freshwater systems of the Pacific Northwest. Fisheries 25(1):15-21.

Grimaldo, L., and S. Zeug. 2001. IEP Resident Fish Project Work Team hosts meeting on green sturgeon. IEP Newsletter 14(4): 19-32.

Groves, P.A., and J.A. Chandler. 1999. Spawning habitat used by fall Chinook salmon in the Snake River. North American Journal of Fisheries Management: 19:912-922.

Gustafson, R.G., T. Wainwright, G. Winans, F. Waknitz, L. Parker, and R. Waples. 1997. Status review of sockeye salmon from Washington and Oregon. U.S. Dept. of Commerce, NOAA Tech. Memo., NMFS-NWFSC-33, 282 p.

Gustafson, R.G., T. Wainwright, G. Winans, F. Waknitz, L. Parker, and R. Waples. 1997. Status review of sockeye salmon from Washington and Oregon. U.S. Dept. of Commerce, NOAA Tech. Memo., NMFS-NWFSC-33, 282 p.

Haas, J.B. 1965. Fishery problems associated with Brownlee, Oxbow, and Hells Canyon Dams on the middle Snake River. Investigative Report No. 4. Fish Commission of Oregon, Portland.

Habitat Technical Subgroup (Habitat Technical Subgroup of the NWF v. NMFS Collaboration Process). 2006a. Guidance from the Habitat Technical Subgroup of the FCRPS Hydropower BiOp Remand Collaboration for providing Columbia River basin estuary habitat action information. Habitat Technical Subgroup, Portland, Oregon.

Habitat Technical Subgroup (Habitat Technical Subgroup of the NWF v. NMFS Collaboration Process).2006b. FCRPS biop remand potential habitat actions and benefits. Table 4. Estimated habitat limiting factor benefits for Washington populations, summary of limiting factor benefits and habitat actions. Habitat Technical Subgroup, Portland, Oregon.

Habitat Technical Subgroup (Habitat Technical Subgroup of the NWF v. NMFS Collaboration Process). 2007a. Summary table. ESU - Snake River steelhead MPG - Clearwater River population - Lochsa. Draft. Habitat Technical Subgroup, Portland, Oregon.

Habitat Technical Subgroup (Habitat Technical Subgroup of the NWF v. NMFS Collaboration Process). 2007b. Summary table. ESU - Snake River steelhead MPG - Clearwater River population - S.F. Clearwater. Draft. Habitat Technical Subgroup, Portland, Oregon.

Hanson, M.B. 2008. Southern Resident killer whales data requests for biological opinion. Communication to A. Agness, National Marine Fisheries Service, from M.B. Hanson, National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, Washington. February 26.

Hanson, M.B., R.W. Baird, and G.S. Schorr. 2005. Focal behavioral observations and fish-eating killer whales: improving our understanding of foraging behavior and prey selection. Poster from the 16th Biennial Conference on the Biology of Marine Mammals, San Diego, California.

Hanson, M.B., R.W. Baird, C. Emmons, J. Hempelmann, G.S. Schorr, J. Sneva, and D. VanDoornik. 2007a. Summer diet and prey stock identification of the fish-eating "southern resident" killer whale: addressing a key recovery need using fish scales, fecal samples, and genetic techniques. Abstract from the 17th Biennial Conference on the Biology of Marine mammals, Capetown, South Africa.

Hanson, M.B., R.W. Baird, C. Emmons, J. Hempelmann, G.S. Schorr, and D.Van Doornik. 2007b. Stock identification of prey selected by "southern resident" killer whales in their summer range. National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, and Cascadia Research Collective, Olympia, Washington.

Hard, J.J., R.P. Jones, Jr., M.R. Delarm, and R.S. Waples. 1992. Pacific salmon and artificial propagation under the Endangered Species Act. U.S. Dept. of Commerce, NOAA Tech. Memo., NMFS-NWFSC-2, 56p.

Hare, S.R., N.J. Mantua, and R.C. Francis. 1999. Inverse production regimes: Alaska and West Coast pacific salmon. Fisheries 24(1):6-14.

Harmon, J. 2008. Marine mammal marks. Communication to G. Griffin, National Marine Fisheries Service, from J. Harmon, National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, Washington. April 23.

Hastings, A. 1993. Complex interactions between dispersal and dynamics: lessons from coupled logistic equations. Ecology 74(5):1362-1372.

Hatch, D., J. Stephenson, J. Whiteaker, S. Narum, R.D. Branstetter, J. Whiteaker, J. Blodgett, D. Fast, J. Blodgett, B. Bosch, T. Newsome, D. Lind, B. Rogers, M. Johnston, C. Fisher, R. Dasher, D. Best, J. Lovtang, M. Powell. 2006. An evaluation of the reproductive success of natural-origin, hatchery-origin and kelt steelhead in the Columbia basin. 2005 annual report. Columbia River Inter-Tribal Fish Commission, Technical Report 06-07, Portland, Oregon.

Helfield, J.M., and R.J. Naiman. 2001. Effects of salmon-derived nitrogen on riparian forest growth and implications for stream productivity. Ecology 82(9):2403-2409.

Hevlin, W. and S. Rainey. 1993. Considerations in the use of adult fish barriers and traps in tributaries to achieve management objectives. Pages 33-40 *in* K. Bates, editor. Fish passage policy and technology, proceedings of a symposium. American Fisheries Society, Bioengineering Section, Portland, Oregon.

Hickey, B.M., L.J. Pietrafesa, D.A. Jay, and W.C. Boicourt. 1997. The Columbia River plume study: subtidal variability in the velocity and salinity field. Journal of Geophysical Research: 103(C5):10339-10368.

Hinrichsen, R.A. 2008. Analytical methods for population viability analysis of endangered salmon ESUs of the interior Columbia River basin. Hinrichsen Environmental Services, Seattle, Washington.

Hockersmith, E.E., W.D. Muir, S.G. Smith, B.P. Sandford, N. S. Adams, J.M. Plumb, R.W. Perry, D.W. Rondorf. 2000. Comparative performance of sham radio tagged and PIT-tagged juvenile salmon. Prepared for the U.S. Army Corps of Engineers, by the National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, Washington.

Hockersmith, E. E. 2007. Passage behavior and survival for radio-tagged yearling Chinook salmon and juvenile steelhead at Lower Monumental Dam, 2007. Report of preliminary results to the U. S Army Corps of Engineers' Fish Facility Design and Review Workgroup, by the National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, Washington.

Hockersmith, E., R. Brown, T. Liedtke. 2008. Comparative performance of acoustic-tagged and PIT-tagged juvenile salmonids. Report of research to the U.S. Army Corps of Engineers by the National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, Washington.

Hollender, B.A. and R.F. Carline. 1994. Injury to wild brook trout by backpack electrofishing. North American Journal of Fisheries Management 14:643-649.

Hooton, R.S. 1987. Catch and release as a management strategy for steelhead in British Columbia. *In* R. Barnhart and T. Roelofs, editors. Proceedings of Catch and Release Fishing: a Decade of Experience, a National Sport Fishing Symposium. Humboldt State University, Arcata, California.

Howe, N.R. and P.R. Hoyt. 1982. Mortality of juvenile brown shrimp *Penaeus aztecus* associated with streamer tags. Transactions of the American Fisheries Society 111:317-325.

Howell, P., K. Jones, D. Scarnecchia, L. Lavoy, W. Kendra, and D. Ortmann. 1985. Stock assessment of Columbia River anadromous salmonids, volume II: steelhead stock summaries, stock transfer guidelines—information needs. Final report 1984. Prepared for Bonneville Power Administration, Portland, Oregon.

HSRG (Hatchery Scientific Review Group). 2004. Hatchery reform: principles and recommendations of the Hatchery Scientific Review Group. HSRG, Seattle, Washington.

HSRG (Hatchery Scientific Review Group). 2007. Draft lower Columbia River Chinook salmon hatchery analysis. HSRG, Seattle, Washington.

Huntly, N., and W. Pearcy. 2008. Clarification on ISAB Review of TRT survival gaps analyses. Communication to C. Toole, B. Suzumoto, and M. Ford, National Marine Fisheries Service, from N. Huntly and W. Pearcy, Independent Scientific Advisory Board, Portland, Oregon. April 8.

Hyde, N., A. Chawla, A. Baptista, J. Zhang, C. Seaton, P. Turner, and M. Zulaf. 2004. Columbia River habitat opportunity: sensitivity to river discharge. Draft. Center for Coastal and Land-Margin Research, Oregon Health Sciences University, Portland.

ICTRT (Interior Columbia Technical Recovery Team). 2003. Independent populations of Chinook, steelhead, and sockeye for listed Evolutionarily Significant Units within the interior Columbia River domain. Working draft.

ICTRT (Interior Columbia Basin Technical Recovery Team). 2006. Calculating population productivity gaps: current status vs. viability curves for interior Columbia spring Chinook and steelhead populations. Interim report.

ICTRT (Interior Columbia Basin Technical Recovery Team). 2007a. Viability criteria for application to interior Columbia basin salmonid ESUs. Review draft.

ICTRT (Interior Columbia Technical Recovery Team). 2007b. Considering alternative artificial propagation programs: implications for the viability of listed anadromous salmonids in the interior Columbia River.

ICTRT (Interior Columbia Technical Recovery Team). 2007c. Required survival rate changes to meet Technical Recovery Team abundance and productivity viability criteria for interior Columbia River basin salmon and steelhead populations.

ICTRT (Interior Columbia Technical Recovery Team). 2007d. Current ICTRT draft population status reports. Memorandum to C. Toole, National Marine Fisheries Service, from T. Cooney, National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, Washington.

ICTRT (Interior Columbia Basin Technical Recovery Team) and R.W. Zabel. 2007. Assessing the impact of anticipated hydropower changes and a range of ocean conditions on the magnitude of survival improvements needed to meet TRT viability goals.

Idaho (State of Idaho), BPA (Bonneville Power Administration), Corps (U.S. Army Corps of Engineers), and USBR (U.S. Bureau of Reclamation). 2008. Draft memorandum of agreement between the State of Idaho, the Bonneville Power Administration, the U.S. Army Corps of Engineers, and the U.S. Bureau of Reclamation. Idaho-Action Agency MOA. April 7.

IDEQ (Idaho Department of Environmental Quality). 2005. 2002 Integrated §303(d)/§305(b) Report. IDEQ, Boise.

IDFG (Idaho Department of Fish and Game). 2006. Project sponsor's (IDFG) response to ISRP review of proposal 199107200: Redfish Lake Sockeye Salmon Captive Broodstock Program. Submitted for fiscal years 2007-2009 funding through the Columbia River Fish and Wildlife Program. Columbia Basin Fish and Wildlife Authority, Portland, Oregon.

IEAB (Independent Economic Analysis Board). 2007. Review of the SOS revenue stream report. IEAB, Report 2007-1, Portland, Oregon.

IPC (Idaho Power Company). 1991. Idaho Power fall Chinook interim recovery plan and study. IPC, Boise.

IPC (Idaho Power Company). 2003. New license application for the Hells Canyon FERC Project No. 1971, chapter E.3.1.1.1. threatened and endangered species. IPC, Boise.

Irving, J.S. and T.C. Bjornn. 1981. Status of Snake River fall Chinook salmon in relation to the Endangered Species Act. Report prepared for U.S. Fish and Wildlife Service, Moscow, Idaho.

ISAB (Independent Scientific Advisory Board). 2001a. Model synthesis report: An analysis of decision support tools used in Columbia River Basin management decisions. ISAB, Report 2001-1, Portland, Oregon.

ISAB (Independent Scientific Advisory Board). 2001b. Review of lower Snake River flow augmentation studies. ISAB, Report 2001-5, Portland, Oregon.

ISAB (Independent Scientific Advisory Board). 2004. ISAB Findings from the Reservoir Operations/Flow Survival Symposium. ISAB, Report 2004-2, Portland, Oregon.

ISAB (Independent Scientific Advisory Board). 2006a. Review of the COMPASS model. ISAB, Report 2006-2, Portland, Oregon.

ISAB (Independent Scientific Advisory Board). 2006b. December 2006 review of the COMPASS model, version 1.0. ISAB, Report 2006-7, Portland, Oregon.

ISAB (Independent Scientific Advisory Board). 2007a. Human population impacts on Columbia River basin fish and wildlife. ISAB, Report 2007-3, Portland, Oregon.

ISAB (Independent Scientific Advisory Board). 2007b. Latent mortality report: review of hypotheses and causative factors contributing to latent mortality and their likely relevance to the "Below Bonneville" component of the COMPASS model. ISAB, Report 2007-1, Portland, Oregon.

ISAB (Independent Scientific Advisory Board). 2007c. Climate change impacts on Columbia River basin fish and wildlife. ISAB, Report 2007-2, Portland, Oregon.

ISAB (Independent Scientific Advisory Board). 2007d. Review of draft viability criteria for application to interior Columbia basin salmonid ESUs. ISAB 2007-4, Portland, Oregon.

ISAB (Independent Scientific Advisory Board) and ISRP (Independent Scientific Review Panel). 2007. Review of the comparative survival study's (CSS) ten-year retrospective summary report. ISAB and ISRP, Report 2007-6, Portland, Oregon.

ISAB (Independent Scientific Advisory Board). 2008. Review of the Interior Columbia River Technical Recovery Team's analyses of survival changes needed to meet viability criteria. ISAB, Report 2008-1, Portland, Oregon.

Israel, J.A. and B. May. 2007. Mixed stock analysis of green sturgeon from Washington State coastal aggregations. Final report. Genomic Variation Laboratory Department of Animal Science, University of California, Davis.

Jay, D.A., K. Leffler, and T. Kukulka. 2004. Summer shallow-water habitat in the Skamokawa-Beaver reach under the reference vs. proposed flow regimes. Prepared for NOAA Fisheries by the Department of Environmental and Biomolecular Systems, OGI School of Science and Engineering, Oregon Health and Science University, Portland.

Jenkins, W.E. and T.I.J. Smith. 1990. Use of PIT tags to individually identify striped bass and red drum brood stocks. Pages 341-345 *in* N. C. Parker, A.E. Giorgi, R.C. Heidinger, D.B. Jester, Jr., E.D. Prince, and G.A. Winans, editors. Fish-marking techniques. American Fisheries Society, Symposium 7, Bethesda, Maryland.

Jones, R. 2008. Chinook releases above Bonneville. Communication to B. Suzumoto and R. Walton, National Marine Fisheries Service, from R. Jones, National Marine Fisheries Service, Portland, Oregon. April 22.

Kamler, J.F., and K.L. Pope. 2001. Non-lethal methods of examining fish stomach contents. Reviews in Fisheries Science 9(1):1-11.

Kapuscinski, A.R. 1997. Rehabilitation of Pacific salmon in their ecosystems: what can artificial propagation contribute? *In* D.J. Stouder, D.A. Bisson, and R.J. Naiman, editors. Pacific salmon and their ecosystems, status and future options. Chapman and Hall, New York.

Keefer, M.L., C.C. Caudill, C.A. Peery, S.R. Lee, B.J. Burke and M.L. Moser. 2006. Effects of transport during juvenile migration on behavior and fate of returning adult Chinook salmon and steelhead in the Columbia-Snake hydrosystem, 2000-2003. Report to the U.S. Army Corps of Engineers by the U.S. Geological Survey, Idaho Cooperative Fish and Wildlife Research Unit, and Northwest Fisheries Science Center, Seattle, Washington.

Keefer, M.L., C.A. Peery, and M.J. Heinrich. 2007. Temperature-mediated en route migration mortality and travel rates of endangered Snake River sockeye salmon. Ecology of Freshwater Fish, OnlineEarly Articles.

Keller, K. 2005a. Evaluate spawning of fall Chinook and chum salmon below the four lowermost Columbia River mainstem dams. 2003 Columbia River chum salmon return. 2003-2004 annual report. Prepared for Bonneville Power Administration, Portland, Oregon.

Keller, K. 2005b. Evaluate spawning of fall Chinook and chum salmon below the four lowermost Columbia River mainstem dams. 2004 Columbia River chum salmon return. 2004-2005 annual report. Prepared for Bonneville Power Administration, Portland, Oregon.

Keller, K. 2006. Evaluate spawning of fall Chinook and chum salmon below the four lowermost Columbia River mainstem dams; 2005 Columbia River chum salmon return. 2005-2006 annual report. Prepared for Bonneville Power Administration, Portland, Oregon.

Kempthorne, D., M. Racicot, J. Kitzhaber, and G. Locke. 2002. Recommendations of the Governors of Idaho, Montana, Oregon and Washington for the protection and restoration of fish in the Columbia River basin.

Kline, P. 1994. Research and recovery of Snake River sockeye salmon. Annual report 1993. Idaho Department of Fish and Game, Nampa.

Kock, T.J., K.F. Tiffan, W.P. Connor, R.K. Steinhorst, D.W. Rondorf. 2007. Evidence for behavior thermoregulation by subyearling fall Chinook salmon in a thermally regulated reservoir. November 2007 review draft. U.S. Geological Survey, Western Fisheries Research Center, Cook, Washington.

Kohler, A.E., D. Taki, and R.G. Griswold. 2005. Snake River sockeye salmon habitat and limnological research. 2004 annual progress report. Prepared for Bonneville Power Administration, Portland, Oregon.

Kohler, A.E., J.L. Myers, R.G. Griswold, D. Taki. 2007. Snake River sockeye salmon habitat and limnological research. 2006 annual progress report. Prepared for Bonneville Power Administration, Portland, Oregon.

Kohlhorst, D.W. 1979. Effect of first pectoral fin ray removal on survival and estimated harvest rate of white sturgeon in the Sacramento-San Joaquin estuary. California Fish and Game 65:173-177.

Kozakiewicz, V. 2007. Snake River sockeye returns. Communication to L. Krasnow, National Marine Fisheries Service from V. Kozakiewicz, National Marine Fisheries Service, Regional Office, Boise, Idaho. September 17.

Krahn, M.M., M.B. Hanson, R.W. Baird, R.H. Boyer, D.G. Burrows, C.K. Emmons, J.K.B. Ford, L.L. Jones, D.P. Noren, P.S. Ross, G.S. Schorr, and T.K. Collier. 2007. Persistent organic pollutants and stable isotopes in biopsy samples (2004/2006) from Southern Resident killer whales. Marine Pollution Bulletin 54:1903-1911.

Krahn, M.M., M.J. Ford, W.F. Perrin, P.R. Wade, R.B. Angliss, M.B. Hanson, B.L. Taylor, G.M. Ylitalo, M.E. Dahlheim, J.E. Stein, and R.S. Waples. 2004. 2004 status review of Southern Resident killer whales (*Orincus orca*) under the Endangered Species Act, U.S. Dept. of Commerce, NOAA Tech. Memo., NMFS-NWFSC-62, 73p.

Krahn, M.M., P.R. Wade, S.T. Kalinowski, M.E. Dahlheim, B.L. Taylor, M.B. Hanson, G.M. Ylitalo, R.B. Angliss, J.E. Stein, and R.S. Waples. 2002. Status review of Southern Resident killer whales (*Orcinus orca*) under the Endangered Species Act, U.S. Dept. of Commerce, NOAA Tech. Memo., NMFS-NWFSC-54, 133p.

Kruse, S. 1991. The interactions between killer whales and boats in Johnstone Strait, B.C. Pages 149-159 *in* K. Pryor and K.S. Norris, editors. Dolphin societies: discoveries and puzzles. University of California Press, Berkley.

Kruzic, L. 2001a. Complete decision package for concurrence of the Willamette River spring Chinook FMEP. Memorandum to the Hatcheries and Inland Fisheries Branch Files from L. Kruzic, National Marine Fisheries Service, Portland, Oregon. February 12.

Kruzic, L. 2001b. Completed decision package for concurrence of the Upper Willamette River steelhead FMEP. Memorandum to the Hatcheries and Inland Fisheries Branch Files, from L. Kruzic, National Marine Fisheries Service, Portland, Oregon. November 15.

Lande, R. 1988. Genetics and demography in biological conservation. Science 241:1455-1460.

LCFRB (Lower Columbia Fish Recovery Board). 2004. Lower Columbia salmon recovery and fish and wildlife subbasin plan, volume 1. LCFRB, Longview, Washington.

LCREP (Lower Columbia River Estuary Program). 1999. Comprehensive conservation and management plan, volume 1. LCREP, Portland, Oregon.

Leigh, E.G. 1981. The average lifetime of a population in a varying environment. Journal of Theoretical Biology 90:213-239.

Levin, P.S. and J.G. Williams. 2002. Interspecific effects of artificially propagated fish: an additional conservation risk for salmon. Conservation Biology 16(6):1581-1587.

Levin, P.S., R.W. Zabel, and J.G. Williams. 2001. The road to extinction is paved with good intentions: negative association of fish hatcheries with threatened salmon. Proceedings of the Royal Society 268: 1153-1158.

Light, R.W., P.H. Adler, and D.E. Arnold. 1983. Evaluation of gastric lavage for stomach analyses. North American Journal of Fisheries Management 3:81-85.

Lindsay, R.B., R.K. Schroeder, and K.R. Kenaston. 2004. Hooking mortality by anatomical location and its use in estimating mortality of spring Chinook salmon caught and released in a river sport fishery. North American Journal of Fisheries Management 24:367-378.

Lower Columbia Tule Chinook Working Group. 2008. Addendum to analyses to support a review of an ESA jeopardy consultation on fisheries impacting lower Columbia River tule Chinook salmon, October 5, 2007.

Mantua, N.J., S. Hare, Y. Zhang, J. Wallace, and R. Frances. 1997. A Pacific interdecadal climate oscillation with impacts on salmon production. Bulletin of the American Meteorological Society 78:1069-1079.

Mantua, N.J., and S.R. Hare. 2002. The Pacific decadal oscillation. Journal of Oceanography 58:35-44.

Marsh, D.M., J.R. Harmon, N.N. Paasch, K.L. Thomas, K.W. McIntyre, B.P. Sandford, G.M. Matthews. 2006. Research related to transportation for juvenile salmonids on the Snake River, 2005. Final report of the 2002 spring/summer Chinook salmon juvenile migration. Prepared for the U.S. Army Corps of Engineers by the National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, Washington

Marsh, D.M., B.P. Sandford, G.M. Matthews, and W.D. Muir. 2007. Research related to transportation of juvenile salmonids on the Columbia River, 2005. Final report for the 2003 hatchery steelhead and juvenile migration. Prepared for U.S. Army Corps of Engineers by the National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, Washington.

Martin, J.T. 2007. Climate and development: salmon caught in the squeeze. Response to 2007 Draft Biological Opinion on the Federal Columbia River Power System and Mainstem Effects of the Upper Snake and Other Tributary Actions.

Martinson, R.D., G.M. Kovalchuk, and D. Balinger. 2007. Monitoring of downstream salmon and steelhead at federal hydroelectric facilities – 2006. Annual report. Pacific States Marine Fisheries Commission, The Dalles, Oregon.

Matthews, K.R., and R.H. Reavis. 1990. Underwater tagging and visual recapture as a technique for studying movement patterns of rockfish. Pages 168– 172 in N. C. Parker, A. E. Giorgi, R.C. Heidinger, D.B. Jester, Jr., E. D. Prince, and G.A. Winans, editors. Fish-marking techniques. American Fisheries Society, Symposium 7, Bethesda, Maryland.

McClure, M., T. Cooney, and Interior Columbia Technical Recovery Team. 2005. Updated population delineation in the interior Columbia Basin. Memorandum to NMFS NW Regional Office, Co-managers and other interested parties from McClure et al., Interior Columbia Technical Recovery Team.

McComas, R.L., G.A. Michael, L. Gilbreath, T.J. Carlson, S.G. Smith, and J.W. Feguson. 2008. Estimates of post-FCRPS juvenile salmonid survival through the lower Columbia River estuary using JSATS acoustic tags, 2005-2007. PowerPoint presentation to the Regional Forum Implementation Team. March 6.

McElhany, P., M. H. Rucklelshaus, M. J. Ford, T. C. Wainwright. 2000. Viable salmonid populations and the recovery of evolutionarily significant units. U.S. Dept. of Commerce, NOAA Tech. Memo., NMFS-NWFSC-42, 156p.

McElhany, P. and J. Payne. 2006. Draft user manual for SPAZ version 1.0 beta. National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, Washington.

McElhany, P., M. Chilcote, J. Myers, and R. Beamesderfer. 2007. Viability status of Oregon salmon and steelhead populations in the Willamette and Lower Columbia basins. Prepared for Oregon Department of Fish and Wildlife and National Marine Fisheries Service by the National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, Washington.

McLain, J. 2006. The likely distribution of the southern distinct population segment of North American green sturgeon in SWR Waters. Memorandum to the Southern Distinct Population Segment of North American green sturgeon consultation guidance from J. McLain, National Marine Fisheries Service, Sacramento, California.

McMichael, G.A. 1993. Examination of electrofishing injury and short-term mortality in hatchery rainbow trout. North American Journal of Fisheries Management 13:229-233.

McMichael, G.A., L. Fritts, and T.N. Pearsons. 1998. Electrofishing injury to stream salmonids; injury assessment at the sample, reach, and stream scales. North American Journal of Fisheries Management 18:894-904

McMichael, G.A., J.A. Vucelick, B.J. Bellgraph, T.J. Carlson, R.L. McComas, L. Gilbreath, S.G. Smith, B. Sandford, G. Matthews, and J.W. Ferguson. 2007a. Technical memo: a study to estimate salmonid survival through the Columbia River Estuary using acoustic tags, 2005 and 2006 synthesis report. Report of research funded by the U.S. Army Corps of Engineers, Portland District, and National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, Washington.

McMichael, G.A. , M.C. Richmond, E.E. Hockersmith, J.A. Vucelick, W.A. Perkins, P.S. Titzler, B.P. Sandford, J.R. Skalski, R.A. Buchanan, and A.L. Setter. 2007b. Migratory behvior of subyearling Chinook salmon in Lower Monumental reservoir. Page 48 *in* AFEP annual review 2007, anadromous fish evaluation program. U.S. Army Corps of Engineers, Portland, Oregon.

McNeil, F.I. and E.J. Crossman. 1979. Fin clips in the evaluation of stocking programs for muskellunge (*Esox masquinongy*). Transactions of the American Fisheries Society 108(4):335-343.

Mears, H.C. and R.W. Hatch. 1976. Overwinter survival of fingerling brook trout with single and multiple fin clips. Transactions of the American Fisheries Society 105(6):669-674.

Meehan, W.R., and R. A. Miller. 1978. Stomach flushing: effectiveness and influence on survival and condition of juvenile salmonids. Journal of the Fisheries Research Board of Canada 35:1359- 1363.

Mellas, E.J. and J.M. Haynes. 1985. Swimming performance and behavior of rainbow trout (*Salmo gairdneri*) and white perch (*Morone americana*): effects of attaching telemetry transmitters. Canadian Journal of Fisheries and Aquatic Sciences 42:488-493.

Mesa, M.G. 1994. Effects of multiple acute stressors on the predator avoidance ability and physiology of juvenile Chinook salmon. Transactions of the American Fisheries Society 123:786-793.

Mesa, M.G., and T.M. Olson. 1993. Prolonged swimming performance of northern squawfish. Transactions of the American Fisheries Society 122:1104-1110.

Mighetto, L., W.J. Ebel. 1994. Saving the salmon: A history of the US Army Corps of Engineers' efforts to protect anadromous fish on the Columbia and Snake Rivers. Historical Research Associates, Seattle, Washington.

Minobe, S. 1997. A 50-70 year climatic oscillation over the North Pacific and North America. Geophysical Research Letters 24(6):683-686.

Mobrand, L., J. Barr, L. Blankenship, D.E. Campton, T. Evelyn, T.A. Flagg, C.V.W. Mahnken, L.W. Seeb, P. Seidel, and W. Smoker. 2005. Hatchery reform in Washington State: principles and emerging issues. Fisheries 30:11-23.

Mongillo, P.E. 1984. A summary of salmonid hooking mortality. Washington Department of Game, Olympia.

Montana (State of Montana). 2008a. Additional clarification of the impact of current operations at Libby and Hungry Horse Dams on Montana's fish. Letter to B. Suzumoto, National Marine Fisheries Service, from J. Litchfield, State of Montana, Helena. February 5.

Montana (State of Montana), BPA (Bonneville Power Administration), Corps (U.S. Army Corps of Engineers) and USBR (U.S. Bureau of Reclamation). 2008b. Draft memorandum of agreement between the State of Idaho, the Bonneville Power Administration, the U.S. Army Corps of Engineers, and the U.S. Bureau of Reclamation. Montana-Action Agency MOA. April 9.

Moring, J.R. 1990. Marking and tagging intertidal fishes: review of techniques. Pages 109 -116 *in* N.C. Parker, A.E. Giorgi, R.C. Heidinger, D.B. Jester, Jr., E.D. Prince, and G.A. Winans, editors. Fish-marking techniques. American Fisheries Society, Symposium 7, Bethesda, Maryland.

Morrison, J. and D. Zajac. 1987. Histologic effect of coded wire tagging in chum salmon. North American Journal of Fisheries Management 7:439-441.

Moser, M. and S. Lindley. 2007. Use of Washington estuaries by subadult and adult green sturgeon. Environmental Biology of Fishes 79:243-253.

Muir, W.D., D.M. Marsh, B.P. Sandford, S.G. Smith, and J.G. Williams. 2006. Post-hydropower system delayed mortality of transported Snake River stream-type Chinook salmon: Unraveling the mystery. Transactions of the American Fisheries Society 135:1523-1534.

Myers, J.M., R.G. Kope, B.J. Lindley, and R.S. Waples. 1998. Status review of Chinook salmon from Washington, Idaho, Oregon, and California. U.S. Dept. of Commerce, NOAA Tech. Memo., NMFS-NWFSC-35, 443p.

Myers, J., C. Busack, D. Rawding, A. Marshall, D. Teel, D. M. Van Doornik, and M. T. Maher. 2006. Historical population structure of Pacific salmonids in the Willamette River and lower Columbia River basins. Dept. of Commerce, NOAA Tech. Memo., NMFS-NWFSC-73, 311p.

Nez Perce Tribe. 2008. Nez Perce Tribe's comments on NOAA's draft FCRPS and Upper Snake BiOps and associated documents. Nez Perce Tribe, Lapwai, Idaho.

Nickelson, T. 2003. The influence of hatchery coho salmon (*Oncorhynchus kisutch*) on the productivity of wild coho salmon populations in Oregon coastal basins. Canadian Journal of Fisheries and Aquatic Sciences 60:1050-1056.

Nicola, S.J. and A.J. Cordone. 1973. Effects of fin removal on survival and growth of rainbow trout (*Salmon gairdneri*) in a natural environment. Transactions of the American Fisheries Society 102(4):753-759.

Nielsen, L.A. 1992. Methods of marking fish and shellfish. Special Publication 23. American Fisheries Society, Bethesda, Maryland.

NMFS (National Marine Fisheries Service). 1991a. Endangered status for Snake River sockeye salmon. Final rule. Federal Register 56:224(20 November 1991):58619-58624.

NMFS (National Marine Fisheries Service). 1991b. Policy on applying the definition of species under the Endangered Species Act to Pacific salmon. Federal Register 56:224(20 November 1991):58612-58618.

NMFS (National Marine Fisheries Service). 1993. Designated critical habitat; Snake River sockeye salmon, Snake River spring/summer Chinook salmon, and Snake River fall Chinook salmon. Final rule. Federal Register 58:247(28 December 1993):68543-68554.

NMFS (National Marine Fisheries Service). 1995a. Endangered Species Act - Section 7 Consultation Biological Opinion for reinitiation of consultation of 1994-1998 operation of the Federal Columbia River Power System and juvenile transportation program in 1995 and future years. NMFS, Portland, Oregon.

NMFS (National Marine Fisheries Service). 1995b. Basis for flow objectives for operation of the Federal Columbia River Power System. NMFS, Northwest Region, Seattle, Washington.

NMFS (National Marine Fisheries Service). 1995c. Proposed recovery plan for Snake River salmon. NMFS, Portland, Oregon.

NMFS (National Marine Fisheries Service) and USFWS (U.S. Fish and Wildlife Service). 1996. Notice of policy for conserving species listed or proposed for listing under the Endangered Species Act while providing and enhancing recreational fisheries opportunities. Federal Register 61:107(3 June 1996):27977-27982.

NMFS (National Marine Fisheries Service). 1997. Endangered and threatened species; listing of several evolutionarily significant units (ESUs) of West Coast steelhead. Final rule. Federal Register 62:159(18 August 1997):43937-43954.

NMFS (National Marine Fisheries Service). 1998. Endangered Species Act - Section 7 Consultation Biological Opinion for reinitiation of consultation on Columbia River Northern Squawfish Management Program for listed steelhead. NMFS, Portland, Oregon.

NMFS (National Marine Fisheries Service). 1999a. Designated critical habitat; revision of critical habitat for Snake River spring/summer Chinook salmon. Final rule. Federal Register 64:205(25 October 1999):57399-57403.

NMFS (National Marine Fisheries Service). 1999b. Endangered Species Act – Section 7 Consultation Biological Opinion for Bureau of Reclamation operations and maintenance of its projects in the Snake River basin above Lower Granite Dam: a supplement to the Biological Opinions signed on March 2, 1995 and May 14, 1998. NMFS, Portland, Oregon.

NMFS (National Marine Fisheries Service). 2000a. White paper: predation on salmonids relative to the federal Columbia River power system. NMFS, Northwest Fisheries Science Center, Seattle, Washington.

NMFS (National Marine Fisheries Service). 2000b. Endangered Species Act – Section 7 Consultation Biological Opinion for reinitiation of consultation on operation of the Federal Columbia River Power System, including the juvenile fish transportation program, and 19 Bureau of Reclamation projects in the Columbia basin. NMFS, Portland, Oregon.

NMFS (National Marine Fisheries Service). 2000c. Endangered and threatened species; final rule governing take of 14 threatened salmon and steelhead evolutionarily significant units (ESUs). Federal Register 65:132(10 July 2000):42422-42481.

NMFS (National Marine Fisheries Service). 2000d. Guidelines for electrofishing waters containing salmonids listed under the Endangered Species Act. NMFS, Portland, Oregon.

NMFS (National Marine Fisheries Service). 2000e. Informal consultation on Mitchell Act irrigation diversion screening programs. Memorandum to R.Z. Smith, National Marine Fisheries Service, from W. Stelle, National Marine Fisheries Service, Northwest Region, Seattle, Washington. January 31.

NMFS (National Marine Fisheries Service) and USFWS (U.S. Fish and Wildlife Service). 2000. Biological Opinion on effects of Cougar Reservoir water temperature control project on upper Willamette River Chinook salmon, its critical habitat, bull trout, northern spotted owl, and its critical habitat. NMFS, Northwest Region, and USFWS, Pacific Region, Portland, Oregon.

NMFS (National Marine Fisheries Service). 2001a. Potential impacts of toxic contaminants in salmonids and prey from the Columbia River estuary. Draft. NMFS, Northwest Fisheries Science Center, Seattle, Washington.

NMFS (National Marine Fisheries Service). 2001b. Endangered Species Act - Section 7 Consultation Biological Opinion on impacts of the interim management agreement for upriver spring Chinook, summer Chinook, and sockeye on salmon and steelhead listed under the Endangered Species Act. NMFS, Portland, Oregon.

NMFS (National Marine Fisheries Service). 2001c. Endangered Species Act – Section 7 Consultation Biological Opinion on U.S. Bureau of Reclamation operations and maintenance of its projects in the Snake River basin above Brownlee Dam from date issued through March 2002. NMFS, Portland, Oregon.

NMFS (National Marine Fisheries Service). 2001d. Endangered Species Act - Reinitiated Section 7 Consultation Biological Opinion and Incidental Take Statement on the effects of the Pacific Coast Salmon Plan and U.S. Fraser Panel fisheries on upper Willamette River Chinook, lower Columbia River Chinook, lower Columbia River chum. NMFS, Seattle, Washington.

NMFS (National Marine Fisheries Service) and USFWS (U.S. Fish and Wildlife Service). 2001. Endangered Species Act - Section 7 Consultation Biological Opinion on the effects of relicensing EWEB’s Leaburg-Walterville Hydroelectric Project in the McKenzie subbasin, Oregon. NMFS and USFWS, Portland, Oregon

NMFS (National Marine Fisheries Service). 2002. Endangered Species Act - Section 7 Consultation Biological Opinion and Magnuson-Stevens Act Essential Fish Habitat Consultation to conduct yearly Chief Joseph Dam tailrace fishery from 2002 through 2012, as described in fishery management plan proposed by the BIA on behalf of the Colville Confederated Tribes. NMFS, Portland, Oregon.

NMFS (National Marine Fisheries Service). 2003a. Policy for evaluation of conservation efforts when making listing decisions. Federal Register 68:60(28 March 2003):15100-15115.

NMFS (National Marine Fisheries Service). 2003b. Endangered Species Act - Section 7 Consultation Biological Opinion and Magnuson-Stevens Act Essential Fish Habitat Consultation on: 1) Issuance of an incidental take statement (ITS) to the USFWS; 2) Issuance of an ITS to the BPA and the Confederated Tribes and Bands of the Yakama Nation (Yakama Nation); and 3) Issuance of permit 1347 jointly to the Washington Department of Fish and Wildlife (WDFW), the Public Utility District No. 1 of Chelan County (Chelan PUD), and the Public Utility District No. 1 of Douglas County (Douglas PUD). NMFS, Portland, Oregon.

NMFS (National Marine Fisheries Service). 2003c. Endangered Species Act - Section 7 Consultation Biological Opinion and Magnuson Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation on Habitat Improvement Program, all Columbia River basin ESUs, Columbia River Basin, Oregon, Washington, and Idaho. NMFS, Portland, Oregon.

NMFS (National Marine Fisheries Service). 2003d. Endangered Species Act - Section 7 Consultation Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Consultation on project surrender application for the Bull Run Hydroelectric Project (FERC No. 477), Sandy River Basin, Oregon. NMFS, Portland, Oregon.

NMFS (National Marine Fisheries Service). 2003e. Regulations governing the taking and importing of marine mammals; Eastern North Pacific Southern Resident killer whales. Federal Register 68:103(29 May 2003):31980-31983.

NMFS (National Marine Fisheries Service). 2004a. Endangered Species Act - Section 7 Consultation Biological Opinion for consultation on remand for operation of the Columbia River Power System and 19 Bureau of Reclamation projects in the Columbia Basin (Revised and reissued to court order, NWF v. NMFS Civ. No. CV 01-640-RE. (D. Oregon)). NMFS, Portland, Oregon.

NMFS (National Marine Fisheries Service). 2004b. Salmon hatchery inventory and effects evaluation report: an evaluation of the effects of artificial propagation on the status and likelihood of extinction of West Coast salmon and steelhead under the Federal Endangered Species Act. U.S. Dept. of Commerce, Tech. Memo., NMFS-NWR/SWR, 557p.

NMFS (National Marine Fisheries Service). 2004c. Endangered Species Act - Section 7 Consultation Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Consultation on operation of the Cowlitz River Hydroelectric Project (FERC No. 2016) through 2038. NMFS, Portland, Oregon.

NMFS (National Marine Fisheries Service). 2004d. Endangered and threatened species: proposed listing determination for 27 ESUs of West Coast salmonids; proposed rule. Federal Register 69:113(14 June 2004): 33102-33179.

NMFS (National Marine Fisheries Service). 2004e. Endangered Species Act - Section 7 Consultation Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Consultation on the effects of issuance of a Corps Section 404 Permit for construction activities (fishway modification, diversion dam modification, fish screen construction and canal headworks rehabilitation) for the City of Albany's diversion dam and Santiam-Albany water canal in the South Santiam subbasin, on Upper Willamette River Spring Chinook Salmon and Upper Willamette River Steelhead. NMFS, Portland, Oregon.

NMFS (National Marine Fisheries Service). 2004f. Endangered Species Act - Section 7 Consultation Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Consultation on the NOAA Restoration Center Programs, all Pacific Northwest ESUs, Oregon, Washington, and Idaho. NMFS, Portland, Oregon.

NMFS (National Marine Fisheries Service). 2004g. Endangered Species Act – Section 7 Consultation Programmatic Biological and Conference Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation for NOAA Restoration Center Programs. NMFS, Portland, Oregon.

NMFS (National Marine Fisheries Service). 2005a. Endangered and threatened species; final listing determinations for 16 evolutionarily significant units of West Coast salmon, and final 4(d) protective regulations for threatened salmonid ESUs. Final rule. Federal Register 70:123(28 June 2005):37160-37204.

NMFS (National Marine Fisheries Service). 2005b. Endangered and threatened species; designation of critical habitat for 12 evolutionarily significant units of West Coast salmon and steelhead in Washington, Oregon, and California. Final rule. Federal Register 70:170(2 September 2005):52630-52858.

NMFS (National Marine Fisheries Service). 2005c. Endangered Species Act - Section 7 Consultation Biological Opinion and Magnuson-Stevens Act Essential Fish Habitat Consultation on impacts of treaty Indian and non-Indian fisheries in the Columbia River basin in years 2005-2007 by the States of Oregon and Washington, the Nez Perce Tribe, the Confederated Tribes of the Umatilla Indian Reservation, the Confederated Tribes of the Warm Springs Reservation of Oregon, and the Yakama Indian Nation. NMFS, Portland, Oregon.

NMFS (National Marine Fisheries Service). 2005d. Endangered and threatened wildlife and plants: endangered status for Southern Resident killer whales. Federal Register 70:222(18 November 2005):69903-69912.

NMFS (National Marine Fisheries Service). 2005e. Endangered Species Act – Section 7 Consultation Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Consultation for the operation and maintenance of 12 U.S. Bureau of Reclamation projects in the upper Snake River basin above Brownlee Reservoir. NMFS, Portland, Oregon.

NMFS (National Marine Fisheries Service). 2005f. Endangered Species Act - Section 7 Consultation, Biological Opinion and Magnuson-Stevens Act Essential Fish Habitat Consultation on issuance of Permit No. 1511 to the Oregon Department of Fish and Wildlife (ODFW). NMFS, Portland, Oregon.

NMFS (National Marine Fisheries Service). 2005g. Endangered Species Act - Section 7 Consultation, Biological Opinion and Magnuson-Stevens Act Essential Fish Habitat Consultation on: 1) Issuance of Permit 1498 to the Port of Bellingham (POB); 2) Issuance of Permit 1499 to the Battelle Marine Sciences Laboratory (BMSL); and 3) Issuance of Permit 1504 to the Pacific Shellfish Institute (PSI). NMFS, Portland, Oregon.

NMFS (National Marine Fisheries Service). 2005h. Endangered Species Act - Section 7 Consultation, Biological Opinion and Magnuson-Stevens Act Essential Fish Habitat Consultation on issuance of Permit No. 1515 to Charles Andrus, Water Works Consulting (WWC). NMFS, Portland, Oregon.

NMFS (National Marine Fisheries Service). 2005i. Endangered Species Act - Section 7 Consultation Biological Opinion and Magnuson-Stevens Act Essential Fish Habitat Consultation on: 1) Issuance of Permit 1403 to the Northwest Fisheries Science Center (NWFSC); 2) Issuance of Permit 1500 to the University of Idaho (U of I); and 3) Issuance of Permit 1502 to the U.S. Forest Service (USFS). NMFS, Portland, Oregon.

NMFS (National Marine Fisheries Service). 2005j. Endangered Species Act - Section 7 Consultation Biological Opinion and Magnuson-Stevens Act Essential Fish Habitat Consultation on: 1) Issuance of Permit No. 1322 to the NMFS Northwest Fisheries Science Center (NWFSC); 2) Issuance of Permit No. 1338 to the USFWS; 3)Issuance of Permit No. 1410 to the NWFSC; 4) Issuance of Permit No. 1479 to the USGS; 5) Issuance of Permit No. 1519 to the Columbia River Estuary Study Taskforce (CREST); 6) Issuance of Permit No. 1523 to the National Council for Air and Stream Improvements (NCASI); and 7) Issuance of Permit No. 1525 to the NWFSC. NMFS, Portland, Oregon.

NMFS (National Marine Fisheries Service). 2005k. Endangered Species Act - Section 7 Consultation Biological Opinion and Magnuson-Stevens Act Essential Fish Habitat Consultation on issuance of Permit No. 1531 to the Southern Oregon University (SOU). NMFS, Portland, Oregon.

NMFS (National Marine Fisheries Service). 2005l. Endangered Species Act - Section 7 Consultation Biological Opinion and Magnuson-Stevens Act Essential Fish Habitat Consultation on: 1) Issuance of Permit 1513 to Washington Trout (WT); 2) Issuance of Permit 1521 to Wyllie-Echeverria Associates (WEA); and 3) Issuance of Permit 1524 to the Northwest Fisheries Science Center (NWFSC). NMFS, Portland, Oregon.

NMFS (National Marine Fisheries Service). 2005m. Endangered Species Act - Section 7 Consultation Biological Opinion and Magnuson-Stevens Act Essential Fish Habitat Consultation on: 1) Issuance of Permit 1119 to the FWS; 2) Issuance of Permit to 1322 to the Northwest Fisheries Science Center (NWFSC); 3) Issuance to Permit 1410 to the NWFSC; 4) Issuance of Permit 1519 to the Columbia River Estuary Study Taskforce (CREST); 5) Issuance of Permit 1525 to the NWFSC; and 6) Issuance of Permit 1532 to the Columbia River Inter-Tribal Fish Commission (CRITFC). NMFS, Portland, Oregon.

NMFS (National Marine Fisheries Service). 2005n. Application of the "destruction or adverse modification" standard under Section 7(a)(2) of the Endangered Species Act. Memorandum to Regional Administrators from W. Hogarth, NMFS, Silver Spring, Maryland. November 7.

NMFS (National Marine Fisheries Service). 2005o. Endangered Species Act - Section 7 Consultation, Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Consultation on the effects of operating PacifiCorp’s Powerdale Hydroelectric Project through 2010 and decommissioning the Project in 2012. NMFS, Portland, Oregon.

NMFS (National Marine Fisheries Service). 2005p. Endangered Species Act - Section 7 Consultation, Biological Opinion, Conference Opinion, and Magnuson-Stevens Fishery Conservation and Management Act Consultation for operation of the Willamette Falls Hydroelectric Project (FERC No. 2233) through 2034, Willamette River, Clackamas County, Oregon. NMFS, Portland, Oregon.

NMFS (National Marine Fisheries Service). 2006a. Endangered and threatened species: final listing determinations for 10 distinct population segments of West Coast Steelhead. Final rule. Federal Register 71:3(5 January 2006):834-862.

NMFS (National Marine Fisheries Service). 2006b. Columbia River estuary recovery plan module. Final draft. NMFS, Portland, Oregon.

NMFS (National Marine Fisheries Service). 2006c. Endangered and threatened species; designation of critical habitat for Southern Resident killer whale. Federal Register 71:229(29 November 2006): 69054-69070

NMFS (National Marine Fisheries Service). 2006d. Endangered and threatened wildlife and plants: threatened status for Southern distinct population segment of North American Green Sturgeon. Federal Register 71:67(7 April 2006):17757-17766.

NMFS (National Marine Fisheries Service). 2006e. Recovery plan module: mainstem Columbia River hydropower projects. NMFS, Portland, Oregon.

NMFS (National Marine Fisheries Service). 2006f. Endangered Species Act - Section 7 Consultation Biological Opinion and Magnuson-Stevens Act Essential Fish Habitat Consultation on issuance of Permit 1535 to R2 Resources Consultants, Inc (R2). NMFS, Portland, Oregon.

NMFS (National Marine Fisheries Service). 2006g. Endangered Species Act - Section 7 Consultation Biological Opinion and Magnuson-Stevens Act Essential Fish Habitat Consultation on: 1) Issuance of Permit No. 1252 to the Washington Department of Transportation (WDOT); 2) Issuance of Permit No. 1290 to the Northwest Fisheries Science Center (NWFSC); 3) Issuance of Permit No. 1318 to the Oregon Department of Fish and Wildlife (ODFW); 4) Issuance of Permit No. 1322 to the NWFSC; 5) Issuance of Permit No. 1330 to the Weyerhaeuser Company (WeyCo); 6) Issuance of Permit No. 1338 to the USFWS; 7) Issuance of Permit No. 1379 to the CRITFC; 8) Issuance of Permit No. 1386 to the Washington Department of Ecology (WDOE); 9) Issuance of Permit No. 1410 to the NWFSC; 10) Issuance of Permit No. 1421 to the USFWS; 11) Issuance of Permit No. 1427 to the Oregon Department of Environmental Quality (ODEQ); 12) Issuance of Permit No. 1461 to the USGS; 13) Issuance of Permit No. 1478 to the USGS; 14) Issuance of Permit No. 1479 to the USGS; 15) Issuance of Permit No. 1484 to the Washington Department of Natural Resources (WDNR); 16) Issuance of Permit No. 1487 to the USFWS; 17) Issuance of Permit No. 1519 to the Columbia River Estuary Study Taskforce (CREST); 18) Issuance of Permit No. 1525 to the NWFSC. NMFS, Portland, Oregon.

NMFS (National Marine Fisheries Service). 2006h. Metrics and other information that NOAA Fisheries will consider in conducting the jeopardy analysis. Memorandum to the FCRPS BiOp Remand PWG (Policy Work Group) (*NWF v. NMFS* Remand) from D.R. Lohn, NMFS, Portland, Oregon. September 11.

NMFS (National Marine Fisheries Service). 2006i. NOAA's intended biological opinion standards and analysis. Memorandum to the FCRPS BiOp Remand PWG (Policy Work Group) (NWF v. NMFS Remand) from D.R. Lohn, NMFS, Portland, Oregon. July 12.

NMFS (National Marine Fisheries Service). 2006j. Endangered Species Act - Section 7 Consultation Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Consultation on interim operation, decommissioning, and removal of the Condit Hydroelectric Project, FERC No. 2342. NMFS, Portland, Oregon.

NMFS (National Marine Fisheries Service). 2006k. Endangered Species Act - Section 7 Consultation Biological Opinion and Section 10 Statement of Findings and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation on the Washington State Forest Practices Habitat Conservation Plan. NMFS, Portland, Oregon.

NMFS (National Marine Fisheries Service). 2006l. Endangered and threatened species; designation of critical habitat for the Southern Resident killer whale. Federal Register 71:115(15 June 2006):34571-34586.

NMFS (National Marine Fisheries Service). 2006m. Endangered Species Act - Section 7 Consultation Biological Opinion on the effects of the 2006 Pacific coast salmon plan on the Southern Resident killer whale (*Orcinus orca*) distinct population segment. NMFS, Northwest Region, Seattle, Washington.

NMFS (National Marine Fisheries Service). 2006n. Endangered Species Act - Section 7 Consultation Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act and Essential Fish Habitat Consultation on the issuance of Section 10(a)(1)(a) ESA Permits to conduct scientific research on the Southern Resident killer whale (*Orcinus orca*) distinct population segment and other endangered and threatened species. NMFS, Northwest Region, Seattle, Washington.

NMFS (National Marine Fisheries Service). 2006o. A framework for determining hatchery effects. NOAA Fisheries input to the Hatchery and Harvest Workgroup and the Policy Workgroup under the Federal Columbia River Power System Remand Collaboration. NMFS, Portland, Oregon.

NMFS (National Marine Fisheries Service). 2007a. Interim endangered and threatened species recovery planning guidance. NMFS, Silver Spring, Maryland.

NMFS (National Marine Fisheries Service). 2007b. Adaptive management for ESA-listed salmon and steelhead recovery: decision framework and monitoring guidance. NMFS, Northwest Fisheries Science Center, Seattle, Washington.

NMFS (National Marine Fisheries Service). 2007c. Endangered and threatened species; recovery plans. Federal Register 72:194(9 October 2007):57303-57307

NMFS (National Marine Fisheries Service). 2007d. Endangered Species Act – Section 7 Consultation Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Consultation: consultation on remand for operation of the Columbia River Power System and 19 Bureau of Reclamation Projects in the Columbia Basin. Draft. NMFS, Portland, Oregon.

NMFS (National Marine Fisheries Service). 2007e. Staff recommendation to relax the regional priority on summer flow augmentation for the upcoming FCRPS biological opinion and request NWFSC review of this recommendation. Memorandum from R. Graves, P. Wagner, and R. Domingue, NMFS, to B. Suzumoto, NMFS, Portland, Oregon. June 12.

NMFS (National Marine Fisheries Service). 2007f. Endangered Species Act - Section 7 Consultation Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Consultation on the operation of PacifiCorp and Cowlitz PUD's Lewis River hydroelectric projects for 50 years from the new licenses issue date(s). NMFS, Portland, Oregon

NMFS (National Marine Fisheries Service). 2007g. ESA consultation standards and guidance on the effects of the 2007 fishing season on ESA listed species. Letter to D. Hansen, Pacific Fishery Management Council from D.R. Lohn and R.R McInnis, NMFS, Northwest Region, Seattle, Washington. March 1.

NMFS (National Marine Fisheries Service). 2007h. Update on NMFS activities related to the conservation of lower Columbia River Chinook and coho. Letter to E. Bowles, Oregon Department of Fish and Wildlife and P. Anderson, Washington Department of Fish and Wildlife, from R.A. Turner, National Marine Fisheries Service, Lacey, Washington. November 28.

NMFS (National Marine Fisheries Service). 2007i. Endangered Species Act - Section 7 Consultation Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Consultation on the construction and operation of the Army Corps of Engineers fish trap at Cougar Dam. NMFS, Portland, Oregon.

NMFS (National Marine Fisheries Services). 2007j. Supplemental comprehensive analysis of the Federal Columbia River Power System and mainstem effects of Upper Snake and other tributary actions. Draft. NMFS, Portland, Oregon.

NMFS (National Marine Fisheries Service). 2007k. Makah Bay Offshore Wave Energy Pilot Project (Project No. 12751-000); Endangered Species Act, Essential Fish Habitat, and Marine Mammal Protection Act Determinations. Letter to K.D. Bose, Federal Energy Regulatory Commission, from K. Kirkendall, NMFS, Portland, Oregon. September 21.

NMFS (National Marine Fisheries Service). 2007l. Endangered Species Act – Section 7 Consultation Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation on the Habitat Restoration Program submitted by the Sate of Washington, Governor's Salmon Recovery Office, or ESA Section 4(d) Limit 8. NMFS, Portland, Oregon.

NMFS (National Marine Fisheries Service). 2008a. Endangered Species Act – Section 7 Consultation Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Consultation: consultation on remand for operation of the Columbia River Power System and 19 Bureau of Reclamation Projects in the Columbia Basin. NMFS, Portland, Oregon.

NMFS (National Marine Fisheries Service). 2008b. Endangered Species Act – Section 7 Consultation Biological Opinion and Magnuson-Stevens Fishery Conservation Management Act Consultation for the operation and maintenance of 12 U.S. Bureau of Reclamation Projects in the upper Snake River Basin above Brownlee Reservoir. NMFS, Portland, Oregon.

NMFS (National Marine Fisheries Service). 2008c. Endangered Species Act – Section 7 Consultation Biological Opinion And Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation. Consultation on Treaty Indian and Non-Indian Fisheries in the Columbia River Basin Subject To the 2008-2017 US v. Oregon Management Agreement. NMFS, Portland, Oregon.

NMFS (National Marine Fisheries Service). 2008d. Endangered Species Act - Section 7 and Magnuson-Stevens Act Essential Fish Habitat Consultation on a program to reduce pinniped impacts on ESA-listed salmon and steelhead below Bonneville Dam. NMFS, Portland, Oregon.

NMFS (National Marine Fisheries Service). 2008e. Endangered Species Act – Section 7 Biological Opinion on the effects of the Pacific Coast Salmon Plan and U.S. Fraser Panel Fisheries on the lower Columbia River coho and lower Columbia River Chinook evolutionarily significant units listed under the Endangered Species Act and Magnuson-Stevens Act Essential Fish Habitat Consultation. NMFS, Portland, Oregon.

NMFS (National Marine Fisheries Service). 2008f. Supplemental comprehensive analysis of the Federal Columbia River Power System and mainstem effects of USBR Upper Snake and other tributary actions. NMFS, Portland, Oregon.

NMFS (National Marine Fisheries Service). 2008g. Comprehensive Passage (COMPASS) Model – Version 1.1 Review DRAFT February 2008. NMFS, Northwest Fisheries Science Center, Seattle, Washington.

NMFS (National Marine Fisheries Service). 2008h. Endangered Species Act – Section 7 Programmatic Consultation Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation on the Habitat Improvement Program Oregon, Washington, and Idaho, CY2007-CY2012 (HIP II). NMFS, Portland, Oregon.

NMFS (National Marine Fisheries Service). 2008i. Guidance on the setting of the 2008 ocean salmon fishing season. Letter to D. Hansen, Pacific Fishery Management Council, from D.R. Lohn and R.R. McInnis, NMFS, Northwest Region, Seattle, Washington. February 26.

NMFS (National Marine Fisheries Service). 2008j. Recovery plan for Southern Resident killer whales (*Orcinus orca*). NMFS, Northwest Region, Seattle, Washington.

NMFS (National Marine Fisheries Service). 2008k. Chinook prey availability and biological requirements in Coastal Range of Southern Residents, re: Supplemental Comprehensive Analysis of Southern Resident killer whales. Memorandum to D.R. Lohn, NMFS, from D.D. Darm, NMFS, Northwest Region, Seattle, Washington. April 11.

NMFS (National Marine Fisheries Service). 2008l. Endangered and threatened species; recovery plans; final recovery plan for Southern Resident killer whales. Federal Register 73:16(24 January 2008):4176-4177.

NMFS (National Marine Fisheries Service). 2008m. Endangered Species Act - Section 7 Consultation Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation on the re-issuance of regional general permit 3, authorizing 23 maintenance activities in Suisun Marsh, Solano County, California. NMFS, Southwest Region, Long Beach, California.

NMFS (National Marine Fisheries Service). 2008n. Anadromous salmonid passage facility design. NMFS, Northwest Region, Portland, Oregon.

NMFS (National Marine Fisheries Service). 2008o. Partial approval of request to authorize the intentional lethal taking of California sea lions that prey on salmon and steelhead listed under the Endangered Species Act. Letter to R. Elicker, Oregon Department of Fish and Wildlife, from J.H. Lecky, National Marine Fisheries Service, Silver Spring, Maryland. March 17.

NMFS (National Marine Fisheries Service). 2008p. Marine mammals; pinniped removal authority; partial approval of application. Federal Register 73:57(24 March 2008):15483-15488.

NOAA (National Oceanic and Atmospheric Administration). 2008. Time-series of MEI conditions from 1950 through November 2007. NOAA, Physical Sciences Division, Earth System Research Laboratory, Boulder, Colorado

Norman, S.A., C.E. Bowlby, M.S. Brancato, J. Calambokidis, D. Duffield, P.J. Gearin, T.A. Gornall, M.E. Gosho, B. Hanson, J. Hodder, S.J. Jeffries, B. Lagerquist, D.M. Lanbourn, B. Mate, B. Norberg, R.W. Osborne, J.A. Rash, S. Riemer, and J. Scordino. 2004. Cetacean strandings in Oregon and Washington between 1930 and 2002. Journal of Cetacean Research and Management 6(1):87-99.

Northwest Indian Fisheries Commission and WDFW (Washington Department of Fish and Wildlife). 1998. Salmonid disease control policy of the fisheries co-managers of Washington State. WDFW, Olympia.

NPCC (Northwest Power and Conservation Council). 2003. Mainstem amendments to the Columbia River Basin Fish and Wildlife Program. NPCC, Portland, Oregon.

NPCC (Northwest Power and Conservation Council). 2004. White Salmon subbasin management plan. NPCC, Portland, Oregon.

NPCC (Northwest Power and Conservation Council). 2007. Carbon dioxide footprint of the Northwest power system. NPCC, Portland, Oregon.

NPPC (Northwest Power Planning Council). 1992. Information on water quality and quantity contained in the salmon and steelhead subbasin plans (above Bonneville Dam). NPPC, Report 93-8, Portland, Oregon

NRC (National Research Council). 1995. Making ESA decisions in the face of uncertainty. Pages 148-178 *in* Science and the Endangered Species Act. National Academy Press, Washington, D.C.

NRC (National Research Council). 1996. Upstream: salmon and society in the Pacific Northwest. National Academy Press, Washington, D.C.

NRC (National Research Council). 2003. Sources of sound inthe ocean and long-term trends in ocean noise. Pages 27-82 *in* Ocean noise and marine mammals. National Academy Press, Washington, D.C.

O'Neill, S., G. Ylitalo, M. Krahn, J. West, J. Bolton, and D. Brown. 2005. Elevated levels of persistent organic pollutants in Puget Sound salmon: the importance of residency in Puget Sound. PowerPoint presentation.

ODEQ (Oregon Department of Environmental Quality). 2007. Guidance for assessing bioaccumulative chemicals of concern in sediment. ODEQ, Portland, Oregon.

ODFW (Oregon Department of Fish and Wildlife) and WDFW (Washington Department of Fish and Wildlife). 2007. Status report: Columbia River fish runs and fisheries, 1938-2002. Tables only.

ODFW (Oregon Department of Fish and Wildlife). 1999. State of Oregon endangered species listing decision for lower Columbia River coho salmon; Oregon Fish and Wildlife Commission action requested. ODFW, Portland.

ODFW (Oregon Department of Fish and Wildlife). 2001a. Fisheries management and evaluation plan. Upper Willamette River spring Chinook in freshwater fisheries of the Willamette Basin and lower Columbia River Mainstem. Final draft. ODFW, Portland, Oregon.

ODFW (Oregon Department of Fish and Wildlife). 2001b. Fisheries management and evaluation plan. Upper Willamette River winter steelhead in sport fisheries of the upper Willamette Basin. Final draft. ODFW, Portland, Oregon.

ODFW (Oregon Department of Fish and Wildlife). 2006a. Oregon native fish status report, volume 1: species management unit summaries, mid Columbia spring Chinook SMU. ODFW, Salem.

ODFW (Oregon Department of Fish and Wildlife). 2006b. Draft guidance regarding the relative impact of limiting factors and threats to viability of seven species of Federally listed salmon and steelhead in Oregon, methodology and results of an expert panel process. Edited by J. Nicholas and J. Rodgers. ODFW, Salem.

Ogden, D.A., E.E. Hockersmith, G.A. Axel, B.J. Burke, K.E. Frick, and B.P. Sandford. 2007. Passage behavior and survival for river-run subyearling Chinook salmon at Ice Harbor Dam, 2005. Report to the U.S. Army Corps of Engineers by the National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, Washington.

Olesiuk, P.F., M.A. Bigg, and G.M. Ellis.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 Community (special issue).

Olesiuk, P.F., G.M. Ellis, and J.K.B. Ford. 2005. Life history and population dynamics of Northern Resident killer whales (*Orcinus orca*) in British Columbia. Fisheries and Oceans Canada, Nanaimo, British Columbia.12:209-244.

Olson, D.E., B. Spateholts, M. Paiya, and D.E. Campton. 2004. Salmon hatcheries for the 21st century: a model at Warm Springs National Fish Hatchery. American Fisheries Society Symposium 44:581-598.

Oregon (State of Oregon). 2008. Comments by the State of Oregon on the "Endangered Species Act - Section 7 Consultation Biological Opinion-Remand Draft" and on the associated "Supplemental Comprehensive Analysis of the Federal Columbia Power System and Mainstem Effects of the Upper Snake and Other Tributary Actions," both documents dated October 30, 2007. Oregon, Salem.

Osborne, R.W. 1999. A historical ecology of Salish Sea "resident" killer whales (*Orcinus orca*): with implications for management. Doctoral dissertation. University of Victoria, Victoria, British Columbia.

OWRD (Oregon Water Resources Department). 1993. Weak stocks and water supply conflicts. Memorandum to D. Moscowitz et al. from T. Kline and B. Fuji, OWRD, Salem, Oregon. September 17.

Park, D.L. 1969. Seasonal changes in downstream migration of age-group 0 Chinook salmon in the upper Columbia River. Transactions of the American Fisheries Society 98:315-317.

Paulsen, C.M., R. Hinrichsen, and T.R. Fisher. 2007. Measure twice, estimate once: Pacific salmon population viability analysis for highly variable populations. Transactions of the American Fisheries Society 136:346–364.

PCSRF (Pacific Coastal Salmon Recovery Fund). 2005. Report to Congress: Pacific Coastal Salmon Recovery Fund FY 2000-2004. National Marine Fisheries Service, Seattle, Washington.

PCSRF (Pacific Coastal Salmon Recovery Fund). 2006. Report to Congress: Pacific Coastal Salmon Recovery Fund FY 2000-2005. National Marine Fisheries Service, Seattle, Washington.

PCSRF (Pacific Coastal Salmon Recovery Fund). 2007. Report to Congress: Pacific Coastal Salmon Recovery Fund FY 2000-2006. National Marine Fisheries Service, Seattle, Washington.

Peltz, L. and J. Miller. 1990. Performance of half-length coded wire tags in a pink salmon hatchery marking program. Pages 244-252 *in* N.C. Parker, A.E. Giorgi, R.C. Heidinger, D.B. Jester, Jr., E.D. Prince, and G.A. Winans, editors. Fish-marking techniques. American Fisheries Society, Symposium 7, Bethesda, Maryland.

Perkins, W.A., and M.C. Richmond. 2001. Long-term, one-dimensional simulation of lower Snake River temperatures for current and unimpounded conditions. Prepared for the U.S. Department of Energy by the Pacific Northwest National Laboratory, Richland, Washington.

Perry, R.W., A. Braatz, M. Novick, J. Lucchesi, G. Rutz, R. Koch, J. Schei, N. Adams, and D. Rondorf. 2007. Survival and migration behavior of juvenile salmonids at McNary Dam, 2005. Final report of research to the U.S. Army Corps of Engineers, by the U.S. Geological Survey, Western Fisheries Research Center, Cook, Washington.

Peterman, R.M. 1984. Density-dependent growth in early ocean life of sockeye salmon (*Oncorhynchus nerka*). Canadian Journal of Fisheries and Aquatic Sciences 41:1825-1829.

Petrosky, C.E., H. Schaller, and P. Budy. 2001. Productivity and survival rate trends in the freshwater spawning and rearing stage of Snake River Chinook salmon (*Oncorhynchus tshawytscha*). Canadian Journal of Fisheries and Aquatic Sciences 58:1196-1207.

Pettit, S.W. 1977. Comparative reproductive success of caught-and-released and unplayed hatchery female steelhead trout (*Salmo gairdneri*) from the Clearwater River, Idaho. Transactions of American Fisheries Society 106(5):431-435.

PFMC (Pacific Fishery Management Council). 1998a. Final environmental assessment: regulatory review for Amendment 11 to Pacific Coast groundfish fishery management plan. PFMC, Portland, Oregon.

PFMC (Pacific Fishery Management Council). 1998b. Amendment 8 (to the Northern Anchovy Fishery Management Plan) incorporating a name change to coastal pelagic species fishery management plan. PFMC, Portland, Oregon.

PFMC (Pacific Fishery Management Council). 1998c. Essential fish habitat, coastal pelagic species. PFMC, Portland, Oregon.

PFMC (Pacific Fishery Management Council). 1999. Amendment 14 to the Pacific coast Salmon Plan, appendix A: description and identification of essential fish habitat, adverse impacts and recommended conservation measures for salmon. PFMC, Portland, Oregon.

PFMC (Pacific Fishery Management Council). 2008. Preseason report III: analysis of council adopted management measures for 2008 ocean salmon fisheries. Prepared by the Salmon Technical Team for PFMC, Portland, Oregon.

Plumb, J.M., A.C. Braatz, J.N. Lucchesi, S.D Fielding, J.M. Sprando, G.T George, N.S. Adams, and D.W. Rondorf. 2003. Behavior of radio-tagged juvenile Chinook salmon and steelhead and performance of a removable spillway weir at Lower Granite Dam, Washington, 2002. Draft annual report of research to the U.S. Army Corps of Engineers, Walla Walla, Washington, by the U.S. Geological Survey, Cook, Washington.

Plumb, J.M., A.C. Braatz, J.N. Lucchesi, S.D Fielding, A.D. Cochran, T.K. Nation, J.M. Sprando, J.L. Schei, R.W. Perry, N.S. Admas, and D.W. Rondorf. 2004. Behavior of radio-tagged juvenile Chinook salmon and steelhead and performance of a removable spillway weir at Lower Granite Dam, Washington, 2003. Final report of research to the U.S. Army Corps of Engineers by the U.S. Geological Survey, Cook, Washington.

Poe, T.P., H.C. Hansel, S. Vigg, D.E. Palmer, and L.A. Prendergast. 1991. Feeding of predaceous fishes on out-migrating juvenile salmonids in John Day Reservoir, Columbia River. Transactions of the American Fisheries Society 120(4):405-420.

Poe, T.P., M.G. Mesa, R.S. Shively, and R.D. Peters. 1994. Development of biological criteria for siting and operation of juvenile bypass systems: implications for protecting juvenile salmonids from predation. Proceedings of a symposium on fish passage responsibility and technology. American Fisheries Society Annual Meeting 1993:169-176.

Prentice, E.F. and D.L. Park. 1984. A study to determine the biological feasibility of a new fish tagging system. Annual report of research, 1983-1984.

Prentice, E.F., T.A. Flagg, and C.S. McCutcheon. 1987. A study to determine the biological feasibility of a new fish tagging system, 1986-1987. Annual report of research to the Bonneville Power Administration, Portland, Oregon.

Prentice, E.F., T.A. Flagg, and C.S. McCutcheon. 1990. Feasibility of using implantable passive integrated transponder (PIT) tags in salmonids. Pages 317-322 *in* N.C. Parker, A.E. Giorgi, R.C. Heidinger, D.B. Jester, Jr., E.D. Prince, and G.A. Winans, editors. Fish-marking techniques. American Fisheries Society, Symposium 7, Bethesda, Maryland.

PWG (Policy Workgroup of the of the NWF v. NMFS Collaboration Process). 2005. Federal defendant's first remand report: update on the nature and scope of the FCRPS proposed action. PWG, Portland, Oregon.

Quinn, T.P. and N.P. Peterson. 1996. The influence of habitat complexity and fish size on over-winter survival and growth of individually marked juvenile coho salmon (*Oncorhynchus kisutch*) in Big Beef Creek, Washington. Canadian Journal Fisheries and Aquatic Sciences 53:1555-1564.

Raymond, H.L. 1968. Migration rates of yearling Chinook salmon in relation to flows and impoundments in the Columbia and Snake Rivers. Transactions of the American Fisheries Society 97:356-359.

Raymond, H.L. 1969. Effect of John Day reservoir on the migration rate of juvenile Chinook salmon and steelhead in the Columbia River. Transactions of the American Fisheries Society 98(3):513-514.

Raymond, H.L. 1979. Effects of dams and impoundments on migrations of juvenile Chinook salmon and steelhead from the Snake River, 1966 to 1975. Transactions of the American Fisheries Society 108(6):505-529.

Raymond, H.L. 1988. Effects of hydroelectric development and fisheries enhancement on spring and summer Chinook salmon and steelhead in the Columbia River basin. North American Journal of Fisheries Management 8(1):1-23.

Reijnders, P.J.H. and A. Aguilar. 2002. Pollution and marine mammals. Pages 948-957 *in* W.F. Perrin, B. Wursig, and J.G.M. Thewissen, editors. Encyclopedia of marine mammals. Academic press, San Diego, California.

Reingold, M. 1975. Effects of displacing, hooking, and releasing on migrating adult steelhead trout. Transactions of the American Fisheries Society 104(3):458-460.

Rich, W. H. 1920. Early history and seaward migration of Chinook salmon in the Columbia and Sacramento rivers. Bulletin of the Bureau of Fisheries 37:1-74.

Ricker, W.E. 1975. Computation and interpretation of biological statistics of fish populations. Bulletin of the Fisheries Research Board of Canada 191:280-296.

Rieman, B.E., R.C. Beamesderfer, S. Vigg, and T.P. Poe. 1991. Estimated loss of juvenile salmonids to predation by northern squawfish, walleyes, and smallmouth bass in John Day Reservoir, Columbia River. Transactions of the American Fisheries Society 120:448-458.

Roby, D.D., D.E. Lyons, D.P. Craig, K. Collis, and G.H. Visser. 2003. Quantifying the effects of predators on endangered species using a bioenergetics approach: Caspian terns and juvenile salmonids in the Columbia River estuary. Canadian Journal of Zoology 81:250-265.

Roby, D.D., K. Collis, D.E. Lyons, Y. Suzuki, J.Y. Adkins, L. Reinalda, N. Hostetter, and L. Adrean. 2008. Research, monitoring, and evaluation of avian predation on salmonid smolts in the lower and mid-Columbia River. Draft 2007 season summary. Prepared for the Bonneville Power Administration by U.S. Geological Survey - Oregon Cooperative Fish and Wildlife Research Unit, Oregon State University, Corvallis.

Rondorf, D.W. and W.H. Miller. 1994. Identification of the spawning, rearing and migratory requirements of fall Chinook salmon in the Columbia River Basin. Annual report prepared for the Bonneville Power Administration, Portland, Oregon.

Ross, P.S., G.M. Ellis, M.G. Ikonomou, L.G. Barrett-Lennard, and R.F. Addison. 2000. High PCB concentrations in free-ranging Pacific killer whales, *Orcinus orca*: effects of age, sex, and dietary preference. Marine Pollution Bulletin 40(6):504-515.

Ruggerone, G.T. 1986. Consumption of migrating juvenile salmonids by gulls foraging below a Columbia River dam. Transactions of the American Fisheries Society 115:736-742.

Ruggerone, G.T., M. Zimmerman, K.W. Myers, J.L. Nielsen, and D.E. Rogers. 2003. Competition between Asian pink salmon (*Oncorhynchus gorbuscha*) and Alaskan sockeye salmon (*O. nerka*) in the North Pacific Ocean. Fisheries Oceanography 12(3):209-219.

Ruggerone, G.T. and F.A. Goetz. 2004. Survival of Puget Sound Chinook salmon (*Oncorhynchus tshawytscha*) in response to climate-induced competition with pink salmon (*Oncorhynchus gorbuscha*). Canadian Journal of Fisheries and Aquatic Science 61:1756-1770.

Ryan, B.A., M.C. Carper, T.M. Gossen, M.G. Callaizakis, A.S. Cameron, E.P. Nunnallee, B.P. Sanford, and G.M. Matthews. 2006. Detection of passive integrated transponder (PIT) tags on piscivorous bird colonies in the Columbia River Basin, 2003-2005. National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, Washington.

Ryan, B.A., M.C. Carper, B.P. Sanford, and G.M. Mathews. 2007. Detection of passive integrated transponder (PIT) tags on piscivorous bird colonies in the Columbia River Basin, 2006. National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, Washington.

Sandford, B.P., and S.G. Smith. 2002. Estimation of smolt-to-adult return percentages for Snake River basin anadromous salmonids, 1990–1997. Journal of Agricultural, Biological, and Environmental Statistics 7(2):243–263.

Saulitis, E., C. Matkin, L. Barrett-Lennard, K. Heise, and G. Ellis. 2000. Foraging strategies of sympatric killer whale (*Orcinus orca*) population in Prince William Sounds, Alaska. Marine Mammal Science 16(1):94-109.

Sauter, S.T., R.M. Schrock, J.H. Petersen, and A.G. Maule. 2004. Assessment of smolt condition: biological and environmental interactions. Final report: the impact of prey and predators on juvenile salmonids. U.S. Geological Survey, Cook, Washington.

Schaller, H., P. Wilson, S. Haeseker, C.L. Petrosky, E. Tinus, T. Dalton, R. Woodin, E. Weber, N. Bouwes, T. Berggren J. McCann, S. Rassk, H. Franzoni, and P. McHugh. 2007. Comparative survival study (CSS) of PIT-tagged spring/summer Chinook and steelhead in the Columbia River basin. Ten-year retrospective analyses report. Prepared for the Bonneville Power Administration, Portland, Oregon.

Scheffer, V.B. and J.W. Slipp. 1948. The whales and dolphins of Washington State with a key to the cetaceans of the West Coast of North America. The American Midland Naturalist 39(2):257-337.

Scheuerell, M.D., J.G. Williams. 2005. Forecasting climate-induced changes in the survival of Snake River spring/summer Chinook salmon (*Oncorhynchus tshawytscha*). Fisheries Oceanography 14(6):448-457.

Scheuerell, M.D., and R.W. Zabel. 2007. Seasonal differences in migration timing lead to changes in the smolt-to-adult survival of two anadromous salmonids (*Onorhynchus spp*). National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, Washington.

Schill, D.J., and R.L. Scarpella. 1995. Wild trout regulation studies. Annual performance report. Idaho Department of Fish and Game, Boise.

Schisler, G.J. and E.P. Bergersen. 1996. Post release hooking mortality of rainbow trout caught on scented artificial baits. North American Journal of Fisheries Management 16(3):570-578.

Schmidt, R.D. 2005. Application of ESPA model curtailment scenario results to estimate impacts of groundwater pumping on Snake River depletions above Minidoka Dam. U.S. Department of Interior, Bureau of Reclamation, Boise, Idaho.

Schreck, C.B., H.W. Li, C.S. Sharpe, K.P. Currens, P.L. Hulett, S.L. Stone, and S.B. Yamada. 1986. Stock identification of Columbia River Chinook salmon and steelhead trout. Final report to Bonneville Power Administration,, Portland, Oregon.

Schroeder, R.K., K.R. Kenaston, and R.B. Lindsay. 2000. Spring Chinook salmon in the Willamette and Sandy Rivers. October 1998 through September 1999. Annual progress report, Fish Research Project Oregon. Oregon Department of Fish and Wildlife, Portland.

Selbie, D.T., B.A. Lewis, J.P. Smol, and B.P. Finney. 2007. Long-term population dynamics of the endangered sockeye salmon: evidence of past influences on stock decline and impediments to recovery. Transactions of the American Fisheries Society 136:800-821.

Shaklee, J.B. 1991. Simulation and other analysis of the 1991 Columbia River spring Chinook GSI baseline. Technical Report 115. Washington Department of Fisheries, Olympia.

Shaklee, J.B., C. Smith, S. Young, C. Marlowe, C. Johnson, and B.B. Sele. 1995. A captive broodstock approach to rebuilding a depleted Chinook stock. American Fisheries Society Symposium 15:567.

Sharber, N.G. and S.W. Carothers. 1988. Influence of electrofishing pulse shape on spinal injuries in adult rainbow trout. North American Journal of Fisheries Management 8:117-122.

Sharber, N.G., S.W. Carothers, J.P. Sharber, J.C. DeVos, Jr. and D.A. House. 1994. Reducing electrofishing-induced injury of rainbow trout. North American Journal of Fisheries Management 14:340-346.

Sherwood, C., D.J.B. Harvey, P. Hamilton, and C. Simenstad. 1990. Historical changes in the Columbia River estuary. Progress in Oceanography 25:299-352.

Simenstad, C.A., K.L. Fresh, and E.O. Salo. 1982. The role of Puget Sound and Washington coastal estuaries in the life history of Pacific salmon: an unappreciated function. Pages 343-364 *in* V.S. Kennedy, editor. Estuarine Comparisons. Academic Press, New York.

Simenstad, C., L. Small, and C. McIntyre. 1990. Consumption processes and food web structure in the Columbia River estuary. Progress in Oceanography 25:271-298.

Simmons, D. 2008. Harvest impact distribution tables. Memorandum to P. Dygert, National Marine Fisheries Service, from D. Simmons, National Marine Fisheries Service, Lacey, Washington. April 17.

Small, M.P., A.E. Frye, J.F. Von Bargen, and S.F. Young. 2006. Genetic structure of chum salmon (*Oncorhyncus keta*) populations in the lower Columbia River: are chum salmon in Cascade tributaries remnant populations? Conservation Genetics 7:65-78.

Smith, S.G, W.D. Muir, E.E. Hockersmith, R.W. Zabel, R.J. Graves, C.V. Ross, W.P. Connor, and B.D. Arnsberg. 2003. Influence of river conditions on survival and travel time of Snake River fall Chinook salmon. North American Journal of Fisheries Management 23:939-961.

Smith, S.G. 2008. 2007 transport rate. Communication to R. Graves, National Marine Fisheries Service, from S.G. Smith, National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, Washington. April 7.

Snake River Water Rights Act. Public Law 108-447 118 Stat. 3431 (2004).

Snow, C. and M. Humling. 2006. Methow River basin steelhead and spawning ground surveys in 2005. Memorandum to R. Klinge and S. Bickford, Washington Department of Fish and Wildlife, from C. Snow and M. Humling. Washington Department of Fish and Wildlife, Methow Field Office, Twisp. March 16.

Snyder, D.E. 1995. Impacts of electrofishing on fish. Fisheries 20(1):26-27.

SOS (Save Our Wild Salmon). 2008. Comments on the "Endangered Species Act - Section 7 Consultation: Biological Opinion - Remand Draft; Consultation on Remand for Operation of the Federal Columbia River Power System, 11 Bureau of Reclamation Projects in the Columbia Basin and ESA Section 10(a)(1)(A) Permit for Juvenile Fish Transportation Program" and on "Endangered Species Act - Section 7 Consultation: Draft Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Consultation" prepared by the National Marine Fisheries Service. SOS, Boise, Idaho.

Spence, B.C., G.A. Lomnicky, R.M Hughes, and R.P. Novitzki. 1996. An ecosystem approach to salmonid conservation. ManTech Environmental Research Services Corporation, Corvallis, Oregon.

Stansell, R.J. 2004. Evaluation of pinniped predation on adult salmonids and other fish in the Bonneville Dam tailrace, 2002-2004. Draft report to U.S. Army Corps of Engineers, Cascade Locks, Oregon.

Stansell, R. 2007a. Latest information on sea lion predation. Communication to R. Graves, National Marine Fisheries Service from R. Stansell, U.S. Army Corps of Engineers, Portland, Oregon. September 13.

Stansell, R. 2007b. Latest information on sea lion predation. Communication to R. Graves, National Marine Fisheries Service from R. Stansell, U.S. Army Corps of Engineers, Portland, Oregon. September 17.

Steig, T.W., J.W. Horchik, G.W. Tritt, J.R. Skalski, and R. Ngouenet. 2003. Comparison of PIT tagged and acoustic tagged juvenile Chinook, steelhead, and sockeye salmon passing Rocky Reach Dam in 2002. Final report to Chelan County Public Utility District No.1, by Hydroacoustic Technology, Seattle, Washington.

Steig, T.W., P.A. Nealson, K.K. Kumagai, B.J. Rowdon, L.S. Klein, and B.D. McFadden. 2007. Route specific passage of juvenile steelhead and sockeye salmon using acoustic tag methodologies at Rocky Reach and Rock Island Dams in 2006. Final report for Chelan County Public Utility District No. 1, by Hydroacoustic Technology, Seattle, Washington.

Steig, T.W., P.A. Nealson, K.K. Kumagai, J.W. Horchik, J.C. Sweet, and C.P. Mott. 2006a. Route specific passage of juvenile steelhead, Chinook, and sockeye salmon using acoustic tag methodologies at Rocky Reach and Rock Island Dams in 2004. Final report to Chelan County Public Utility District No.1, by Hydroacoustic Technology, Seattle, Washington.

Steig, T.W., P.A. Nealson, K.K. Kumagai, L.S. Brown, G.W. Tritt, K.C. Molitor, J.W. Horchik, M.A. Timko, J.C. Sweet, and C.P. Mott. 2006b. Route specific passage of juvenile steelhead, Chinook, and sockeye salmon using acoustic tag methodologies at Rocky Reach and Rock Island Dams in 2005. Final Report to Chelan County Public Utility District No.1, by Hydroacoustic Technology, Seattle, Washington.

Steigenberger, L.W. and P.A. Larkin. 1974. Feeding activity and rates of digestion of northern squawfish (*Ptychocheilus oregonensis*). Journal of Fisheries Research Board of Canada 31(4):411-420.

Stephenson, J., D. Hatch, R. Branstetter, J. Whiteaker, S. Narum, D. Fast, J. Blodgett, B. Bosch, M. Johnston, T. Newsome, D. Lind, B. Rogers, C. Fisher, R. Dasher, D. Best, J. Lovtang, and M. Gauvin. 2007. An evaluation of the reproductive success of natural-origin, hatchery-origin, and kelt steelhead in the Columbia Basin. 2006 annual report prepared for the Bonneville Power Administration by the Columbia River Inter-Tribal Fish Commission, Portland, Oregon.

Stier, J., and R. Hinrichsen. 2008. A method for estimating population productivity changes resulting from certain improvements to artificial propagation programs. Bonneville Power Administration, Portland, Oregon.

Stolte, L.W. 1973. Differences in survival and growth of marked and unmarked coho salmon. Progressive Fish-Culturist 35(4):229-230.

Strange, C. D., and G. J. Kennedy. 1981. Stomach flushing of salmonids: a simple and effective technique for the removal of the stomach contents. Fisheries Management 12(1):9–15.

Tabor, R.A., R.S. Shively, and T.P. Poe. 1993. Predation of juvenile salmonids by smallmouth bass and northern squawfish in the Columbia River near Richland, Washington. North American Journal of Fisheries Management 13:831-838.

TAC (*U.S. v. Oregon* Technical Advisory Committee). 2008. Biological assessment of incidental impacts on salmon species listed under the Endangered Species Act in the 2008-2017 non-Indian and treaty Indian fisheries in the Columbia River Basin.

Taki, D., A.E. Kohler, R.G. Griswold, and K. Gilliland. 2006. Snake River sockeye salmon habitat and limnological research: 2005 annual progress report. Prepared for Bonneville Power Administration, Portland, Oregon.

Taylor, G., and R.A. Barnhart. 1999. Mortality of angler caught and released steelhead. California Cooperative Fish and Wildlife Research Unit, Arcata.

Taylor, M. 2004. Southern Resident orcas: population change, habitat degradation and habitat protection. Report of the International Whaling Commission SC/56/E32.

Taylor, M.J., and K.R. White. 1992. A meta-analysis of hooking mortality of nonanadromous trout. North American Journal of Fisheries Management 12:760-767.

Thomas, D.W. 1981. Historical analysis of the Columbia River estuary: an ecological approach. Columbia River Estuary Study Taskforce, Astoria, Oregon.

Thompson, K.G., E.P. Bergersen, R.B. Nehring, and D.C. Bowden. 1997. Long-term effects of electrofishing on growth and body condition of brown and rainbow trout. North American Journal of Fisheries Management 17:154-159.

Thurow, R. 1987. Completion report: evaluation of the South Fork Salmon River steelhead trout fishery restoration program. Performed for the U.S. Department of the Interior, Fish and Wildlife Service. Lower Snake River fish and wildlife compensation plan. Idaho Department of Fish and Game, Boise.

Tiffan, K.F., D.W. Rondorf, W.P. Connor, and H.L. Burge. 1999. Post-release attributes and survival of hatchery and natural fall Chinook salmon in the Snake River. Annual report. Prepared for Bonneville Power Administration, Portland, Oregon.

Timko, M.A., L.S. Brown, C.D. Wright, R.R. O'Connor, C.A. Fitzgerald, M.L. Meager, S.E. Rizor, P.A. Nealson, and S.V. Johnston. 2007. Analysis of juvenile Chinook, steelhead, and sockeye salmon behavior using acoustic tags at Wanapum and Priest Rapids Dams, 2006. Final report for Public Utility District No. 2 of Grant County, by Hydroacoustic Technology, Seattle, Washington.

Turner, R. 2008. Hatchery return of Chinook salmon to the Columbia River. Communication to Alison Agness, National Marine Fisheries Service, from R. Turner, National Marine Fisheries Service, Portland, Oregon. April 4.

UCSRB (Upper Columbia Salmon Recovery Board). 2007. Upper Columbia spring Chinook salmon and steelhead recovery plan. UCSRB, Wenatchee, Washington.

USBR (U.S. Department of the Interior, Bureau of Reclamation). 1997. A combined report: a description of Bureau of Reclamation system operation above Milner Dam January 1996 (revised December 1997); a description of Bureau of Reclamation system operation of the Boise and Payette Rivers November 1996 (revised December 1997); a description of system operation miscellaneous tributaries of the Snake River April 1997 (revised December 1997). USBR, Boise, Idaho.

USBR (U.S. Department of the Interior, Bureau of Reclamation). 1998. Biological assessment on Bureau of Reclamation operations and maintenance in the Snake River basin above Lower Granite reservoir. USBR, Boise, Idaho.

USBR (U.S. Department of the Interior, Bureau of Reclamation). 1999. Cumulative effects of water use: an estimate of the hydrologic impacts of water resource development in the Columbia River basin. Final report. USBR, Boise, Idaho.

USBR (U.S. Department of the Interior, Bureau of Reclamation). 2001. Amended biological assessment on operations and maintenance in the Snake River basin above Brownlee Reservoir. USBR, Boise, Idaho.

USBR (U.S. Department of the Interior, Bureau of Reclamation). 2004a. Biological assessment for Bureau of Reclamation operations and maintenance in the Snake River basin above Brownlee Reservoir. USBR, Boise, Idaho.

USBR (U.S. Department of the Interior, Bureau of Reclamation). 2004b. Operations description for Bureau of Reclamation projects in the Snake River basin above Brownlee Reservoir. USBR, Boise, Idaho.

USBR (U.S. Bureau of Reclamation). 2007. Biological assessment for Bureau of Reclamation operations and maintenance in the Snake River basin above Brownlee Reservoir. USBR, Boise, Idaho.

USDA (U.S. Department of Agriculture). 2003. Final forest plan revision: Sawtooth National Forest. Pages III:1-123. USDA, Payette and Sawtooth National Forests, Twin Falls, Idaho.

USDOI (U.S. Department of the Interior). 2007. Statement of findings: Snake River Water Rights Act of 2004. Federal Register 72:93(15 May):27325.

US District Court (D. Oregon). 2005. US v. Oregon. Civil No. 68-513KI. 2005-2007 interim management agreement for upriver Chinook, sockeye, steelhead, coho and white sturgeon. May 11.

US District Court, (D. Oregon). 2006. American Rivers v. NOAA Fisheries, CV-04-0061-RE. Opinion and Order. May 23.

USFWS (U.S. Fish and Wildlife Service). 2005.Caspian tern management to reduce predation of juvenile salmonids in the Columbia River estuary. Final environmental impact statement. USFWS, Portland, Oregon.

US v Oregon Workgroup. 2008. Estimated survival adjustments for expected future steelhead and Snake River fall Chinook harvest rates. Memorandum to Bruce Suzumoto, National Marine Fisheries Service, from U.S. v. Oregon Workgroup. February 8.

Utter, F., G. Milner, G. Stahl, and D. Teel. 1989. Genetic population structure of Chinook salmon, *Oncorhynchus tshawytscha*, in the Pacific Northwest. Fisheries Bulletin 87(2): 239-264.

Van Hyning, J.M. 1973. Factors affecting the abundance of fall Chinook salmon in the Columbia River. Research Report of Fisheries Commission of Oregon 4(1):3-87.

Varanasi, U., E. Casillas, M.R. Arkoosh, T. Hom, D.A. Misitano, D.W. Brown, S-L Chan, T. L. Collier, B.B. McCain and J.E. Stein. 1993. Contaminant exposure and associated biological effects in juvenile Chinook salmon (*Oncorhynchus tshawytscha*) from urban and nonurban estuaries of Puget Sound. U.S. Dept. of Commerce, NOAA Tech. Memo., NMFS-NWFSC-8, 112p.

Vigg, A. and C.C. Burley. 1991. Temperature dependent maximum daily consumption of juvenile salmonids by northern squawfish (*Ptychocheilus oregonensis*) from the Columbia River. Canadian Journal of Fisheries and Aquatic Sciences 48:2491-2498.

Vigg, S., T.P. Poe, L.A. Prendergast, and H.C. Hansel. 1991. Rates of consumption of juvenile salmonids and alternate prey fish by northern squawfish, walleyes, smallmouth bass, and channel catfish in John Day Reservoir, Columbia River. Transactions of the American Fisheries Society 120:421-438.

Volkhardt, G., D. Rawding, L. Kishimoto, P. Hanratty, P. Topping, M. Ackley, C. Kinsel, K. Kiyohara, C. Sharp, J. Serl, J. Henning, and J. Holowatz. 2008. 2008 wild coho forecasts for Puget Sound, the Washington Coast, and lower Columbia. Washington Department of Fish and Wildlife, Science Division, Olympia.

Wagner, T., J.L. Congleton, D.M. Marsh. 2004. Smolt-to-adult return rates of juvenile Chinook salmon transported through the Snake-Columbia River hydropower system, USA, in relation to densities of co-transported juvenile steelhead. Fisheries Research 68:259-270

Waples, R.S., D.J. Teel, and P.B. Aebersold. 1991. A genetic monitoring and evaluation program for supplemented population of salmon and steelhead in the Snake River Basin. Prepared for the Bonneville Power Administration by the National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, Washington.

Waples, R.S., P.B. Aebersold, and G.A. Winans. 1997. Population genetic structure and life history variability in *Oncorhynchus nerka* from the Snake River basin. Final report. Bonneville Power Administration, Portland, Oregon.

Ward, D.L., J.H. Petersen, and J.J. Loch. 1995. Index of predation of juvenile salmonids by northern squawfish in the lower and middle Columbia River and the lower Snake River. Transactions of the American Fisheries Society 124:321-334.

WDFW (Washington Department of Fish and Wildlife) and ODFW (Oregon Department of Fish and Wildlife). 2002. Status report Columbia River fish runs and fisheries, 1938-2000. Joint Columbia River Management Staff, Clackamas, Oregon/Vancouver, Washington.

WDFW (Washington Department of Fish and Wildlife), ODFW (Oregon Department of Fish and Wildlife), and IDFG (Idaho Fish and Game). 2006. Request for MMPA Section 120 pinniped removal authority. Application to the National Marine Fisheries Service for the intentional lethal removal of California sea lions in the Columbia River.

WDFW (Washington Department of Fish and Wildlife) and ODFW (Oregon Department of Fish and Wildlife). 2008. Progress regarding planning and implementation of recovery activities for lower Columbia fall Chinook and coho that are listed under the Federal Endangered Species Act. Letter to R. Turner, National Marine Fisheries Service, from P. Anderson, WDFW, Olympia and E. Bowles, ODFW, Salem. January 15.

WDFW (Washington Department of Fish and Wildlife), Western Washington Treaty Indian Tribes, and Northwest Indian Fisheries Commission. 1995. Dungeness River Chinook salmon rebuilding project progress report 1992-1993. C.J. Smith and P. Wampler, editors. Northwest Fishery Resource Bulletin. Project Report Series No. 3. Northwest Indian Fisheries Commission, Olympia, Washington.

WDOE (Washington Department of Ecology). 2002. Evaluating standards for protecting aquatic life in Washington surface water quality standards, temperature criteria. Draft discussion paper and literature summary. WDOE, Olympia.

Weitkamp, D.E, R.D. Sullivan, T. Swant, and J. Dos Santos. 2003. Behavior of resident fish relative to total dissolved gas supersaturation in the lower Clark Fork River. Transactions of the American Fisheries Society 132:856-864.

Weitkamp, L.A. 1994. A review of the effects of dams on the Columbia River estuary environment, with special reference to salmonids. Bonneville Power Administration, Portland, Oregon and National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, Washington.

Welch, D.W., S.D. Batten, and B.R. Ward. 2007. Growth, survival, and rates of tag retention for surgically implanted acoustic tags in steelhead trout (*O. mykiss*). Hydrobiologia 582:289–299.

Welch, H.E., and K.H. Mills. 1981. Marking fish by scarring soft fin rays. Canadian Journal of Fisheries and Aquatic Sciences 38:1168-1170.

Wertheimer, R.H. 2007. Evaluation of a surface flow bypass system for steelhead kelt passage at Bonneville Dam, Washington. North American Journal of Fisheries Management 27:21-29.

Wertheimer, R.H., and A.F. Evans. 2005. Downstream passage of steelhead kelts through hydroelectric dams on the lower Snake and Columbia Rivers. Transactions of the American Fisheries Society 134:853-865.

Wiles, G.J. 2004. Washington State status report for the killer whale. Washington Department of Fish and Wildlife, Olympia.

Williams, R., A.W. Trites, and D.E. Bain. 2002a. Behavioural responses to killer whales (*Orcinus orca*) to whale-watching boats: opportunistic observations and experimental approaches. Journal of The Zoological Society of London 256:255-270.

Williams, R., D.E. Bain, J.K.B. Ford, and A.W. Trites. 2002b. Behavioural responses of male killer whales to a 'leapfrogging' vessel. Journal of Cetacean Research and Management 4(3):305-310.

Williams, J.G., S.G. Smith, R.W. Zabel, W.D. Muir, M.D. Scheuerell, B.P. Sandford, D.M. Marsh, R.A. McNatt, and S. Achord. 2005. Effects of the Federal Columbia River Power System on salmonid populations. U.S. Dept. of Commerce, NOAA Tech. Memo., NMFS-NWFSC-63, 150 p.

Wilson, P.H. 2003. Using population projection matrices to evaluate recovery strategies for Snake River spring and summer Chinook salmon. Conservation Biology 17(3): 782-794.

WLCTRT (Willamette/Lower Columbia Technical Recovery Team). 2003. Interim report on viability criteria for Willamette and Lower Columbia basin Pacific salmonids.

WLCTRT (Willamette/Lower Columbia Technical Recovery Team). 2004. Status evaluation of salmon and steelhead populations in the Willamette and lower Columbia River basins.

WLCTRT (Willamette/Lower Columbia Technical Recovery Team) and ODFW (Oregon Department of Fish and Wildlife). 2006. Revised viability criteria for salmon and steelhead in the Willamette and lower Columbia basins. Review draft.

Wursig, B. 1990. Cetaceans and oil: ecological perspectives. Pages 129-166 *in* J.R. Geraci and D.J. St. Aubin, editors. Sea mammals and oil: confronting the risks. Academic Press, New York.

Wydoski, R.S. 1997. Relation of hooking mortality and sublethal hooking stress to quality fishery management. Pages 43-87 *in* R.A. Barnhart and T.D. Roelofs, editors. Proceedings of a national symposium on catch-and-release fishing as a management tool. Humboldt State University, Arcata, California.

Ylitalo, G.M., C.O. Matikin, J. Buzitis, M.M. Krahn, L.J. Jones, T. Rowles, J.E. Stein. 2001. Influence of life-history parameters on organochlorine concentrations in free-ranging killer whales (*Orcinus orca*) from Prince William Sound, AK. The Science of the Total Environmental 281:183-203.

Zabel, R. W., M.D. Scheuerell, M.M. McClure, and J.G. Williams. 2006. The interplay between climate variability and density dependence in the population viability of Chinook salmon. Conservation Biology 20 (1):190-200.

Zabel, R., J. Faulkner, S.G. Smith, J.J. Anderson, C. Van Holmes, N. Beer, S. Iltis, J. Krinke, G. Fredricks, B. Bellerud, J. Sweet, and A. Giorgi. 2007. Comprehensive passage (COMPASS) model: a model of downstream migration and survival of juvenile salmonids through a hydropower system. Accepted for publication in Hydrobiolgia.

Zimmerman, M.P. 1999. Food habits of smallmouth bass, walleyes, and northern pikeminnow in the lower Columbia River basin during outmigration of juvenile anadromous salmonids. Transactions of the American Fisheries Society 128:1036-1054.