CHAPTER 9

ENVIRONMENTAL BASELINE

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9. ENVIRONMENTAL BASELINE

9.1 Introduction

The environmental baseline refers to the condition of the listed species or its designated critical habitat in the action area, without the consequences to the listed species or designated critical habitat caused by the proposed action. The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions which are contemporaneous with the consultation in process. The consequences to listed species or designated critical habitat from ongoing agency activities or existing agency facilities that are not within the agency's discretion to modify are part of the environmental baseline (50 CFR 402.02).

The key purpose of the environmental baseline is to describe the natural and anthropogenic factors influencing the status and condition of Endangered Species Act (ESA)-listed species and designated critical habitat in the action area. Since this is a consultation on a program with a large geographic scope, this environmental baseline focuses more generally on the status and trends of the aquatic ecosystems on the U.S. west coast and the consequences of that status for listed resources.

Activities that negatively impact water quality also threaten aquatic species. The deterioration of water quality is a contributing factor that has led to the reduction in populations of some ESA-listed aquatic species under the National Marine Fisheries' (NMFS) jurisdiction. Declines in populations of these species leave them vulnerable to a multitude of threats. Due to the cumulative effects of reduced abundance, low or highly variable growth capacity, and the loss of essential habitat, these species are less resilient to additional disturbances. In larger populations, stressors that affect only a limited number of individuals could once be tolerated by the species without resulting in population level impacts; in smaller populations, the same stressors are more likely to reduce the likelihood of survival. In addition, populations that have ongoing stressors already present in the environment are less likely to be resilient to additional stressors resulting from the action. It is with this understanding of the Environmental Baseline that we will consider the effects of the proposed action on endangered and threatened species and their designated critical habitat. The action area for this consultation covers a very large number of individual watersheds and an even larger number of specific water bodies (e.g., lakes, rivers, streams, estuaries). It is, therefore, not practicable to describe the environmental baseline and assess risk for each particular area. Accordingly, this Opinion approaches the environmental baseline on a region-by-region basis, describing the activities, conditions and stressors which adversely affect ESA-listed species and designated critical habitat. These include natural threats (e.g., parasites and disease, predation and competition, wildland fires), water quality, hydromodification projects, land use changes, dredging, mining, artificial propagation, non-native species, fisheries, vessel traffic, and climate changes. For each of these threats we start with a general overview of the problem, followed by a more focused analysis at the regional level for the species listed above, as appropriate and where such data are available.

Our summary of the environmental baseline complements the information provided in the Status of Species and Critical Habitats Likely to Be Adversely Affected section (Chapter 7), and provides background necessary to evaluate and interpret information presented in the Effects of the Action and Cumulative Effects sections (Chapters 10, 12, 15).

The quality of the biophysical components within aquatic ecosystems is affected by natural events as well as human activities conducted within and around coastal waters, estuarine and riparian zones, as well as those conducted more remotely in the upland portion of the watershed. Industrial activities can result in discharge of pollutants, changes in water temperature and levels of dissolved oxygen, and the addition of nutrients. In addition, forestry and agricultural practices can result in erosion, run-off of fertilizers, herbicides, insecticides or other chemicals, nutrient enrichment and alteration of water flow.

The information from the environmental baseline is treated as a "risk modifier" in the Integration and Synthesis section (Chapters 13, 16). Factors which have the potential to "modify" the risk are those which are able to interact with the effects of the action. For example, elevated temperatures have been demonstrated to increase the toxicity of organophosphate pesticides in fish (Mayer and Ellersieck 1986; Mayer and Ellersieck 1988; Osterauer and Köhler 2008) and certain mixtures of cholinesterase inhibiting pesticide increase the toxicity to juvenile coho salmon (Laetz et al. 2014). While many of the factors described in this section have the potential to modify the action, and were thus considered, two of the factors present in the environmental baseline were consistently found to have a high potential to modify the risk. The two factors are: 1) elevated freshwater temperatures, and 2) pesticide environmental mixtures. Elevated temperatures may increase risk to species because adverse toxicological responses are heightened with increases in temperature. Pesticide environmental mixtures may increase risk because of additive or synergist effects. Current methodologies for calculating mixture toxicity indicate that additivity is the appropriate initial assumption (Cedergreen and Streibig 2005) unless available data suggest antagonism (less than additive toxicity) or synergism (greater than additive toxicity) is more appropriate. We found no published data showing antagonism or synergism in mixtures containing metolachlor or telone. Therefore, additive toxicity is the default assumption in this Opinion. We therefore developed two key questions to guide our synthesis of the information within the environmental baseline section:

1. Are freshwater temperatures elevated?

2. Are pesticide mixtures present, or anticipated based on current land use?

We used best available information to answer these two questions for each of our species. To assess elevated temperature, we evaluated the most recent Total Maximum Daily Load (TMDL) 303(d) listings to calculate the total river-kilometers of recorded temperature exceedance within each species range (e.g. Table 6). Species recovery plans, status updates, and listing documents also contributed species specific information regarding documented temperature exceedances. To assess pesticide environmental mixtures we examined land use categories within each species range by performing an overlap analysis with the most recent National Land Cover Database (NLCD) information (e.g. ***Table 2***). We found the United States Geological Survey's (USGS) most recent National Water-Quality Assessment (NAWQA) report (Ryberg et al. 2014) corroborated previous reports findings of trends between concentration and land use for pesticides with both agricultural and urban applications. As such, we used land use categories such as "cultivated crops", "pasture/hay", and "developed land" as proxies for areas with an increased potential for environmental mixtures. Additional sources of information used to characterize the occurrence of pesticide environmental mixtures within specie habitats include: species recovery plans, status updates, listing documents, pesticide monitoring data, incident data, existing pesticide consultations, and pesticide usage information.

Within the Integration and Synthesis section (Chapters 13 and 16) we characterize the overall magnitude of influence of the environmental baseline as either "low" or "high". This characterization includes directionality (i.e. positive influence which equates to less risk or negative influence which equates to more risk) as well as confidence. The magnitude, directionality, and confidence of the influence are supported by answers provided to the two questions outlined above. We acknowledge that the magnitude, and directionality of these two factors varies on a species-by-species basis, for example the same proportion of habitat with elevated temperatures may affect two species in different ways. We further acknowledge that the quantitative data (e.g. 303(d), NLCD) is incomplete without considering the qualitative data often provided in recovery plans, status reports and listing documents. Therefore, we characterized magnitude and directionality with the following guidelines:

- If answers to one or both key questions are in the affirmative, and, if the extent of one or both factors are considered to be of sufficient concern for that species, then the magnitude is large and the directionality is negative;

- If both key questions are answered in the negative, and, if other baseline factors for that species (e.g. prey availability) indicate a positive baseline, then the magnitude will be small and the directionality will be positive;

- If answers to both key questions are in the negative, and, if other baseline factors for that species (e.g. prey availability) indicate a negative baseline, then the magnitude will be small and the directionality will be negative.

The three guidelines above are not exhaustive of all possible combinations of the factors examined in the baseline, rather they outline only those combinations which were encountered in this Opinion. We characterize the overall confidence in the magnitude and directionality as either "low" or "high". Confidence is determined by assessing the amount of evidence provided, as well as by further considering the species-specific implications of the two factors. It is important to note that the key-question framework (described above) is a tool to help guide our risk assessors in making transparent and consistent determinations. However, the ultimate consideration of increased or decreased risk attributable to the environmental baseline is not restricted to the consideration of the key questions alone. All information relevant to the environmental baseline within the action area is considered in the risk assessment.

The environmental baseline that follows is organized into three general sections: 1) a general overview of baseline factors relevant to all west coast salmonids; 2) baseline factors specific to the Pacific Northwest region, and 3) baseline factors specific to the California region.

9.2 General Baseline Factors

9.2.1 Coastal Condition Assessment

The West coastal region includes rocky coasts, estuaries, bays, sub-estuaries and city harbors. In total the west coast contains 2,200 square miles of estuaries, over 60% of which is part of three major estuarine systems: the San Francisco Estuary, Columbia River Estuary, and Puget Sound (USEPA 2015). The coastal counties of the West Coast are home to 19% of the U.S. population, and 63% of the total population of the West Coast states. The population in these coastal counties has nearly doubled since 1970 and is currently estimated to be around 40 million people (USEPA 2015).

Figure 1 shows a summary of findings from the Environmental Protection Agency's (EPA) National Coastal Condition Assessment Report for the Northeast Region (USEPA 2015). A total of 134 sites were sampled to assess approximately 2,200 square miles of West Coast coastal waters. Biological quality is rated as good in 71% of the West coast region based on the benthic index. Poor biological conditions occur in 3% of the coastal area. About 21% of the region reported missing results. Based on the water quality index, 64% of the West Coast is in good condition, 26% is rated fair, and 2% is rated poor.

Based on the sediment quality index, 31% of the West Coast area sampled is in good condition, 23% is in fair condition, and 27% is in poor condition (19% were reported "missing"). Compared to ecological risk-based thresholds for fish tissue contamination, 5% of the West coast is rated as good, 29% is rated fair, and 44% is rated poor. The contaminants that most often exceed the thresholds for a “poor” rating in the assessed areas of the West Coast are selenium, mercury, arsenic, and, in a small proportion of the area, total polychlorinated biphenyls (PCBs).

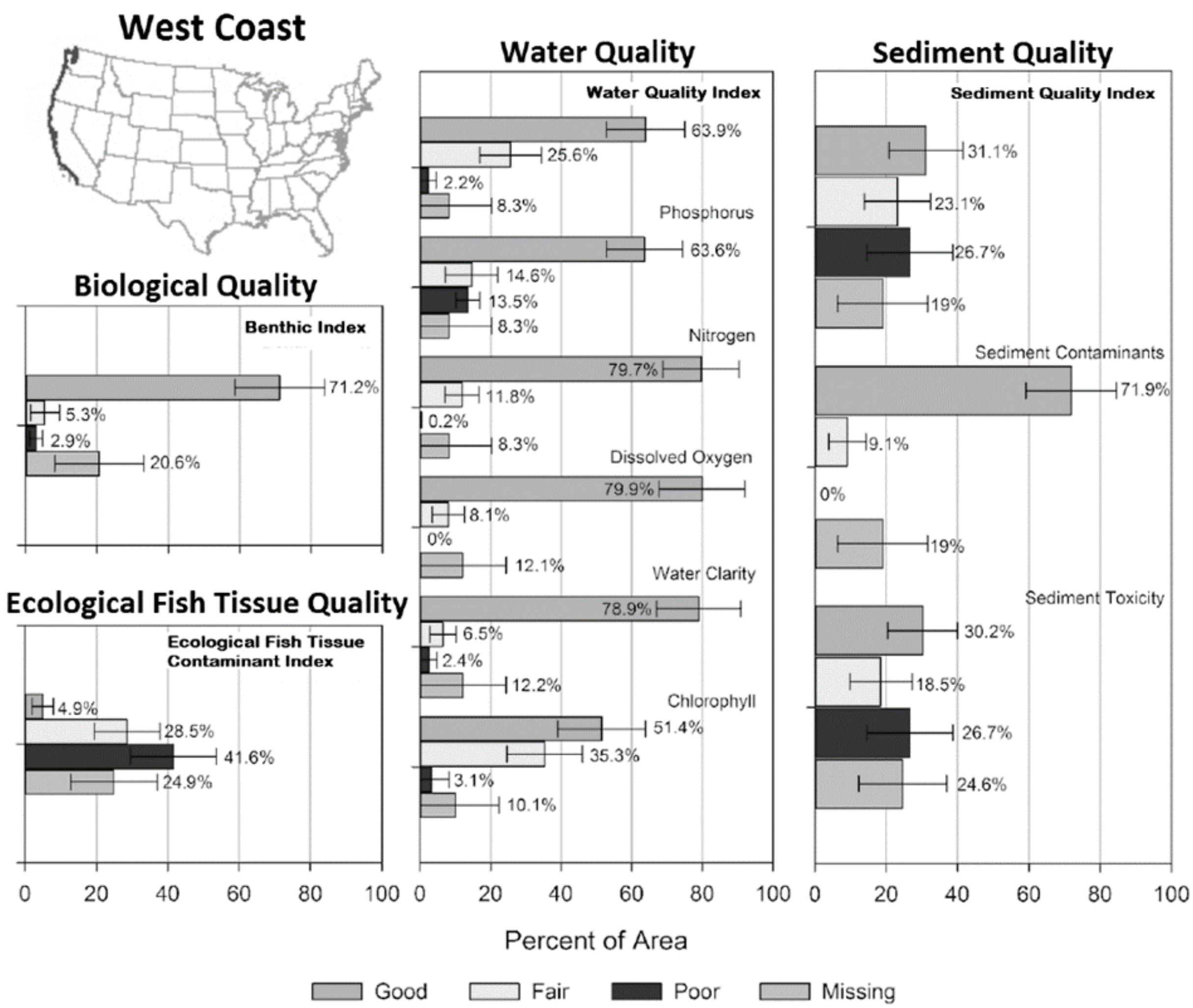

Figure 1. National Coastal Condition Assessment 2010 Report findings for the West Coast Region. Bars show the percentage of coastal area within a condition class for a given

indicator (n = 134 sites sampled). Error bars represent 95% confidence levels (USEPA 2015).

9.2.2 Parasites and/or Disease

Most young fish are highly susceptible to disease during the first two months of life. The cumulative mortality in young animals can reach 90 to 95%. Although fish disease organisms occur naturally in the water, native fish have co-evolved with them. Fish can carry these diseases at less than lethal levels (Foott et al. 2003; Kier Associates 1991; Walker and Foott 1993). However, disease outbreaks may occur when water quality is diminished and fish are stressed from crowding and diminished flows (Guillen 2003; Spence et al. 1996). Young coho salmon or other salmonid species may become stressed and lose their resistance in higher temperatures (Spence et al. 1996). Consequently, diseased fish become more susceptible to predation and are less able to perform essential functions, such as feeding, swimming, and defending territories (McCullough 1999). Examples of parasites and disease for salmonids include whirling disease, infectious hematopoietic necrosis (IHN), sea-lice (e.g. *Lepeophtheirus salmonis*, various *Caligus* species *Henneguya salminicola*, or Ich (*Ichthyopthirius multifiliis)* and Columnaris *(Flavobacterium columnare*)).

Whirling disease is a parasitic infection caused by the microscopic parasite *Myxobolus cerebrali*. Infected fish continually swim in circular motions and eventually expire from exhaustion. The disease occurs in the wild and in hatcheries and results in losses to fry and fingerling salmonids, especially rainbow trout. The disease is transmitted by infected fish, fish parts and birds.

IHN is a viral disease in many wild and farmed salmonid stocks in the Pacific Northwest. This disease affects rainbow/steelhead trout, cutthroat trout (*Salmo clarki*), brown trout (*Salmo trutta*), Atlantic salmon (*Salmo salar*), and Pacific salmon including Chinook, sockeye, chum, and coho salmon. The virus is triggered by low water temperatures and is shed in the feces, urine, sexual fluids, and external mucus of salmonids. Transmission is mainly from fish to fish, primarily by direct contact and through the water.

Sea lice is a marine ectoparasite found in coastal waters that can also cause deadly infestations of farm-grown salmon and may affect wild salmon. *Henneguya salminicola*, a protozoan parasite, is commonly found in the flesh of salmonids, particularly in British Columbia. The fish responds by walling off the parasitic infection into a number of cysts that contain milky fluid. This fluid is an accumulation of a large number of parasites. Fish with the longest freshwater residence time as juveniles have the most noticeable infection. The order of prevalence for infection is coho followed by sockeye, Chinook, chum, and pink salmon. The *Henneguya* infestation does not appear to cause disease in the host salmon – even heavily infected fish tend to return to spawn successful.

Additionally, ich (a protozoan) and Columnaris (a bacterium) are two common fish diseases that were implicated in the massive kill of adult salmon in the Lower Klamath River in September 2002 (CDFG 2003; Guillen 2003).

9.2.3 Predation

Salmonids are exposed to high rates of natural predation, during freshwater rearing and migration stages, as well as during ocean migration. Salmon along the U.S. west coast are prey for marine mammals, birds, sharks, and other fishes. Concentrations of juvenile salmon in the coastal zone experience high rates of predation. In the Pacific Northwest, the increasing size of tern, seal, and sea lion populations may have reduced the survival of some salmon ESUs/DPSs. Threatened Puget Sound Chinook adults are preferred prey of endangered Southern Resident Killer Whales (Orcas).

9.2.3.1 Marine Mammal Predation

Marine mammals are known to attack and eat salmonids. Harbor seals (Phoca vitulina), California sea lions (Zalophus californianus), and killer whales (Orcinus orca) prey on juvenile or adult salmon. As indicated above, southern resident killer whales have a strong preference for Chinook salmon (up to 78% of identified prey) during late spring to fall (Ford and Ellis 2006; Hanson et al. 2005; Hard et al. 1992). Generally, harbor seals do not feed on salmonids as frequently as California sea lions (Pearcy 1997). California sea lions from the Ballard Locks in Seattle, Washington have been estimated to consume about 40% of the steelhead runs since 1985/1986 (Gustafson et al. 1997). In the Columbia River, salmonids may contribute substantially to sea lion diet at specific times and locations (Pearcy 1997). Spring Chinook salmon and steelhead are subject to pinniped predation when they return to the estuary as adults (NMFS 2006). Adult Chinook salmon in the Columbia River immediately downstream of Bonneville Dam have also experienced increased predation by California sea lions. In recent years, sea lion predation of adult Lower Columbia River winter steelhead in the Bonneville tailrace has increased. This prompted ongoing actions to reduce predation effects. They include the exclusion, hazing, and in some cases, lethal take of marine mammals near Bonneville Dam (NMFS 2008d).

9.2.3.2 Avian Predation

Large numbers of fry and juveniles are eaten by birds such as mergansers (Mergus spp.), common murre (Uria aalage), gulls (Larus spp.), and belted kingfishers (Megaceryle alcyon). Avian predators of adult salmonids include bald eagles (Haliaeetus leucocephalus) and osprey (Pandion haliaetus) (Pearcy 1997). Caspian terns (Sterna caspia) and cormorants (Phalacrocorax spp.) also take significant numbers of juvenile or adult salmon. Stream-type juveniles, especially yearling smolts from spring-run populations, are vulnerable to bird predation in the estuary. This vulnerability is due to salmonid use of the deeper, less turbid water over the channel, which is located near habitat preferred by piscivorous birds (Binelli et al. 2005). Recent research shows that subyearlings from the LCR Chinook salmon ESU are also subject to tern predation. This may be due to the long estuarine residence time of the LCR Chinook salmon (Ryan et al. 2006). Caspian terns and cormorants may be responsible for the mortality of up to 6% of the outmigrating stream-type juveniles in the Columbia River basin (Collis 2007; Roby et al. 2006).

Antolos et al. (2005) quantified predation on juvenile salmonids by Caspian terns nesting on Crescent Island in the mid-Columbia reach. Between 1,000 and 1,300 adult terns were associated with the colony during 2000 and 2001, respectively. These birds consumed about 465,000 juvenile salmonids in the first and approximately 679,000 salmonids in the second year. However, caspian tern predation in the estuary was reduced from 13,790,000 smolts to 8,201,000 smolts after relocation of the colony from Rice to East Sand Island in 1999. Based on PIT-tag recoveries at the colony, these were primarily steelhead for Upper Columbia River stocks. Less than 0.1% of the in-river migrating yearling Chinook salmon from the Snake River and less than 1% of the yearling Chinook salmon from the Upper Columbia were consumed. PIT-tagged coho smolts (originating above Bonneville Dam) were second only to steelhead in predation rates at the East Sand Island colony in 2007 (Roby et al. 2008). There are few quantitative data on avian predation rates on Snake River sockeye salmon.

9.2.3.3 Fish Predation

Pikeminnows (Ptychocheilus oregonensis) are significant predators of yearling juvenile migrants (Friesen and Ward 1999). Chinook salmon were 29% of the prey of northern pikeminnows in lower Columbia reservoirs, 49% in the lower Snake River, and 64% downstream of Bonneville Dam. Sockeye smolts comprise a very small fraction of the overall number of migrating smolts (Ferguson 2006) in any given year. The significance of fish predation on juvenile chum is unknown. There is little direct evidence that piscivorous fish in the Columbia River consume juvenile sockeye salmon. The ongoing Northern Pikeminnow Management Program has reduced predation-related juvenile salmonid mortality since 1990. Benefits of recent northern pikeminnow management activities to chum salmon are unknown. However, it may be comparable to those for other salmon species with a sub-yearling juvenile life history (Friesen and Ward 1999).

The primary fish predators in estuaries are probably adult salmonids or juvenile salmonids which emigrate at older and larger sizes than others. They include cutthroat trout (O. clarki) or steelhead smolts preying on chum or pink salmon smolts. Outside estuaries, many large non-salmonid populations reside just offshore and may consume large numbers of smolts. These fishes include Pacific hake (Merluccius productus), Pacific mackerel (Scomber japonicus), lingcod (Ophiodon elongates), spiny dogfish (Squalus acanthias), various rock fish, and lamprey (Beamish and Neville 1995; Beamish et al. 1992; Pearcy 1992).

9.2.4 Wildland Fire

Wildland fires that are allowed to burn naturally in riparian or upland areas may benefit or harm aquatic species, depending on the degree of departure from natural fire regimes. Although most fires are small in size, large size fires increase the chances of adverse effects on aquatic species. Large fires that burn near the shores of streams and rivers can have biologically significant short-term effects. They include increased water temperatures, ash, nutrients, pH, sediment, toxic chemicals, and loss of large woody debris (Buchwalter et al. 2004; Rinne 2004). Nevertheless, fire is also one of the dominant habitat-forming processes in mountain streams (Bisson et al. 2003). As a result, many large fires burning near streams can result in fish kills with the survivors actively moving downstream to avoid poor water quality conditions (Greswell 1999; Rinne 2004). The patchy, mosaic pattern burned by fires provides a refuge for those fish and invertebrates that leave a burning area or simply spares some fish that were in a different location at the time of the fire (USFS 2000). Small fires or fires that burn entirely in upland areas also cause ash to enter rivers and increase smoke in the atmosphere, contributing to ammonia concentrations in rivers as the smoke adsorbs into the water (Greswell 1999).

The presence of ash also has indirect effects on aquatic species depending on the amount of ash entry into the water. All ESA-listed salmonids rely on macroinvertebrates as a food source for at least a portion of their life histories. When small amounts of ash enter the water, there are usually no noticeable changes to the macroinvertebrate community or the water quality (Bowman and Minshall 2000). When significant amounts of ash are deposited into rivers, the macroinvertebrate community density and composition may be moderately to drastically reduced for a full year with long-term effects lasting 10 years or more (Buchwalter et al. 2003; Buchwalter et al. 2004; Minshall et al. 2001). Larger fires can also indirectly affect fish by altering water quality. Ash and smoke contribute to elevated ammonium, nitrate, phosphorous, potassium, and pH, which can remain elevated for up to four months after forest fires (Buchwalter et al. 2003).

9.2.5 Climate Variability and Climate Change

There is a large and growing body of literature on past, present, and future impacts of global climate change, exacerbated and accelerated by human activities. Effects of climate change include sea level rise, increased frequency and magnitude of severe weather events, changes in air and water temperatures, and changes in precipitation patterns, all of which are likely to impact ESA resources. The National Oceanic and Atmospheric Association’s (NOAA) climate information portal provides basic background information on these and other measured or anticipated climate change effects (see https://www.climate.gov).

In order to evaluate the implications of different climate outcomes and associated impacts throughout the 21st century, many factors have to be considered. The amount of future greenhouse gas emissions is a key variable. Developments in technology, changes in energy generation and land use, global and regional economic circumstances, and population growth must also be considered.

A set of four scenarios was developed by the Intergovernmental Panel on Climate Change (IPCC) to ensure that starting conditions, historical data, and projections are employed consistently across the various branches of climate science. The scenarios are referred to as representative concentration pathways (RCPs), which capture a range of potential greenhouse gas emissions pathways and associated atmospheric concentration levels through 2100 (IPCC 2014a). The RCP scenarios drive climate model projections for temperature, precipitation, sea level, and other variables: RCP2.6 is a stringent mitigation scenario; RCP2.5 and RCP6.0 are intermediate scenarios; and RCP8.5 is a scenario with no mitigation or reduction in the use of fossil fuels. The IPCC future global climate predictions (2014 and 2018) and national and regional climate predictions included in the Fourth National Climate Assessment for U.S. states and territories (2018) use the RCP scenarios.

The increase of global mean surface temperature change by 2100 is projected to be 0.3 to 1.7°C under RCP2.6, 1.1 to 2.6°C under RCP 4.5, 1.4 to 3.1°C under RCP6.0, and 2.6 to 4.8°C under RCP8.5 with the Arctic region warming more rapidly than the global mean under all scenarios (IPCC 2014a). The Paris Agreement aims to limit the future rise in global average temperature to 2°C, but the observed acceleration in carbon emissions over the last 15 to 20 years, even with a lower trend in 2016, has been consistent with higher future scenarios such as RCP8.5 (Hayhoe et al. 2018).

The globally-averaged combined land and ocean surface temperature data, as calculated by a linear trend, show a warming of approximately 1.0°C from 1901 through 2016 (Hayhoe et al. 2018). The IPCC Special Report on the Impacts of Global Warming (2018) (IPCC 2018) noted that human-induced warming reached temperatures between 0.8 and 1.2°C above pre-industrial levels in 2017, likely increasing between 0.1 and 0.3°C per decade. Warming greater than the global average has already been experienced in many regions and seasons, with most land regions experiencing greater warming than over the ocean (Allen et al. 2018). Annual average temperatures have increased by 1.8°C across the contiguous U.S. since the beginning of the 20th century with Alaska warming faster than any other state and twice as fast as the global average since the mid-20th century (Jay et al. 2018). Global warming has led to more frequent heatwaves in most land regions and an increase in the frequency and duration of marine heatwaves (Allen et al. 2018). Average global warming up to 1.5°C as compared to pre-industrial levels is expected to lead to regional changes in extreme temperatures, and increases in the frequency and intensity of precipitation and drought (Allen et al. 2018).

Climate change has the potential to impact species abundance, geographic distribution, migration patterns, and susceptibility to disease and contaminants, as well as the timing of seasonal activities and community composition and structure [(MacLeod et al. 2005); (Robinson et al. 2005); (Kintisch 2006); (Learmonth et al. 2006); (McMahon and Hays 2006); (Evans and Bjørge 2013); (IPCC 2014a)]. Though predicting the precise consequences of climate change on highly mobile marine species is difficult (Simmonds and Isaac 2007), recent research has indicated a range of consequences already occurring.

Changes in the marine ecosystem caused by global climate change (e.g., ocean acidification, salinity, oceanic currents, dissolved oxygen levels, nutrient distribution) could influence the distribution and abundance of lower trophic levels (e.g., phytoplankton, zooplankton, submerged aquatic vegetation, crustaceans, mollusks, forage fish), ultimately affecting primary foraging areas of ESA-listed species including marine mammals, sea turtles, and fish. Marine species ranges are expected to shift as they align their distributions to match their physiological tolerances under changing environmental conditions (Doney et al. 2012). (Hazen et al. 2012) examined top predator distribution and diversity in the Pacific Ocean in light of rising sea surface temperatures using a database of electronic tags and output from a global climate model. They predicted up to a 35 percent change in core habitat area for some key marine predators in the Pacific Ocean, with some species predicted to experience gains in available core habitat and some predicted to experience losses.

These changes will not be spatially homogeneous across the Pacific Northwest. The largest hydrologic responses are expected to occur in basins with significant snow accumulation, where warming decreases snow pack, increases winter flows, and advances the timing of spring melt (Mote 2016; Mote et al. 2014). Rain-dominated watersheds and those with significant contributions from groundwater may be less sensitive to predicted changes in climate (Mote et al. 2014; Tague et al. 2013).

Decreases in summer precipitation of as much as 30 percent by the end of the century are consistently predicted across climate models (Abatzoglou et al. 2014). Precipitation is more likely to occur during October through March and less during summer months. More winter precipitation will be rain than snow (ISAB 2007) (Mote et al. 2013; Mote et al. 2014). Earlier snowmelt will cause lower stream flows in late spring, summer, and fall, and water temperatures will be warmer (ISAB 2007; Mote et al. 2014). Models consistently predict increases in the frequency of severe winter precipitation events (i.e., 20-year and 50-year events), in the western United States (Dominguez et al. 2012). The largest increases in winter flood frequency and magnitude are predicted in mixed rain-snow watersheds (Mote et al. 2014).

The combined effects of increasing air temperatures and decreasing spring through fall flows are expected to cause increasing stream temperatures; in 2015 this resulted in 3.5-5.3 degree increases in Columbia Basin streams and a peak temperature of 26 degrees Celsius in the Willamette (NWFSC 2015). Overall, about one-third of the current cold-water salmonid habitat in the Pacific Northwest is likely to exceed key water temperature thresholds by the end of this century (Mantua et al. 2009).

Higher temperatures will reduce the quality of available salmonid habitat for most freshwater life stages (ISAB 2007). Reduced flows will make it more difficult for migrating fish to pass physical and thermal obstructions, limiting their access to available habitat (Isaak et al. 2012; Mantua and Hamlet 2010). Temperature increases shift timing of key life cycle events for salmonids and species forming the base of their aquatic foodwebs (Crozier et al. 2008; Tillmann and Siemann 2011; Winder and Schindler 2004). Higher stream temperatures will also cause decreases in dissolved oxygen and may also cause earlier onset of stratification and reduced mixing between layers in lakes and reservoirs, which can also result in reduced oxygen (Meyer et al. 1999; Raymondi et al. 2013; Winder and Schindler 2004). Higher temperatures are likely to cause several species to become more susceptible to parasites, disease, and higher predation rates (Crozier et al. 2008; Raymondi et al. 2013; Wainwright and Weitkamp 2013).

As more basins become rain-dominated and prone to more severe winter storms, higher winter stream flows may increase the risk that winter or spring floods in sensitive watersheds will damage spawning redds and wash away incubating eggs (Goode et al. 2013). Earlier peak stream flows will also alter migration timing for salmon smolts, and may flush some young salmon and steelhead from rivers to estuaries before they are physically mature, increasing stress and reducing smolt survival (Lawson et al. 2004; McMahon and Hartman 1989). In addition to changes in freshwater conditions, predicted changes for coastal waters in the Pacific Northwest as a result of climate change include increasing surface water temperature, increasing but highly variable acidity, and increasing storm frequency and magnitude (Mote et al. 2014). Elevated ocean temperatures already documented for the Pacific Northwest are highly likely to continue during the next century, with sea surface temperature projected to increase by 1.0-3.7 degrees Celsius by the end of the century (IPCC 2014b). Habitat loss, shifts in species’ ranges and abundances, and altered marine food webs could have substantial consequences to anadromous, coastal, and marine species in the Pacific Northwest (Reeder et al. 2013; Tillmann and Siemann 2011).

9.2.6 Oceanographic Factors

As atmospheric carbon emissions increase, increasing levels of carbon are absorbed by the oceans, changing the pH of the water. A 38 percent to 109 percent increase in acidity is projected by the end of this century in all but the most stringent CO2 mitigation scenarios, and is essentially irreversible over a time scale of centuries (IPCC 2014b). Regional factors appear to be amplifying acidification in Northwest ocean waters, which is occurring earlier and more acutely than in other regions and is already impacting important local marine species (Barton et al. 2012; Feely et al. 2012). Acidification also affects sensitive estuary habitats, where organic matter and nutrient inputs further reduce pH and produce conditions more corrosive than those in offshore waters (Feely et al. 2012; Sunda and Cai 2012).

Global sea levels are expected to continue rising throughout this century, reaching likely predicted increases of 10-32 inches by 2081-2100 (IPCC 2014b). These changes will likely result in increased erosion and more frequent and severe coastal flooding, and shifts in the composition of nearshore habitats (Reeder et al. 2013; Tillmann and Siemann 2011). Estuarine-dependent salmonids such as chum and Chinook salmon are predicted to be impacted by significant reductions in rearing habitat in some Pacific Northwest coastal areas (Glick et al. 2007). Historically, warm periods in the coastal Pacific Ocean have coincided with relatively low abundances of salmon and steelhead, while cooler ocean periods have coincided with relatively high abundances, and therefore these species are predicted to fare poorly in warming ocean conditions (Scheuerell and Williams 2005; Zabel et al. 2006). This is supported by the recent observation that anomalously warm sea surface temperatures off the coast of Washington from 2013 to 2016 resulted in poor coho and Chinook salmon body condition for juveniles caught in those waters (NWFSC 2015). Changes to estuarine and coastal conditions, as well as the timing of seasonal shifts in these habitats, have the potential to impact a wide range of listed aquatic species (Reeder et al. 2013; Tillmann and Siemann 2011).

Oceanographic features of the action area may influence prey availability and habitat for Pacific salmonids. These features comprise climate regimes which may suffer regime shifts due to climate changes or other unknown influences. The action area includes important spawning and rearing grounds and physical or biological features essential to the conservation of listed Pacific salmonids - *i.e.*, water quality, prey, and passage conditions. These Pacific oceanographic conditions, climatic variability, and climate change may affect salmonids in the action area.

There is evidence that Pacific salmon abundance may have fluctuated for centuries as a consequence of dynamic oceanographic conditions (Beamish and Bouillon 1993; Beamish et al. 2009; Finney et al. 2002). Sediment cores reconstructed for 2,200-year records have shown that Northeastern Pacific fish stocks have historically been regulated by these climate regimes (Finney et al. 2002). The long-term pattern of the Aleutian Low pressure system has corresponded to the trends in salmon catch, to copepod production, and to other climate indices, indicating that climate and the marine environment may play an important role in salmon production. Pacific salmon abundance and corresponding worldwide catches tend to be large during naturally-occurring periods of strong Aleutian low pressure causing stormier winters and upwelling, positive Pacific Decadal Oscillation (PDO), and an above average Pacific circulation index (Beamish et al. 2009). A trend of an increasing Aleutian Low pressure indicates high pink and chum salmon production and low production of coho and Chinook salmon (Beamish et al.

2009). The abundance and distribution of salmon and zooplankton also relate to shifts in North Pacific atmosphere and ocean climate (Francis and Hare 1994).

Over the past century, regime shifts have occurred as a result of the North Pacific's natural climate regime. Reversals in the prevailing polarity of the PDO occurred around 1925, 1947, 1977, and 1989 (Hare and Mantua. 2000; Mantua et al. 1997). The reversals in 1947 and 1977 correspond to dramatic shifts in salmon production regimes in the North Pacific Ocean (Mantua et al. 1997). During the pre-1977 climate regime, the productivity of salmon populations from the Snake River exceeded expectations (residuals were positive) when values of the PDO were negative (Levin 2003). During the post-1977 regime when ocean productivity was generally lower (residuals were negative), the PDO was negative (Levin 2003).

A smaller, less pervasive regime shift occurred in 1989 (Hare and Mantua. 2000). Beamish *et al.* (2000) analyzed this shift and found a decrease in marine survival of coho salmon in Puget Sound and off the coast of California to Washington. Trends in coho salmon survival were linked over the southern area of their distribution in the Northeast Pacific to a common climatic event. The Aleutian Low Pressure Index and the April flows from the Fraser River also changed abruptly about this time (Beamish et al. 2000).

Poor environmental conditions for salmon survival and growth may be more prevalent with projected warming increases and ocean acidification. Increasing climate temperatures can influence smolt development which is limited by time and temperature (McCormick et al. 2009). Food availability and water temperature may affect proper maturation and smoltification and feeding behavior (Mangel 1994). Climate change may also have profound effects on seawater entry and marine performance of anadromous fish, including increased salinity intrusion in estuaries due to higher sea levels, as well as a projected decrease of seawater pH (Orr et al. 2005). There is evidence that Chinook salmon survival in the Pacific during climate anomalies and El Nino events changes as a result of a shift from predation- to competition-based mortality in response to declines in predator and prey abundances and increases in pink salmon abundance (Ruggerone and Goetz 2004). If climate change leads to an overall decrease in the availability of food, then returning fish will likely be smaller (Mangel 1994). Finally, future climatic warming could lead to alterations of river temperature regimes, which could further reduce available fish habitat (Yates et al. 2008).

We expect changing weather and oceanographic conditions may affect prey availability, temperature and water flow in habitat conditions, and growth for all 28 ESUs/DPSs. Consequently, we expect the long-term survival and reproductive success for listed salmonids to be negatively affected by global climate change.

9.2.7 Pesticides

9.2.7.1 Monitoring Data – General Overview

The following discussion is a general overview of monitoring information. Details specific to each region are provided in 9.3.4 and 9.4.4 below. The USGS NAWQA program assessed trends in pesticide concentration at 59 sites across the U.S. for three overlapping periods: 1992-2001, 1997-2006, and 2001-2010. Trends in reported agriculture use intensity were assessed for the same periods at 57 sites (Ryberg et al. 2014). The report found widespread agreement between trends in concentration and use for agricultural pesticides. Additionally, the report found that trends between concentration and use for pesticides with both agricultural and urban use could be explained by taking into consideration concentration trends in urban streams (Ryberg et al. 2014).

Pesticide concentrations were detected at concentrations which exceeded aquatic-life benchmarks in many rivers and streams throughout the 20-year sampling period (Stone et al. 2014). In a more recent decade sampled (2002 – 2011), 61% of streams and rivers which drain agricultural watersheds contained pesticides at concentrations which exceeded thresholds. In Addition, 46% of mixed-land and 90% of urban streams were found to have pesticides in exceedance of aquatic-life benchmarks. According to (Stone et al. 2014) a number of important pesticides were not included in the sampling protocol and thus the potential for adverse effect is likely greater than is suggested by the percent of streams with exceedances.

When pesticides are released into the environment, they frequently end up as contaminants in aquatic environments. Depending on their physical properties some are rapidly transformed via chemical, photochemical, and biologically mediated reactions into other compounds, known as degradates. These degradates may become as prevalent as the parent pesticides depending on their rate of formation and their relative persistence.

Another dimension of pesticides and their degradates in the aquatic environment is their simultaneous occurrence as mixtures (Gilliom et al. 2006). Mixtures result from the use of different pesticides for multiple purposes within a watershed or groundwater recharge area. Pesticides generally occur more often in natural waterbodies as mixtures than as individual compounds.

Mixtures of pesticides were detected more often in streams than in ground water and at relatively similar frequencies in streams draining areas of agricultural, urban, and mixed land use. More than 90% of the time, water from streams in these developed land use settings had detections of two or more pesticides or degradates. About 70% and 20% of the time, streams had five or more and 10 or more pesticides or degradates, respectively (Gilliom et al. 2006). Fish exposed to multiple pesticides at once may also experience additive and synergistic effects. If the effects on a biological endpoint from concurrent exposure to multiple pesticides can be predicted by adding the potency of the pesticides involved, the effects are said to be additive. If, however, the response to a mixture leads to a greater than expected effect on the endpoint, and the pesticides within the mixture enhance the toxicity of one another, the effects are characterized as synergistic. These effects are of particular concern when the pesticides share a mode of action. NAWQA analysis of all detections indicates that more than 6,000 unique mixtures of 5 pesticides were detected in agricultural streams (Gilliom et al. 2006). The number of unique mixtures varied with land use.

During the years 2012-2014 the USEPA and USGS conducted an assessment of targeted-chemical composition and cumulative biochemical activity of water samples collected from streams across the United States. Eight of the 10 most-frequently detected anthropogenic organics were pesticides with frequencies ranging 66-84% of all sites (Bradley et al. 2017).

Pollution originating from a discrete location such as a pipe discharge or wastewater treatment outfall is known as a point source. Point sources of pollution require a National Pollutant Discharge Elimination System (NPDES) permit. These permits are issued for aquaculture, concentrated animal feeding operations, industrial wastewater treatment plants, biosolids (sewer/sludge), pre-treatment and stormwater overflows. The Environmental Protection Agency (EPA) administers the NPDES permit program and states certify that NPDES permit holders comply with state water quality standards. Nonpoint source discharges do not originate from discrete points; thus, nonpoint sources are difficult to identify, quantify, and are not regulated. Examples of nonpoint source pollution include, but are not limited to, urban runoff from impervious surfaces, areas of fertilizer and pesticide application, sedimentation, and manure.

According to EPA's database of NPDES permits, about 243 NPDES individual permits are co-located with listed Pacific salmonids in California. Collectively, the total number of EPA-recorded NPDES permits in Idaho, Oregon, and Washington, that are co-located with listed Pacific salmonids is 1,978.

On November 27, 2006, EPA issued a final rule which exempted pesticides from the NPDES permit process, provided that application was approved under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). The NPDES permits, then, do not include any point source application of pesticides to waterways in accordance with FIFRA labels. On January 7, 2009, the Sixth Circuit Court of Appeals vacated this rule (National Cotton Council v. EPA, 553 F.3d 927 (6th Cir. 2009)). The result of the vacatur, according to the Sixth Circuit, is that "discharges of pesticide pollutants are subject to the NPDES permitting program" under the CWA. In response, EPA has developed a Pesticide General Permit through the NPDES permitting program to regulate such discharges.

9.2.7.2 Baseline Pesticide Consultations

NMFS has consulted with EPA on the registration of several 33 pesticides. NMFS (NMFS 2008b) determined that current use of chlorpyrifos, diazinon, and malathion is likely to jeopardize the continued existence of 27 listed salmonid ESUs/DPSs.[1] NMFS (NMFS 2009b) further determined that current use of carbaryl and carbofuran is likely to jeopardize the continued existence of 22 ESUs/DPSs; and the current use of methomyl is likely to jeopardize the continued existence of 18 ESUs/DPSs of listed salmonids. NMFS also published conclusions regarding the registration of 12 different a.i.s (NMFS 2010b). NMFS concluded that pesticide products containing azinphos methyl, disulfoton, fenamiphos, methamidophos, or methyl parathion are not likely to jeopardize the continuing existence of any listed Pacific Salmon or destroy or adversely modify designated critical habitat. NMFS also concluded that the effects of products containing bensulide, dimethoate, ethoprop, methidathion, naled, phorate, or phosmet are likely to jeopardize the continued existence of some listed Pacific Salmonids and to destroy or adversely modify designated habitat of some listed salmonids. NMFS issued a biological Opinion on the effects of four herbicides and two fungicides (NMFS 2011b). NMFS concluded that products containing 2,4-D are likely to jeopardize the existence of all listed salmonids, and adversely modify or destroy the critical habitat of some ESU / DPSs. Products containing chlorothalonil or diuron were also likely to adversely modify or destroy critical habitat, but not likely to jeopardize listed salmonids. NMFS also concluded that products containing captan, linuron, or triclopyr BEE do not jeopardize the continued existence of any ESUs/DPSs of listed Pacific salmonids or adversely modify designated critical habitat. NMFS still found however, that an incidental take statement was necessary for each of these chemicals to reduce harm to individuals. In 2012, NMFS completed two additional Opinions covering four more pesticides. In May, 2012 NMFS issued an Opinion on oryzalin, pendimethalin, and trifluralin concluding each of these chemicals are likely to jeopardize the continued existence of some listed Pacific salmonids, and adversely modify designated critical habitat of some listed salmonids (NMFS 2012b). In July 2012, NMFS issued an Opinion on thiobencarb, an herbicide authorized for use only on rice. California is the only state within the range of listed Pacific salmonids that has approved the use of thiobencarb and is the only state among the action area states that grows rice. The thiobencarb Opinion focused on three listed Pacific salmon ESUs/DPSs in California's Central Valley where rice is grown. NMFS concluded EPAs registration of thiobencarb would harm listed species, but not jeopardize the continued existence of these three species and would not adversely modify their designated critical habitat. In 2013, NMFS issued an Opinion on the effects of three pesticides: diflubenzuron, fenbutatin oxide, and propargite. NMFS concluded that products containing diflubenzuron, fenbutatin oxide, and propargite are likely to jeopardize the

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[1] The Fourth Circuit Court of Appeals remanded this Opinion on February 21, 2013. The Opinion was remanded to address the issues raised by the Court. Those issues are addressed in this Opinion.

existence of many listed salmonids, and adversely modify or destroy the critical habitat of many ESU / DPSs. All of NMFS previous Opinions on pesticides can be found at https://www.fisheries.noaa.gov/national/consultations/pesticide-consultations.

9.2.7.3 Pesticide Usage

As described in the introduction, the environmental baseline refers to the condition of the listed species or its designated critical habitat in the action area, without the consequences to the listed species or designated critical habitat caused by the proposed action. The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions which are contemporaneous with the consultation in process. The consequences to listed species or designated critical habitat from ongoing agency activities or existing agency facilities that are not within the agency's discretion to modify are part of the environmental baseline (50 CFR 402.02).

The key purpose of the environmental baseline is to describe the natural and anthropogenic factors influencing the status and condition of ESA-listed species and designated critical habitat in the action area. The information from the environmental baseline is treated as a "risk modifier" in the Integration and Synthesis section. Factors which have the potential to "modify" the risk are those which are able to interact with the effects of the action. While many of the factors described in this section have the potential to impact listed salmon and their designated critical habitat, and were thus considered, two of the factors presented in the environmental baseline were consistently found to have a high potential to modify the risk. The two factors are: 1) elevated freshwater temperatures, and 2) pesticide environmental mixtures. Elevated temperatures may increase risk to species because adverse toxicological responses are heightened with increases in temperature. Pesticide environmental mixtures may increase risk because of additive or synergist effects. Current methodologies for calculating mixture toxicity indicate that additivity is the appropriate initial assumption (Cedergreen and Streibig 2005) unless available data suggest antagonism (less than additive toxicity) or synergism (greater than additive toxicity) is more appropriate. We found no published data showing antagonism or synergism in mixtures containing metolachlor or telone. Therefore, additive toxicity is the default assumption in this Opinion.

To assess pesticide environmental mixtures we examined land use categories within each species range by performing an overlap analysis with the National Land Cover Database (NLCD) information (NLCD, 2011) (e.g. ***Table 2***). We found the United States Geological Survey's (USGS) most recent National Water-Quality Assessment (NAWQA) report (Ryberg et al. 2014) corroborated previous reports findings of trends between concentration and land use for pesticides with both agricultural and urban applications. As such, we used land use categories such as “cultivated crops”, “pasture/hay”, and “developed land” as proxies for areas with an increased potential for environmental mixtures. Additional sources of information available to characterize the occurrence of pesticide environmental mixtures include: species recovery plans, status updates, listing documents, pesticide monitoring data, pesticide usage information, and incident data. We also consider existing consultations on pesticide use within the species range. However, note that of the more than 1200 active ingredients authorized for use in pesticide products in the United States, only 34 have been the subject of section 7 consultation with listed Pacific salmonids.

The following section (in addition to the state-specific sections later in this chapter) describes the general sources of pesticide usage information which were considered in the environmental baseline. Note that pesticide usage information is just one of numerous types of information qualitatively considered when evaluating pesticide environmental mixtures within species habitats.

The term “use” describes the authorized parameters (e.g. application rate, frequency, crop type, etc.) of pesticide application as described on the FIFRA label. EPA authorizes the FIFRA label that describe when, where, and how pesticide products can legally be applied. Therefore, the label defines the Federal action and is the subject of the analysis in the “Effects of the Action” portion of this Biological Opinion.

A related concept is that of “usage” which describes parameters (e.g. rate, frequency, percent treated) related to the ways in which a particular pesticide has been applied in the past. In short, use describes how pesticides are authorized to be applied whereas usage describes how pesticides have been applied in the past. Both use and usage can change over time. While use of metolachlor and telone defines the action being evaluated in this Opinion, the usage of all pesticides and other stressors that occur in the action area from past and present actions are also evaluated in the environmental baseline section. Ultimately, the conclusions regarding the species and designated critical habitat are derived through an integration of the information presented in the Status, Environmental Baseline, Effects of the Action, and Cumulative Effects sections of the Biological Opinion.

EPA has provided NMFS with national and state use and usage summaries for both metolachlor and telone which cover the years 2013-2017. The use information (i.e., registered use sites and application rates) comes from approved product labels and summarizes the maximum permitted usage. The usage information within these reports comes from both direct pesticide usage reporting (e.g., California Department of Pesticide Regulation) as well as usage estimates from proprietary surveys (e.g., the AgroTrak Study from Kynetec USA, Inc). This and other pesticide usage information is considered as part of the environmental baseline i.e. “past and present impacts of all Federal, State, or private actions” as described in 50 CFR 402.02. Summaries of the usage information available for Pacific Northwest and California Regions are provided below. The complete reports as compiled and provided by EPA are provided in Attachment 1. Note that the consideration of pesticide usage in the environmental baseline is not limited to metolachlor and telone, rather the environmental baseline considers the usage of all pesticides within the species range. The metolachlor and telone specific usage information are thus provided in this section an example of the type of information available.

9.2.8 Reports of Ecological Incidents

Section 6(a)(2) of the Federal Insecticide, Fungicide and Rodenticide Act requires pesticide product registrants to report adverse effects information, such as incident data involving fish and wildlife. Criteria require reporting of large-scale incidents. For example, pesticide registrants are required to report the following (40 CFR part 159):

- Fish – Affecting 1,000 or more individuals of a schooling species or 50 or more individuals of a non-schooling species.

- Birds – Affecting 200 or more individuals of a flocking species, or 50 or more individuals of a songbird species, or 5 or more individuals of a predatory species.

- Mammals, reptiles, amphibians – Affecting 50 or more individuals of a relatively common or herding species or 5 or more individuals of a rare or solitary species.

The number of documented incidents is believed to be a very small fraction of total incidents caused by pesticides for a variety of reasons. Incident reports for non-target organisms typically provide information only on mortality events and plant damage. Sub-lethal effects in organisms such as abnormal behavior, reduced growth and/or impaired reproduction are rarely reported, except for phytotoxic effects in terrestrial plants. An absence of reports does not necessarily equate to an absence of incidents given the nature of the incident reporting.

Information on the potential effects of pesticides on non-target plants and animals is compiled in the Ecological Incident Information System (EIIS). The EIIS is a database containing adverse effect (typically mortality) reports on non-target organisms where such effects have been associated with the use of pesticides. Other Ecological Incident databases used are the Incident Data System (IDS), Aggregated Incident Database, and Avian Information Monitoring System (AIMS).

Each incident record indicates whether the incident occurred due to a misuse, registered use, or whether it is undetermined. Each incident is additionally classified with a certainty of the association with the identified active ingredient and are classified as: “highly probable,” “probable,” “possible,” and “unlikely.”

Incidents Involving 1,3-Dichloropropene

The following summary of ecological incidents was provided in EPA's 2013 Problem Formulation document for 1,3-Dichloropropene. Note that not all of the incidents described in the summary occurred within the Action Area relevant to this consultation. Four additional incidents were reported between the publication of the Problem Formulation and the 2019 Draft Risk Assessment for 1,3-D. Details of the four additional incidents were not provided.

From EPA's Problem Formulation: EIIS returned eight terrestrial plant incidents in Washington, California, Idaho, Florida, Mississippi, and South Carolina attributed to 1,3-D use with "possible" to "highly probable" certainty (USEPA, 2007b). Most of the incidents resulted from registered uses of products co- formulated with 1,3-D and chloropicrin; however, a few resulted from use of 1,3-D only. Incident #I007358-001 occurred in January 1998 when apple trees were planted on a field previously treated with 1,3-D and chloropicrin. Some trees didn't leaf out fully, were sick, or died. Incident #I012366-064 occurred in March 2001 when a registered use of 1,3,-D and chloropicrin damaged 52 acres of watermelons. Incident #I013636-048 occurred in April 2001 when 80 acres of grape fields were fumigated with 1,3-D. Roughly half of the crop died as a result of 1,3-D phytotoxicity and a settlement was reached. Incident #I014702-075 occurred in June 2002 when a registered use of 1,3-D damaged 20 acres of potatoes, resulting in poor yield and crop quality. Incident #I014702-076 occurred in September 2003 when a registered use of 1,3-D and chloropicrin damaged 91 acres of watermelon seedlings. Incident #s I014871-001 and I016962-028 occurred in July 2003 and May 2005, respectively, when golf courses treated with 1,3-D experienced significant burn shortly after application. Incident #I017958-012 occurred in August 2006 when 1,3-D applied to peach seedlings several months before killed the entire crop. In addition to the terrestrial plant incident, EIIS reports one aquatic incident (#I016738-016) when 1,3-D and chloropicrin applied to strawberry fields via irrigation accidently spilled into a nearby creek, resulting in 1000 fish killed. Residues taken from the fish confirmed the exposure. As of 30 April, 2012, AIMS identified no ecological incidents involving 1,3-D. Registrants reported 5 minor plant incidents and 1 minor wildlife incident with 1,3-D between 2000 and 2012. Unless additional information on these aggregated incidents becomes available, they will be assumed to be representative of registered uses of 1,3-D in the risk assessment.

Incidents Involving Metolachlor

The following summary of ecological incidents was provided in EPA's 2014 Problem Formulation document for Metolachlor. Note that not all of the incidents described in the summary occurred within the Action Area relevant to this consultation. EPA conducted a search of available databases again in 2019 as part of the Draft Risk Assessment. The 2019 search indicated a total of 623 ecological incidents associated with the use of S-metolachlor and metolachlor.

From EPA's Problem Formulation: A preliminary review on June 27, 2014 of the Ecological Incident Information System (EIIS, version 2.1.1), which is maintained by the Agency's Office of Pesticide Programs, and the Avian Monitoring Information System (AIMS), which is maintained by the American Bird Conservancy, indicates a total of 269 reported ecological incidents associated with the use of metolachlor and 206 reported ecological incidents associated with the use of S-metolachlor. This total excludes incidents classified as 'unlikely' or 'unrelated' and only includes those incidents with certainty categories of 'possible', 'probable', and 'highly probable' (for EIIS) and 'possible', 'probable', 'likely', 'highly likely' and 'certain' (for AIMS). Incidents classified as 'unlikely' the result of or 'unrelated' to metolachlor or S-metolachlor will not be included in this Problem Formulation or the ecological risk assessment conducted for Registration Review.

All of the metolachlor incidents, excluding those classified as 'unlikely' or 'unrelated', occurred between 1984 and 2014. Thirteen of the metolachlor incidents reported in the EIIS database involved aquatic animals, 2 involved terrestrial animals, and 254 involved plants. The certainty categories regarding the likelihood that the use of metolachlor caused the 269 incidents were probable (99 incidents), possible (167 incidents), and highly probable (3 incidents). One hundred and sixty-seven of the incidents were considered registered uses at the time of the incident, 17 involved misuses, and the legality of use was undetermined in 85 incidents. The reported incidents for metolachlor involved 265 uses that are currently registered [agriculture area, corn, nut, peanut, potato, soybean, turf, and wheat], and 4 in which the use site was not specified.

Incidents are reported separately for S-metolachlor, but the number and type of reports are similar. There were a total of 206 reported incidents for S-metolachlor. Twenty-nine involved terrestrial animals and 177 involved plants. Of the 29 incidents that involved terrestrial animals, only 1 was a bird incident also reported in AIMS (EIIS: 1015105). The certainty categories regarding the likelihood that the use of S-metolachlor caused the 206 incidents were probable (74 incidents) and possible (132 incidents). One hundred and forty-two of the incidents were considered registered uses at the time of the incident, 7 involved misuses, and the legality of use was undetermined in 57 incidents. Based on the data, it appears that most of the reports are undesired effects treatment site, when applied in accordance with a registered use. The most commonly reported crops damaged were corn, cotton, and soybean.

In addition to the incidents recorded in EIIS and AIMS, additional incidents have been reported to the Agency in aggregated incident reports. Pesticide registrants report certain types of incidents to the Agency as aggregate counts of incidents occurring per product per quarter.

Ecological incidents reported in aggregate reports include those categorized as 'minor fish and wildlife' (W-B), 'minor plant' (P-B), and 'other non-target' (ONT) incidents. 'Other non-target' incidents include reports of adverse effects to insects and other terrestrial invertebrates. For metolachlor, registrants have reported 5 minor fish and wildlife incidents, 44 minor plant incidents, and 0 other non-target incidents. For S-metolachlor, registrants have reported 4 minor fish and wildlife incidents, 672 minor plant incidents, and 0 other non-target incidents. Unless additional information on these aggregated incidents becomes available, they will be assumed to be representative of registered uses of metolachlor and S-metolachlor in the risk assessment.

In the risk assessment, the incidents will be further evaluated to determine if the reported incidents represent current patterns of use for metolachlor and S-metolachlor. Examples of additional considerations are mitigation (e.g., reduced application rates), product cancellations, and changes in use patterns that have occurred since the date of the reported incident(s).

9.2.9 Water Temperature

Elevated temperature is considered a pollutant in most states with approved Water Quality Standards under the federal Clean Water Act (CWA) of 1972. Under the authority of the CWA, states periodically prepare a list of all surface waters in the state for which beneficial uses are impaired by pollutants including drinking, recreation, aquatic habitat, and industrial uses. This process is in accordance with section 303(d) of the CWA. Estuaries, lakes, and streams listed under 303(d) are those that are considered impaired or threatened by pollution. They are water quality limited, do not meet state surface water quality standards, and are not expected to improve within the next two years.

Each state has unique 303(d) listing criteria and processes. Generally, a water body is listed separately for each standard it exceeds, so it may appear on the list more than once. If a water body is not on the 303(d) list, it is not necessarily contaminant-free; rather it may not have been tested. Therefore, the 303(d) list is a minimum list for each state regarding polluted water bodies by parameter.

After states develop their lists of impaired waters, they are required to prioritize and submit their lists to EPA for review and approval. Each state establishes a priority ranking for such waters, considering the severity of the pollution and the uses to be made of such waters. States are expected to identify high priority waters targeted for TMDL development within two years of the 303(d) listing process.

Temperature is significant for the health of aquatic life. Water temperatures affect the distribution, health, and survival of native cold-blooded salmonids in the Pacific Northwest and elsewhere. These fish will experience adverse health effects when exposed to temperatures outside their optimal range. For listed Pacific salmonids, water temperature tolerance varies between species and life stages. Optimal temperatures for rearing salmonids range from 10ºC to 16ºC. In general, the increased exposure to stressful water temperatures and the reduction of suitable habitat caused by drought conditions reduce the abundance of salmon. Warm temperatures can reduce fecundity, reduce egg survival, retard growth of fry and smolts, reduce rearing densities, increase susceptibility to disease, decrease the ability of young salmon and trout to compete with other species for food, and to avoid predation (McCullough 1999; Spence et al. 1996). Migrating adult salmonids and upstream migration can be delayed by excessively warm stream temperatures. Excessive stream temperatures may also negatively affect incubating and rearing salmonids (Gregory and Bisson 1997).

Sublethal temperatures (above 24ºC) could be detrimental to salmon by increasing susceptibility to disease (Colgrove and Wood 1966) or elevating metabolic demand (Brett 1995). Substantial research demonstrates that many fish diseases become more virulent at temperatures over 15.6ºC (McCullough 1999). Due to the sensitivity of salmonids to temperature, states have established lower temperature thresholds for salmonid habitat as part of their water quality standards.

9.2.10 Baseline Habitat Condition

As noted in the status of the species section, the riparian zones for many of the Evolutionarily Significant Units (ESUs)/Distinct Population Segments (DPSs) are degraded. Riparian zones are the areas of land adjacent to rivers and streams. These systems serve as the interface between the aquatic and terrestrial environments. Riparian vegetation is characterized by emergent aquatic plants and species that thrive on close proximity to water, such as willows. This vegetation maintains a healthy river system by reducing erosion, stabilizing main channels, and providing shade. Leaf litter that enters the river becomes an important source of nutrients for invertebrates (Bisson and Bilby 2001). Riparian zones are also the major source of large woody debris (LWD). When trees fall and enter the water, they become an important part of the ecosystem. The LWD alters the flow, creating the pools of slower moving water preferred by salmon (Bilby et al. 2001). While not necessary for pool formation, LWD is associated with around 80% of pools in northern California, Washington, and the Idaho pan-handle (Bilby and Bisson 2001).

Bilby and Bisson (2001) discuss several studies that associate increased LWD with increased pools, and both pools and LWD with salmonid productivity. Their review also includes documented decreases in salmonid productivity following the removal of LWD. Other benefits of LWD include deeper pools, increased sediment retention, and channel stabilization.

Floodplains are relatively flat areas adjacent to streams and rivers that stretch from the banks of the channel to the base of the enclosing valley walls. They allow for the lateral movement of the main channel and provide storage for floodwaters during periods of high flow. The floodplain includes the floodway, which consists of the stream channel, and adjacent areas that actively carry flood flows downstream; and the flood fringe, which are areas that are inundated, but which do not experience a strong current. Water stored in the floodplain is later released during periods of low flow. This process ensures adequate flows for salmonids during the summer months, and reduces the possibility of high-energy flood events destroying salmonid redds (Smith 2005).

Periodic flooding of these areas creates habitat used by salmonids. Thus, floodplain areas vary in depth and widths and may be intermittent or seasonal. Storms also wash sediment and LWD into the main stem river, often resulting in blockages. These blockages may force the water to take an alternate path and result in the formation of side channels and sloughs (Benda et al. 2001). Side channels and sloughs are important spawning and rearing habitat for salmonids. The degree to which these off-channel habitats are linked to the main channel via surface water connections is referred to as connectivity (PNERC 2002). As river height increases with heavier flows, more side channels form and connectivity increases. Juvenile salmonids migrate to and rear in these channels for a certain period of time before swimming out to the open sea.

Healthy riparian habitat and floodplain connectivity are vital for supporting a salmonid population. Chinook salmon and steelhead have life history strategies that rely on floodplains during their juvenile life stages. Chum salmon use adjacent floodplain areas for spawning. Soon after their emergence, chum salmon use the riverine system to rapidly reach the estuary where they mature, rear, and migrate to the ocean. Coho salmon use the floodplain landscape extensively for rearing. Estuarine floodplains can provide value to juveniles of all species once they reach the salt water interface.

Once floodplain areas have been disturbed, it can take decades for their recovery (Smith 2005). Consequently, most land use practices cause some degree of impairment. Development leads to construction of levees and dikes, which isolate the mainstem river from the floodplain. Agricultural development and grazing in riparian areas also significantly change the landscape. Riparian areas managed for logging, or logged in the past, are often impaired by a change in species composition. Most areas in the northwest were historically dominated by conifers. Logging results in recruitment of deciduous trees, decreasing the quality of LWD in the rivers. Deciduous trees have smaller diameters than conifers; they decompose faster and are more likely to be displaced (Smith 2005).

Without a properly functioning riparian zone, salmonids contend with a number of limiting factors. They face reductions in quantity and quality of both off-channel and pool habitats. Also, when seasonal flows are not moderated, both higher and lower flow conditions exist. Higher flows can displace fish and destroy redds, while lower flows cut off access to parts of their habitat. Finally, decreased vegetation limits the available shade and cover, exposing individuals to higher temperatures and increased predation.

9.3 Pacific Northwest Region

9.3.1 Land Use and Population Growth

The Pacific Northwest subregion includes all of Washington and parts of California, Idaho, Montana, Nevada, Oregon, Utah, and Wyoming. The subregion totals roughly 700,000 km^2 of which about 600,000 km^2 is classified as undeveloped, 30,000 km^2 is classified as developed and about 70,000 km^2 is classified as agriculture (Figure 2).

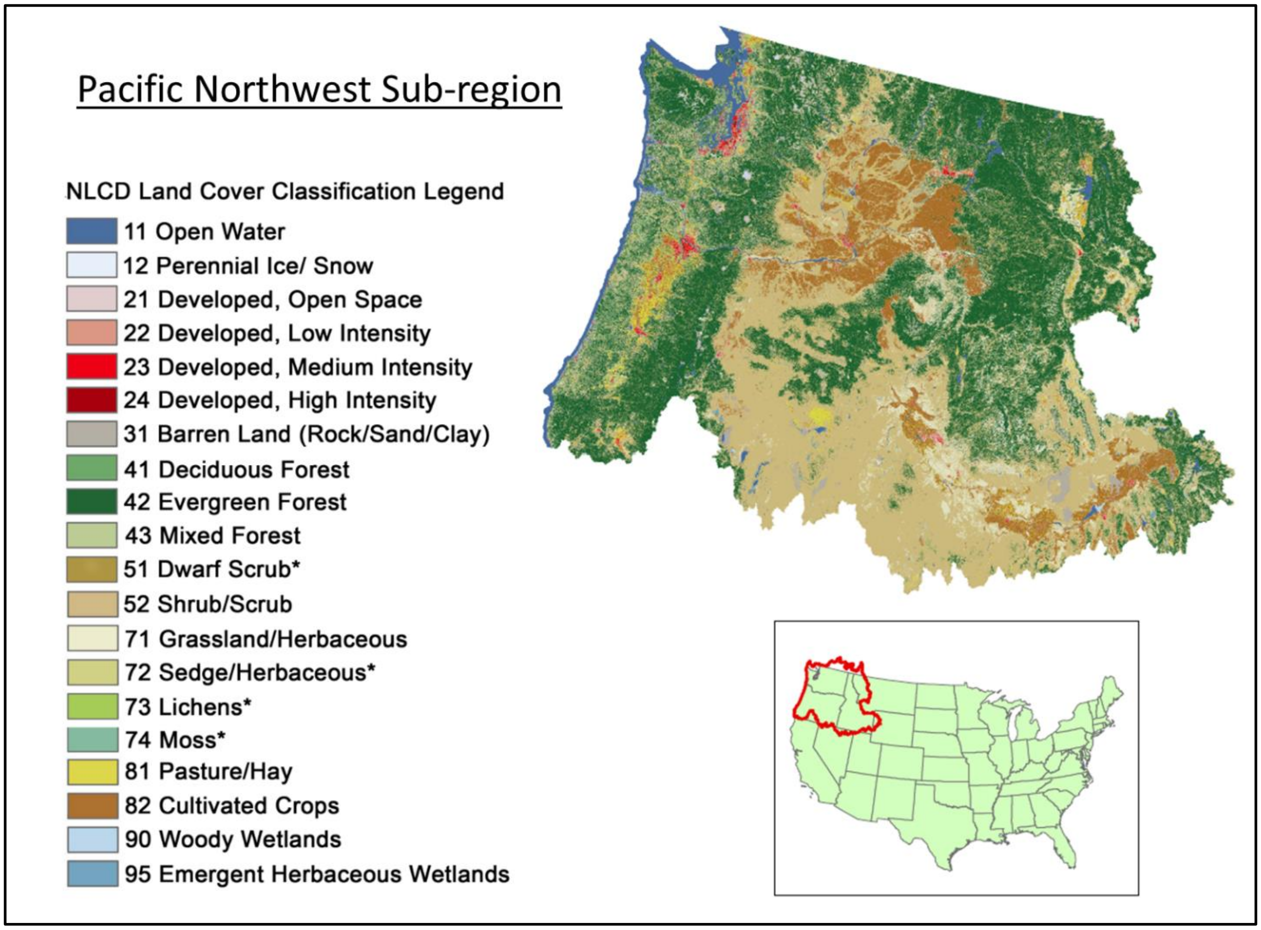


Figure 2. Landuse in the Pacific Northwest sub-region. Data from the NLCD 2011 (www.mrlc.gov).

Nineteen of the 28 species addressed in the Opinion occur in this subregion. They are: chinook salmon (ESUs: Snake River spring/summer-run, Snake River fall-run, Puget Sound, Upper Columbia River spring-run, Lower Columbia River, and Upper Willamette River), chum salmon (ESUs: Columbia River, and Hood Canal summer-run), coho salmon (ESUs: Oregon coast, Southern Oregon/Northern California coast, Lower Columbia River), sockeye salmon (ESUs: Ozette Lake, and Snake River), steelhead (DPSs: Upper Columbia River, Upper Willamette

River, Middle Columbia River, Lower Columbia River, Snake River basin, Puget Sound). *Table 1*, *Table 2*, and *Table 3* show the types and areas of land use within each of the species' ranges.

Table 1. Area of land use categories within Pacific Northwest subregion selected Chinook salmon ranges in km². The total area for each category is given in bold. Land cover was determined via the NLCD 2011. Land cover class definitions are available at: http://www.mrlc.gov/nlcd_definitions.php

Land Cover	Chinook salmon					
NLCD Sub category	Snake River spring/ summer	Snake River fall	Puget Sound	Upper Columbia River spring	Lower Columbia River	Upper Willamette River
Water	**1,813**	**1,694**	**807**	**1,814**	**747**	**651**
Open Water	1,780	1,694	534	1,802	717	651
Perennial Ice/Snow	33	0	273	12	30	-
Developed Land	**2,643**	**1,719**	**4,883**	**2,343**	**2,161**	**2,259**
Open Space	1,009	674	1,528	742	807	653
Low Intensity	571	478	1,524	691	581	744
Medium Intensity	322	300	766	386	330	461
High Intensity	119	117	303	133	138	194
Barren Land	622	150	762	392	305	208
Undeveloped Land	**72,964**	**14,730**	**20,204**	**19,657**	**15,330**	**14,396**
Deciduous Forest	335	319	1,024	318	616	305
Evergreen Forest	38,727	4,277	12,395	6,789	9,584	9,242
Mixed Forest	444	429	2,210	435	968	711
Shrub/Scrub	18,996	5,637	2,917	9,463	2,788	2,471
Grassland/Herbaceous	13,771	3,587	966	2,032	718	983
Woody Wetlands	371	270	502	362	436	465
Emergent Wetlands	320	210	191	257	218	220
Agriculture	**8,761**	**4,552**	**1,395**	**3,892**	**1,076**	**4,744**
Pasture/Hay	789	372	1,140	710	745	2,968
Cultivated Crops	7,971	4,180	255	3,183	330	1,776
TOTAL (inc. open water)	**86,180**	**22,696**	**27,289**	**27,706**	**19,314**	**22,051**
TOTAL (w/o open water)	**84,367**	**21,001**	**26,482**	**25,892**	**18,567**	**21,400**

Table 2. Area of land use categories within Pacific Northwest subregion selected chum, coho and sockeye species' ranges in km². The total area for each category is given in bold.

Land cover was determined via the NLCD 2011. Land cover class definitions are available at: http://www.mrlc.gov/nlcd_definitions.php

Land Cover	Chum salmon		Coho salmon			Sockeye salmon	
NLCD Sub category	Columbia River	Hood Canal summer-run	Oregon Coast	Southern Oregon/ Northern California	Lower Columbia River	Ozette Lake	Snake River
Water	**691**	**57**	**193**	**1,657**	**745**	**30**	**1,699**
Open Water	687	13	193	1,646	715	30	1,682
Perennial Ice/Snow	4	44	0	12	30	-	17
Developed Land	**1,894**	**369**	**1,676**	**2,063**	**2,139**	**4**	**1,685**
Open Space	668	130	1,106	1,394	795	1	622
Low Intensity	541	78	168	235	574	0	478
Medium Intensity	334	23	61	114	329	0	297
High Intensity	137	7	24	31	137	-	116
Barren Land	213	131	317	289	304	3	172
Undeveloped Land	**8,629**	**3,053**	**25,050**	**43,886**	**14,938**	**198**	**18,880**
Deciduous Forest	522	99	334	1,041	611	4	304
Evergreen Forest	4,116	2,096	13,762	27,973	9,311	138	6,955
Mixed Forest	836	185	3,774	2,425	962	3	426
Shrub/Scrub	1,912	431	4,991	9,490	2,703	30	7,155
Grassland/Herbaceous	672	168	1,619	2,710	702	13	3,527
Woody Wetlands	363	55	305	155	430	9	286
Emergent Wetlands	210	19	265	92	218	1	226
Agriculture	**1,069**	**80**	**919**	**1,228**	**1,071**	**-**	**3,833**
Pasture/Hay	694	79	857	761	742	-	501
Cultivated Crops	375	2	61	467	330	-	3,332
TOTAL (inc. open water)	**12,283**	**3,558**	**27,838**	**48,834**	**18,893**	**232**	**26,097**
TOTAL (w/o open water)	**11,592**	**3,502**	**27,645**	**47,177**	**18,148**	**202**	**24,399**

Table 3. Area of land use categories within Pacific Northwest subregion selected steelhead species' ranges in km². The total area for each category is given in bold. Land cover was

determined via the NLCD 2011. Land cover class definitions are available at: http://www.mrlc.gov/nlcd_definitions.php

Land Cover	Steelhead salmon DPS					
NLCD Sub category	Upper Columbia River	Upper Willamette River	Middle Columbia River	Lower Columbia River	Snake River Basin	Puget Sound
Water	**768**	**704**	**1,633**	**1,191**	**1,813**	**597**
Open Water	12	-	1,616	1,160	1,780	392
Perennial Ice/Snow	756	704	17	30	33	205
Developed Land	**1,959**	**2,076**	**3,566**	**2,070**	**2,643**	**4,836**
Open Space	701	832	1,677	734	1,009	1,517
Low Intensity	389	514	969	574	571	1,521
Medium Intensity	134	209	444	330	322	777
High Intensity	418	174	144	137	119	302
Barren Land	318	347	331	295	622	719
Undeveloped Land	**20,658**	**11,476**	**64,159**	**13,939**	**72,964**	**18,912**
Deciduous Forest	7,138	4,483	341	572	335	1,005
Evergreen Forest	436	1,104	19,856	8,840	38,727	11,202
Mixed Forest	9,901	2,019	451	809	444	2,210
Shrub/Scrub	2,087	845	39,441	2,446	18,996	2,859
Grassland/Herbaceous	830	2,804	3,015	630	13,771	970
Woody Wetlands	266	220	505	427	371	506
Emergent Wetlands	1	1	550	215	320	161
Agriculture	**3,868**	**2,361**	**13,797**	**1,061**	**8,761**	**1,345**
Pasture/Hay	3,495	1,908	1,155	732	789	1,094
Cultivated Crops	373	453	12,643	329	7,971	251
TOTAL (inc. open water)	**27,254**	**16,617**	**83,155**	**18,260**	**86,180**	**25,690**
TOTAL (w/o open water)	**26,485**	**15,913**	**81,522**	**17,069**	**84,367**	**25,094**

Population growth within communities in areas where salmon occur will place pressures on water availability and water quality. Oregon’s estimated population reached 4.14 million on July 1, 2017. This is an increase of 310,026 persons or 8.1 percent since the 2010 Census count. While growth slowed during the 2008 recession, Oregon’s growth rate now ranks in the top 10 in the nation (Vaidya 2017). Between 2017 and 2018, Oregon’s population grew by an additional 54,000 people, The largest gains are in metropolitan areas, with Oregon’s three most populous counties in the Portland metropolitan area. Multnomah and Washington counties each added more than 10,000 residents, and Clackamas County added over 6,000. The largest percentage growth occurred in Deschutes and Crook Counties in Central Oregon (PSU Population Research Center 2018). According to Washington's 2018 Population Trends report, the state grew by 117,300 persons, or 1.6 percent. Growth was concentrated in the five largest metropolitan counties: King, Pierce, Snohomish, Spokane and Clark. Eastern Washington grew by 1.4 percent and Western Washington by 1.7 percent. Counties along the Interstate 5 corridor grew by 1.7 percent versus 1.4 percent for rest of the state. Metropolitan counties grew 1.6 percent compared to nonmetropolitan counties, which grew 1.3 percent. Counties that border, or are within, Puget Sound grew by 1.7 percent versus non-Puget Sound counties, which grew by 1.5 percent. Rural counties grew by 1.3 percent versus 1.7 percent for nonrural counties (Washington Office of Financial Management 2018).

9.3.2 Water Temperature

Temperature is significant for the health of aquatic life. Water temperatures affect the distribution, health, and survival of native cold-blooded salmonids in the Pacific Northwest and elsewhere. These fish will experience adverse health effects when exposed to temperatures outside their optimal range. For listed Pacific salmonids, water temperature tolerance varies between species and life stages. Optimal temperatures for rearing salmonids range from 10ºC to 16ºC. In general, the increased exposure to stressful water temperatures and the reduction of suitable habitat caused by drought conditions reduce the abundance of salmon. Warm temperatures can reduce fecundity, reduce egg survival, retard growth of fry and smolts, reduce rearing densities, increase susceptibility to disease, decrease the ability of young salmon and trout to compete with other species for food, and to avoid predation (McCullough 1999; Spence et al. 1996). Migrating adult salmonids and upstream migration can be delayed by excessively warm stream temperatures. Excessive stream temperatures may also negatively affect incubating and rearing salmonids (Gregory and Bisson 1997). ***Figure 3*** depicts waterbodies with 303(d) temperature exceedances within the Pacific Northwest subregion.

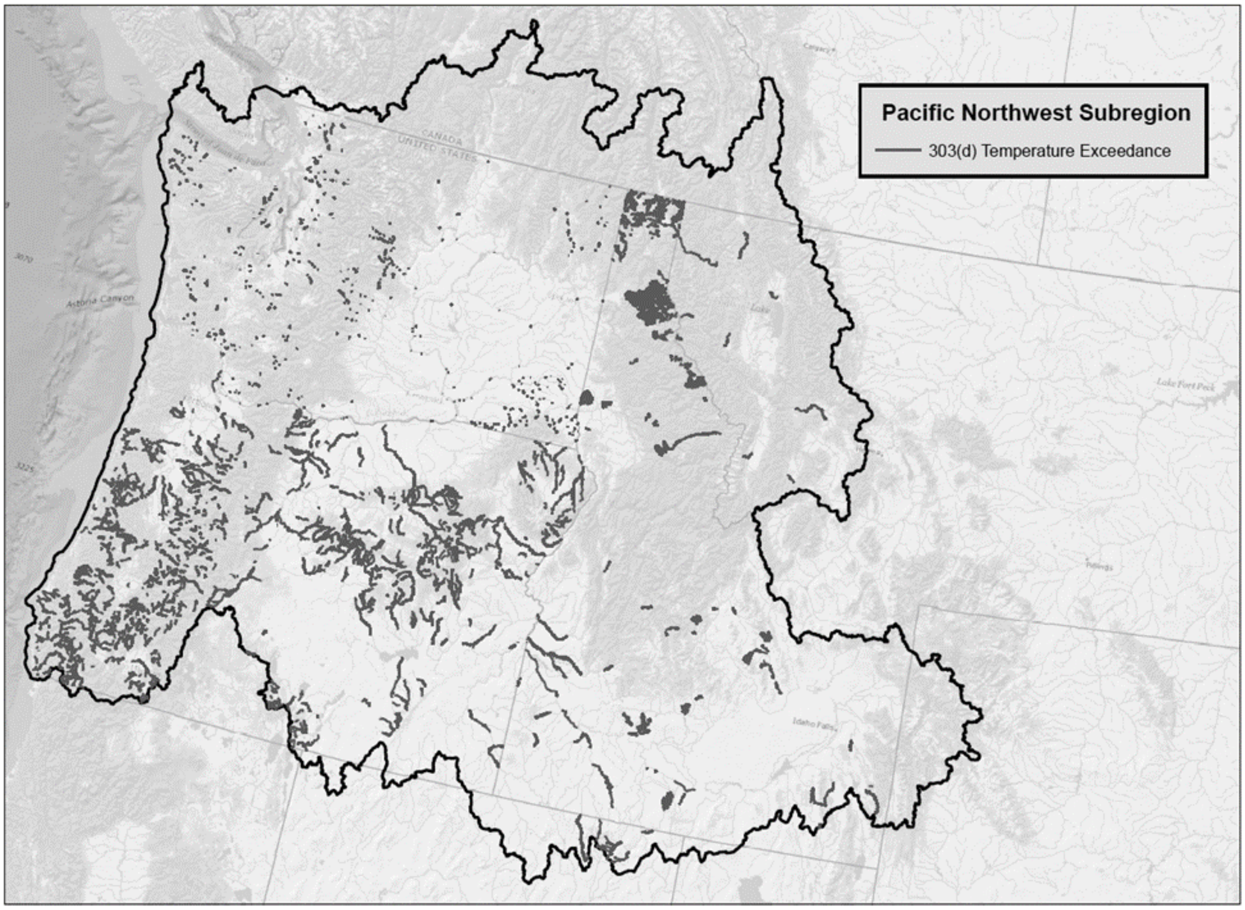


Figure 3. 303(d) temperature exceedances within the Pacific Northwest subregion. Data downloaded from USEPA ATTAINS website; "303(d) May 1, 2015 National Extract layer".

We used GIS layers made publically available through USEPA's Assessment and Total Maximum Daily Load Tracking and Implementation System (ATTAINS) to determine the number of km on the 303(d) list for exceeding temperature thresholds within the boundaries of those species which utilize freshwater habitats (Table 4). Because the 303(d) list is limited to the subset of rivers tested, the chart values should be regarded as lower-end estimates. While some ESU/DPS ranges do not contain any 303(d) rivers listed for temperature, others show considerable overlap. These comparisons demonstrate the relative significance of elevated temperature among ESUs/DPSs. Increased water temperature may result from wastewater discharge, decreased water flow, minimal shading by riparian areas, and climatic variation.

Table 4. Number of kilometers of river, stream and estuaries included in ATTAINS 303(d) lists due to temperature that are located within selected Pacific Northwest species

(ESU/DPS) ranges. Data were taken from USEPA ATTAINS website: May 1, 2015 National Extract.

Species	River-kilometers of recorded temperature exceedance 303(d)
Chinook, Snake River spring/summer-run ESU	1,378
Chinook, Snake River fall-run ESU	395
Chinook, Puget Sound ESU	269
Chinook, Upper Columbia River spring-run ESU	310
Chinook, Lower Columbia River ESU	286
Chinook, Upper Willamette River ESU	1,516
Chum, Columbia River ESU	302
Chum, Hood Canal summer-run ESU	45
Coho, Oregon Coast ESU	2,498
Coho, Southern Oregon/Northern California coasts ESU	5,509
Coho, Lower Columbia River ESU	281
Sockeye, Ozette Lake ESU	2
Sockeye, Snake River ESU	305
Steelhead, Upper Columbia River DPS	312
Steelhead, Upper Willamette River DPS	944
Steelhead, Middle Columbia River DPS	3,509
Steelhead, Lower Columbia River DPS	276
Steelhead, Snake River Basin DPS	1,378
Steelhead, Puget Sound DPS	267

9.3.3 Pesticide Usage

The sources of information used to characterize the occurrence of pesticide environmental mixtures include within specie habitats include: land use information, species recovery plans, status updates, listing documents, pesticide monitoring data, incident data, existing pesticide consultations, and pesticide usage information.

Sources of pesticide usage information and analyses considered in this baseline assessment include United States Department of Agriculture (USDA) National Agricultural Statistics Service (NASS) census of agriculture and chemical use programs; USGS national water quality assessment (NAWQA) project – pesticide national synthesis project; State-based surface and groundwater monitoring programs; California Department of Pesticide Regulation – Pesticide Use Reporting (PUR); as well as survey data from proprietary sources as summarized by EPA (see Attachment 1).

Washington

In 2017, pesticides were applied to over 8.7 million acres in Washington State to control for insects; weeds, grass or brush; nematodes; diseases in crops and orchards; or to control growth, thin fruit, ripen, or defoliate (USDA, 2017). The previous census (2012) reported about 8.1 million acres treated for these use categories. During the period 2010-2016 an average of about 230 different active ingredients were applied annually in Washington State to control pests on crop groups: corn, wheat, vegetables and fruit, orchards and grapes, alfalfa, pasture and hay, and other crops. EPA has provided NMFS with national and state use and usage summaries for both metolachlor and telone which cover the years 2013-2017. The usage information within these reports come from both direct pesticide usage reporting (e.g. California Department of Pesticide Regulation) as well as usage estimates based on surveys (e.g. USDA NASS and proprietary estimates from Kynetec USA, Inc). See Table 5 and Table 6 for the available usage information for metolachlor and telone in Washington. Note that the consideration of pesticide usage in the environmental baseline is not limited to metolachlor and telone, rather the environmental baseline considers the usage of all pesticides within the species range. The metolachlor and telone usage tables are thus provided as an example of the type of information available.

Table 5. Washington 1,3-Dichloropropene Agricultural and Non-Agricultural Usage. Modified from EPA National and State Use and Usage Summary (Attachment 1).

Crop	Avg. Annual Crop Acres Grown	Avg. Annual Total Lbs. AE Applied	Min. Annual PCT	Max. Annual PCT	Avg. Annual PCT
Alfalfa	400,000	Surveyed but no usage reported			
Almonds	Not Surveyed[2]				
Apples	200,000	4,000	0	<2.5	<1
Apricots	Not Surveyed[2]				
Artichoke	Not Surveyed[2]				
Asparagus	3,000	Surveyed but no usage reported			
Avocados	Not Surveyed[2]				
Barley	100,000	Surveyed but no usage reported			
Beans, Lima	2,000	Surveyed but no usage reported			
Beans, Dry	300,000	Surveyed but no usage reported			
Beans, Snap, Bush, Pole, String	Not Surveyed[2]				
Beets	Not Surveyed[2]				
Bitter Melon	Not Surveyed[2]				
Blueberry	10,000	Surveyed but no usage reported			
Broccoli	Not Surveyed[2]				
Brussel Sprouts	Not Surveyed[2]				
Cabbage	Not Surveyed[2]				
Caneberries	5,000	Surveyed but no usage reported			
Canola	Not Surveyed[2]				

Cantaloupe	Not Surveyed[2]				
Carrots	6,000	600,000	35	85	65
Cauliflower	Not Surveyed[2]				
Celery	Not Surveyed[2]				
Cherries	40,000	6,000	0	<2.5	<1
Chinese Cabbage	Not Surveyed[2]				
Corn	200,000	Surveyed but no usage reported			
Corn, Forage-Fodder	Not Surveyed[2]				
Cotton	Not Surveyed[2]				
Cucumbers	<500	Surveyed but no usage reported			
Dates	Not Surveyed[2]				
Daikon	Not Surveyed[2]				
Eggplant	<500	Surveyed but no usage reported			
Figs	Not Surveyed[2]				
Garlic	Not Surveyed[2]				
Grape, Table/Raisin	Not Surveyed[2]				
Grape, Wine	60,000	Surveyed but no usage reported			
Grapefruit	Not Surveyed[2]				
Hazelnuts	Not Surveyed[2]				
Honeydew	D	Surveyed but no usage reported			
Kale	Not Surveyed[2]				
Kiwifruit	Not Surveyed[2]				
Leeks	Not Surveyed[2]				
Lemons	Not Surveyed[2]				
Lettuce	Not Surveyed[2]				
Peppermint	Not Surveyed[2]				
Nectarines	2,000	Surveyed but no usage reported			
Nursery Crops	Not Surveyed[2]				
Oats	4,000	Surveyed but no usage reported			
Olives	Not Surveyed[2]				
Onions	20,000	200,000	0	10	5
Oranges	Not Surveyed[2]				
Parsley	Not Surveyed[2]				
Pasture	900,000	Surveyed but no usage reported			
Peaches	1,000	Surveyed but no usage reported			
Peanuts	Not Surveyed[2]				
Pears	20,000	Surveyed but no usage reported			
Peas	40,000	Surveyed but no usage reported			
Pecans	Not Surveyed[2]				
Peppers	Not Surveyed[2]				
Persimmons	Not Surveyed[2]				
Pineapple	Not Surveyed[2]				
Pistachio	Not Surveyed[2]				
Plums	Not Surveyed[2]				
Pomegranates	Not Surveyed[2]				
Prunes	Not Surveyed[2]				

Potatoes	200,000	10,600,000	35	60	45
Pumpkins	2,000	Surveyed but no usage reported			
Rice	Not Surveyed[2]				
Rye	Not Surveyed[2]				
Safflower	Not Surveyed[2]				
Sorghum	Not Surveyed[2]				
Soybeans	Not Surveyed[2]				
Spinach	Not Surveyed[2]				
Squash	Not Surveyed[2]				
Strawberries	<500	Surveyed but no usage reported			
Sugar Beets	Not Surveyed[2]				
Sugarcane	Not Surveyed[2]				
Sunflower	Not Surveyed[2]				
Sweet Corn	90,000	Surveyed but no usage reported			
Sweet Potato	Not Surveyed[2]				
Tangelo	Not Surveyed[2]				
Tangerines	Not Surveyed[2]				
Tobacco	Not Surveyed[2]				
Tomato	Not Surveyed[2]				
Walnuts	Not Surveyed[2]				
Watermelon	Not Surveyed[2]				
Wheat, spring	600,000	Surveyed but no usage reported			
Wheat, summer	1,700,000	Surveyed but no usage reported			
Golf Course	Surveyed but no usage reported at national level				

[1]*Not surveyed at national level*
[2]*Not surveyed for within Washington*

Table 6. Washington Metolachlor Agricultural and Usage. Modified from EPA National and State Use and Usage Summary (Attachment 1).

Crop	Avg. Annual Crop Acres Grown	Avg. Annual Total Lbs. AE Applied	Min. Annual PCT	Max. Annual PCT	Avg. Annual PCT
Corn	NA	Surveyed but no usage reported			
Sorghum	Not surveyed				
Sweet Corn	NA	Surveyed but no usage reported			
Tomato	Not surveyed				
Beans (Snap, Bush, Pole, String)	Not surveyed				
Dry Beans/Peas	300,000	900	0	<2.5	<1
Lima Beans	Not surveyed				
Peanuts	Not surveyed				
Peas (Fresh, Green, Sweet)	NA	Surveyed but no usage reported			
Soybeans	Not surveyed				
Cotton	Not surveyed				
Safflower	Not surveyed				

Sunflowers	Not surveyed	
Potatoes	NA	Surveyed but no usage reported

[1] *Not surveyed at national level*
[2] *Not surveyed for within Washington*

Table 7. Washington S-Metolachlor Agricultural and Usage. Modified from EPA National and State Use and Usage Summary (Attachment 1).

Crop	Avg. Annual Crop Acres Grown	Avg. Annual Total Lbs. AE Applied	Min. Annual PCT	Max. Annual PCT	Avg. Annual PCT
Blueberries	Not surveyed				
Currant	Not surveyed				
Elderberry	Not surveyed				
Gooseberry	Not surveyed				
Huckleberry	Not surveyed				
Strawberries	Not surveyed				
Blackberries	Not surveyed				
Raspberries	Not surveyed				
Loganberry	Not surveyed				
Chive	Not surveyed				
Garlic	Not surveyed				
Leek	Not surveyed				
Onions	Not surveyed				
Shallot	Not surveyed				
Corn	200,000	30,000	0	35	20
Sorghum	Not surveyed				
Sweet Corn	90,000	10,000	5	25	10
Cantaloupes	Not surveyed				
Citron	Not surveyed				
Cucumbers	Not surveyed				
Muskmelon	Not surveyed				
Pumpkins	Surveyed but no use reported				
Squash	Not surveyed				
Watermelons	Not surveyed				
Eggplant	Not surveyed				
Okra	Not surveyed				
Peppers	Not surveyed				
Tomatoes	Not surveyed				
Broccoli	Not surveyed				
Brussel Sprouts	Not surveyed				
Chinese Cabbage	Not surveyed				
Cauliflower	Not surveyed				
Cabbage	Not surveyed				
Broccoli Raab	Not surveyed				

Mustard Spinach	Not surveyed				
Rape Greens	Not surveyed				
Collards	Not surveyed				
Mizuna	Not surveyed				
Mustard Greens	Not surveyed				
Kale	Not surveyed				
Celery	Not surveyed				
Cilantro	Not surveyed				
Rhubarb	Not surveyed				
Spinach	Not surveyed				
Swiss Chard	Not surveyed				
Turnip Greens	Not surveyed				
Beans (Snap, Bush, Pole, String)	Not surveyed				
Dry Beans/Peas	300,000	30,000	<2.5	25	15
Lentils	Not surveyed				
Lima Beans	2,000	3,000	55	100	85
Peas (Fresh, Green, Sweet)	40,000	<500	0	<2.5	<1
Soybeans	Not surveyed				
Alfalfa	Not surveyed				
Cotton	Not surveyed				
Safflower	Not surveyed				
Sesame	Not surveyed				
Sunflowers	Not surveyed				
Daikon Radish	Not surveyed				
Horseradish	Not surveyed				
Parsnip	Not surveyed				
Rutabaga	Not surveyed				
Sweet Potatoes	Not surveyed				
Sugar Beets	Not surveyed				
Garden Beets	Not surveyed				
Carrots	Not surveyed				
Celeriac	Not surveyed				
Radish	Not surveyed				
Asparagus	Not surveyed				
Potatoes	200,000	20,000	10	30	15
Peanuts	Not surveyed				
Stevia	Not surveyed				
Rights of Way	Surveyed but no usage reported – at national level				
Agricultural Turf	Surveyed but no usage reported – at national level				
Ornamental Lawns, Turf and associated Ornamentals	Surveyed but no usage reported – at national level				
Institutional Turf Facilities	Surveyed but no usage reported – at national level				
Golf Courses	Surveyed but no usage reported – at national level				
Nursery and Greenhouse Ornamentals	Surveyed but no usage reported – at national level				

Oregon

In 2017, pesticides were applied to over 4.6 million acres in Oregon to control for insects; weeds, grass or brush; nematodes; diseases in crops and orchards; or to control growth, thin fruit, ripen, or defoliate (USDA 2017). The previous census (2012) reported about 4.3 million acres treated for these use categories. During the period 2010-2016 an average of about 230 different active ingredients were applied annually in Oregon to control pests on crop groups: corn, wheat, vegetables and fruit, orchards and grapes, alfalfa, pasture and hay, and other crops.

EPA has provided NMFS with national and state use and usage summaries for both metolachlor and telone which cover the years 2013-2017. The usage information within these reports come from both direct pesticide usage reporting (e.g. California Department of Pesticide Regulation) as well as usage estimates based market research surveys (e.g. Agricultural Market Research Data). See Table 8 and Table 9 for the available usage information for metolachlor and telone in Oregon. Note that the consideration of pesticide usage in the environmental baseline is not limited to metolachlor and telone, rather the environmental baseline considers the usage of all pesticides within the species range. The metolachlor and telone usage tables are thus provided as an example of the type of information available.

Table 8. Oregon 1,3-Dichloropropene Agricultural and Non-Agricultural Usage. Modified from EPA National and State Use and Usage Summary (Attachment 1).

Crop	Avg. Annual Crop Acres Grown	Avg. Annual Total Lbs. AE Applied	Min. Annual PCT	Max. Annual PCT	Avg. Annual PCT
Alfalfa	400,000	Surveyed but no usage reported			
Almonds	Not Surveyed[2]				
Apples	2,000	Surveyed but no usage reported			
Apricots	Not Surveyed[2]				
Artichoke	Not Surveyed[2]				
Asparagus	Not Surveyed[2]				
Avocados	Not Surveyed[2]				
Barley	50,000	Surveyed but no usage reported			
Beans, Lima	Not Surveyed[2]				
Beans, Dry	Not Surveyed[2]				
Beans, Snap, Bush, Pole, String	10,000	Surveyed but no usage reported			
Beets	Not Surveyed[2]				
Bitter Melon	Not Surveyed[2]				
Blueberry	10,000	Surveyed but no usage reported			
Broccoli	Not Surveyed[2]				
Brussel Sprouts	Not Surveyed[2]				
Cabbage	Not Surveyed[2]				

Caneberries	10,000	Surveyed but no usage reported			
Canola	Not Surveyed[2]				
Cantaloupe	Not Surveyed[2]				
Carrots	Not Surveyed[2]				
Cauliflower	Not Surveyed[2]				
Celery	Not Surveyed[2]				
Cherries	6,000	Surveyed but no usage reported			
Chinese Cabbage	Not Surveyed[2]				
Corn	Not Surveyed[2]				
Corn, Forage-Fodder	Not Surveyed[2]				
Cotton	Not Surveyed[2]				
Cucumbers	Not Surveyed[2]				
Dates	Not Surveyed[2]				
Daikon	Not Surveyed[2]				
Eggplant	<500	Surveyed but no usage reported			
Figs	Not Surveyed[2]				
Garlic	Not Surveyed[2]				
Grape, Table/Raisin	Not Surveyed[2]				
Grape, Wine	Not Surveyed[2]				
Grapefruit	Not Surveyed[2]				
Hazelnuts (filbert)	40,000	Surveyed but no usage reported			
Honeydew	D	Surveyed but no usage reported			
Kale	Not Surveyed[2]				
Kiwifruit	Not Surveyed[2]				
Leeks	Not Surveyed[2]				
Lemons	Not Surveyed[2]				
Lettuce	Not Surveyed[2]				
Peppermint	Not Surveyed[2]				
Nectarines	<500	Surveyed but no usage reported			
Nursery Crops	Not Surveyed[2]				
Oats	10,000	Surveyed but no usage reported			
Olives	<500	Surveyed but no usage reported			
Onions	20,000	200,000	0	25	10
Oranges	Not Surveyed[2]				
Parsley	Not Surveyed[2]				
Pasture	1,700,000	Surveyed but no usage reported			
Peaches	Not Surveyed[2]				
Peanuts	Not Surveyed[2]				
Pears	20,000	Surveyed but no usage reported			
Peas	20,000	Surveyed but no usage reported			
Pecans	Not Surveyed[2]				
Peppers	Not Surveyed[2]				
Persimmons	Not Surveyed[2]				
Pineapple	Not Surveyed[2]				
Pistachio	Not Surveyed[2]				
Plums	Not Surveyed[2]				

Pomegranates	Not Surveyed[2]				
Prunes	Not Surveyed[2]				
Potatoes	40,000	1,600,000	5	40	25
Pumpkins	2,000	Surveyed but no usage reported			
Rice	Not Surveyed[2]				
Rye	Not Surveyed[2]				
Safflower	Not Surveyed[2]				
Sorghum	Not Surveyed[2]				
Soybeans	Not Surveyed[2]				
Spinach	Not Surveyed[2]				
Squash	3,000	Surveyed but no usage reported			
Strawberries	1,000	Surveyed but no usage reported			
Sugar Beets	Not Surveyed[2]				
Sugarcane	Not Surveyed[2]				
Sunflower	Not Surveyed[2]				
Sweet Corn	20,000	Surveyed but no usage reported			
Sweet Potato	Not Surveyed[2]				
Tangelo	Not Surveyed[2]				
Tangerines	Not Surveyed[2]				
Tobacco	Not Surveyed[2]				
Tomato	Not Surveyed[2]				
Walnuts	Not Surveyed[2]				
Watermelon	Not Surveyed[2]				
Wheat, spring	90,000	Surveyed but no usage reported			
Wheat, summer	700,000	Surveyed but no usage reported			
Golf Course	Surveyed but no usage reported at national level				

[1]*Not surveyed at national level*
[2]*Not surveyed for within Oregon*

Table 9. Oregon Metolachlor Agricultural and Usage. Modified from EPA National and State Use and Usage Summary (Attachment 1).

Crop	Avg. Annual Crop Acres Grown	Avg. Annual Total Lbs. AE Applied	Min. Annual PCT	Max. Annual PCT	Avg. Annual PCT
Corn	Not surveyed				
Sorghum	Not surveyed				
Sweet Corn	NA	Surveyed but no usage reported			
Tomato	Not surveyed				
Beans (Snap, Bush, Pole, String)	10,000	<500	0	5	<1
Dry Beans/Peas	Not surveyed				
Lima Beans	Not surveyed				
Peanuts	Not surveyed				
Peas (Fresh, Green, Sweet)	NA	Surveyed but no usage reported			
Soybeans	Not surveyed				

Cotton	Not surveyed	
Safflower	Not surveyed	
Sunflowers	Not surveyed	
Potatoes	NA	Surveyed but no usage reported

Table 10. Oregon S-Metolachlor Agricultural and Usage. Modified from EPA National and State Use and Usage Summary (Attachment 1).

Crop	Avg. Annual Crop Acres Grown	Avg. Annual Total Lbs. AE Applied	Min. Annual PCT	Max. Annual PCT	Avg. Annual PCT
Blueberries	9,000	(D)	(D)	(D)	(D)
Currant	Not surveyed				
Elderberry	Not surveyed				
Gooseberry	Not surveyed				
Huckleberry	Not surveyed				
Strawberries	Surveyed but no use reported				
Blackberries	Not surveyed				
Raspberries	3,000	(D)	(D)	(D)	(D)
Loganberry	Not surveyed				
Chive	Not surveyed				
Garlic	Not surveyed				
Leek	Not surveyed				
Onions	Not surveyed				
Shallot	Not surveyed				
Corn	Not surveyed				
Sorghum	Not surveyed				
Sweet Corn	20,000	10,000	5	25	10
Cantaloupes	Not surveyed				
Citron	Not surveyed				
Cucumbers	Not surveyed				
Muskmelon	Not surveyed				
Pumpkins	2,000	<500	0	15	10
Squash	Not surveyed				
Watermelons	Not surveyed				
Eggplant	Not surveyed				
Okra	Not surveyed				
Peppers	Not surveyed				
Tomatoes	Not surveyed				
Broccoli	Not surveyed				
Brussel Sprouts	Not surveyed				
Chinese Cabbage	Not surveyed				
Cauliflower	Not surveyed				
Cabbage	Not surveyed				
Broccoli Raab	Not surveyed				

Mustard Spinach	Not surveyed				
Rape Greens	Not surveyed				
Collards	Not surveyed				
Mizuna	Not surveyed				
Mustard Greens	Not surveyed				
Kale	Not surveyed				
Celery	Not surveyed				
Cilantro	Not surveyed				
Rhubarb	Not surveyed				
Spinach	Not surveyed				
Swiss Chard	Not surveyed				
Turnip Greens	Not surveyed				
Beans (Snap, Bush, Pole, String)	10,000	7,000	55	70	65
Dry Beans/Peas	Not surveyed				
Lentils	Not surveyed				
Lima Beans	Not surveyed				
Peas (Fresh, Green, Sweet)	20,000	<500	0	5	<2.5
Soybeans	Not surveyed				
Alfalfa	Not surveyed				
Cotton	Not surveyed				
Safflower	Not surveyed				
Sesame	Not surveyed				
Sunflowers	Not surveyed				
Daikon Radish	Not surveyed				
Horseradish	Not surveyed				
Parsnip	Not surveyed				
Rutabaga	Not surveyed				
Sweet Potatoes	Not surveyed				
Sugar Beets	Not surveyed				
Garden Beets	Not surveyed				
Carrots	Not surveyed				
Celeriac	Not surveyed				
Radish	Not surveyed				
Asparagus	Not surveyed				
Potatoes	40,000	20,000	15	55	35
Peanuts	Not surveyed				
Stevia	Not surveyed				
Rights of Way	Surveyed but no usage reported – at national level				
Agricultural Turf	Surveyed but no usage reported – at national level				
Ornamental Lawns, Turf and associated Ornamentals	Surveyed but no usage reported – at national level				
Institutional Turf Facilities	Surveyed but no usage reported – at national level				
Golf Courses	Surveyed but no usage reported – at national level				
Nursery and Greenhouse Ornamentals	Surveyed but no usage reported – at national level				

Idaho

In 2017, pesticides were applied to over 7.1 million acres in Idaho to control for insects; weeds, grass or brush; nematodes; diseases in crops and orchards; or to control growth, thin fruit, ripen, or defoliate (USDA 2017). The previous census (2012) reported about 6.7 million acres treated for these use categories.. During the period 2010-2016 an average of about 200 different active ingredients were applied annually in Idaho to control pests on crop groups: corn, wheat, vegetables and fruit, orchards and grapes, alfalfa, pasture and hay, and other crops.

EPA has provided NMFS with national and state use and usage summaries for both metolachlor and telone which cover the years 2013-2017. The usage information within these reports come from both direct pesticide usage reporting (e.g. California Department of Pesticide Regulation) as well as usage estimates based market research surveys (e.g. Agricultural Market Research Data). See Table 11 and Table 12 for the available usage information for metolachlor and telone in Idaho. Note that the consideration of pesticide usage in the environmental baseline is not limited to metolachlor and telone, rather the environmental baseline considers the usage of all pesticides within the species range. The metolachlor and telone usage tables are thus provided as an example of the type of information available.

Table 11. Idaho 1,3-Dichloropropene Agricultural and Non-Agricultural Usage. Modified from EPA National and State Use and Usage Summary (Attachment 1).

Crop	Avg. Annual Crop Acres Grown	Avg. Annual Total Lbs. AE Applied	Min. Annual PCT	Max. Annual PCT	Avg. Annual PCT
Alfalfa	1,100,000	Surveyed but no usage reported			
Almonds	Not Surveyed[2]				
Apples	Not Surveyed[2]				
Apricots	Not Surveyed[2]				
Artichoke	Not Surveyed[2]				
Asparagus	Not Surveyed[2]				
Avocados	Not Surveyed[2]				
Barley	600,000	Surveyed but no usage reported			
Beans, Lima	Not Surveyed[2]				
Beans, Dry	200,000	Surveyed but no usage reported			
Beans, Snap, Bush, Pole, String	Not Surveyed[2]				
Beets	Not Surveyed[2]				
Bitter Melon	Not Surveyed[2]				
Blueberry	<500	Surveyed but no usage reported			
Broccoli	Not Surveyed[2]				
Brussel Sprouts	Not Surveyed[2]				
Cabbage	Not Surveyed[2]				

Caneberries	Not Surveyed[2]				
Canola	Not Surveyed[2]				
Cantaloupe	Not Surveyed[2]				
Carrots	Not Surveyed[2]				
Cauliflower	Not Surveyed[2]				
Celery	Not Surveyed[2]				
Cherries	Not Surveyed[2]				
Chinese Cabbage	Not Surveyed[2]				
Corn	300,000	Surveyed but no usage reported			
Corn, Forage-Fodder	Not Surveyed[2]				
Cotton	Not Surveyed[2]				
Cucumbers	Not Surveyed[2]				
Dates	Not Surveyed[2]				
Daikon	Not Surveyed[2]				
Eggplant	<500	Surveyed but no usage reported			
Figs	Not Surveyed[2]				
Garlic	Not Surveyed[2]				
Grape, Table/Raisin	Not Surveyed[2]				
Grape, Wine	Not Surveyed[2]				
Grapefruit	Not Surveyed[2]				
Hazelnuts (filbert)	Not Surveyed[2]				
Honeydew	-	Surveyed but no usage reported			
Kale	Not Surveyed[2]				
Kiwifruit	Not Surveyed[2]				
Leeks	Not Surveyed[2]				
Lemons	Not Surveyed[2]				
Lettuce	Not Surveyed[2]				
Peppermint	Not Surveyed[2]				
Nectarines	<500	Surveyed but no usage reported			
Nursery Crops	Not Surveyed[2]				
Oats	10,000	Surveyed but no usage reported			
Olives	Not Surveyed[2]				
Onions	8,000	20,000	0	15	<2.5
Oranges	Not Surveyed[2]				
Parsley	Not Surveyed[2]				
Pasture	1,300,000	Surveyed but no usage reported			
Peaches	Not Surveyed[2]				
Peanuts	Not Surveyed[2]				
Pears	Not Surveyed[2]				
Peas	Not Surveyed[2]				
Pecans	Not Surveyed[2]				
Peppers	Not Surveyed[2]				
Persimmons	Not Surveyed[2]				
Pineapple	Not Surveyed[2]				
Pistachio	Not Surveyed[2]				
Plums	Not Surveyed[2]				

Pomegranates	Not Surveyed[2]				
Prunes	Not Surveyed[2]				
Potatoes	300,000	2,700,000	5	10	10
Pumpkins	Not Surveyed[2]				
Rice	Not Surveyed[2]				
Rye	Not Surveyed[2]				
Safflower	Not Surveyed[2]				
Sorghum	Not Surveyed[2]				
Soybeans	Not Surveyed[2]				
Spinach	Not Surveyed[2]				
Squash	Not Surveyed[2]				
Strawberries	Not Surveyed[2]				
Sugar Beets	200,000	Surveyed but no usage reported			
Sugarcane	Not Surveyed[2]				
Sunflower	Not Surveyed[2]				
Sweet Corn	Not Surveyed[2]				
Sweet Potato	Not Surveyed[2]				
Tangelo	Not Surveyed[2]				
Tangerines	Not Surveyed[2]				
Tobacco	Not Surveyed[2]				
Tomato	Not Surveyed[2]				
Walnuts	Not Surveyed[2]				
Watermelon	Not Surveyed[2]				
Wheat, spring	500,000	Surveyed but no usage reported			
Wheat, summer	800,000	Surveyed but no usage reported			
Golf Course	Surveyed but no usage reported at national level				

[1]*Not surveyed at national level*
[2]*Not surveyed for within Idaho*

Table 12. Idaho Metolachlor Agricultural and Usage. Modified from EPA National and State Use and Usage Summary (Attachment 1).

Crop	Avg. Annual Crop Acres Grown	Avg. Annual Total Lbs. AE Applied	Min. Annual PCT	Max. Annual PCT	Avg. Annual PCT
Corn	300,000	20,000	<1	10	5
Sorghum	Not surveyed				
Sweet Corn	Not surveyed				
Tomato	Not surveyed				
Beans (Snap, Bush, Pole, String)	Not surveyed				
Dry Beans/Peas	200,000	2,000	0	<2.5	<1
Lima Beans	Not surveyed				
Peanuts	Not surveyed				
Peas (Fresh, Green, Sweet)	Not surveyed				
Soybeans	Not surveyed				

Cotton	Not surveyed				
Safflower	Not surveyed				
Sunflowers	Not surveyed				
Potatoes	300,000	2,000	0	<1	<1

[1]Not surveyed at national level
[2]Not surveyed for within Washington

Table 13. Idaho S-Metolachlor Agricultural and Usage. Modified from EPA National and State Use and Usage Summary (Attachment 1).

Crop	Avg. Annual Crop Acres Grown	Avg. Annual Total Lbs. AE Applied	Min. Annual PCT	Max. Annual PCT	Avg. Annual PCT
Blueberries	Not surveyed				
Currant	Not surveyed				
Elderberry	Not surveyed				
Gooseberry	Not surveyed				
Huckleberry	Not surveyed				
Strawberries	Not surveyed				
Blackberries	Not surveyed				
Raspberries	Not surveyed				
Loganberry	Not surveyed				
Chive	Not surveyed				
Garlic	Not surveyed				
Leek	Not surveyed				
Onions	8,000	600	0	40	15
Shallot	Not surveyed				
Corn	300,000	20,000	<2.5	10	5
Sorghum	Not surveyed				
Sweet Corn	Not surveyed				
Cantaloupes	Not surveyed				
Citron	Not surveyed				
Cucumbers	Not surveyed				
Muskmelon	Not surveyed				
Pumpkins	Not surveyed				
Squash	Not surveyed				
Watermelons	Not surveyed				
Eggplant	Not surveyed				
Okra	Not surveyed				
Peppers	Not surveyed				
Tomatoes	Not surveyed				

Broccoli	Not surveyed				
Brussel Sprouts	Not surveyed				
Chinese Cabbage	Not surveyed				
Cauliflower	Not surveyed				
Cabbage	Not surveyed				
Broccoli Raab	Not surveyed				
Mustard Spinach	Not surveyed				
Rape Greens	Not surveyed				
Collards	Not surveyed				
Mizuna	Not surveyed				
Mustard Greens	Not surveyed				
Kale	Not surveyed				
Celery	Not surveyed				
Cilantro	Not surveyed				
Rhubarb	Not surveyed				
Spinach	Not surveyed				
Swiss Chard	Not surveyed				
Turnip Greens	Not surveyed				
Beans (Snap, Bush, Pole, String)	Not surveyed				
Dry Beans/Peas	200,000	20,000	<2.5	15	10
Lentils	Not surveyed				
Lima Beans	Not surveyed				
Peas (Fresh, Green, Sweet)	Not surveyed				
Soybeans	Not surveyed				
Alfalfa	Not surveyed				
Cotton	Not surveyed				
Safflower	Not surveyed				
Sesame	Not surveyed				
Sunflowers	Not surveyed				
Daikon Radish	Not surveyed				
Horseradish	Not surveyed				
Parsnip	Not surveyed				
Rutabaga	Not surveyed				
Sweet Potatoes	Not surveyed				
Sugar Beets	200,000	<500	0	<1	<1
Garden Beets	Not surveyed				
Carrots	Not surveyed				
Celeriac	Not surveyed				
Radish	Not surveyed				
Asparagus	Not surveyed				
Potatoes	300,000	60,000	15	20	15

Peanuts	Not surveyed
Stevia	Not surveyed
Rights of Way	Surveyed but no usage reported – at national level
Agricultural Turf	Surveyed but no usage reported – at national level
Ornamental Lawns, Turf and associated Ornamentals	Surveyed but no usage reported – at national level
Institutional Turf Facilities	Surveyed but no usage reported – at national level
Golf Courses	Surveyed but no usage reported – at national level
Nursery and Greenhouse Ornamentals	Surveyed but no usage reported – at national level

9.3.4 Monitoring Data

Washington

The Washington State Department of Agriculture – Natural Resources Assessment Section (NRAS) program focuses on monitoring and evaluating the impacts of agriculture chemicals on Washington State’s natural resources, including ESA-listed endangered species. Several programs at NRAS have high relevance to this consultation including: 1) the agricultural land use mapping geodatabase; 2) the surface and groundwater monitoring program; and 3) the development of crop-based typical use profiles which describe factors including rate, application timing, percent crop treated, and application method.

The WSDA agricultural land use geodatabase combines targeted fieldwork, expertise in agricultural practice/crop identification, and existing land use data to provide high quality crop mapping data. The crop data is classified by several categories: 1) general crop group (berry, cereal grain, orchard, vegetable, etc.); 2) crop types (blueberry, wheat, apple, potato, etc.), and 3) irrigation method (center pivot, drip, rill, none, etc.). Additional information on WSDA’s agricultural land use mapping program, including an interactive land use web map, are available at https://agr.wa.gov/departments/land-and-water/natural-resources/agricultural-land-use.

The WSDA has monitored surface water throughout the state since 2003. The program adds and removes sampling sites and subbasins based on pesticide detection history, changing pesticide use practices, site conditions, land use patterns, and the presence of listed threatened or endangered species (Tuttle et al. 2017). Currently, the program is monitoring waters at 16 locations including three locations in urban settings. The complete set of surface water monitoring reports, as well as an interactive surface water monitoring web map, are available at https://agr.wa.gov/departments/land-and-water/natural-resources.

Washington State also has a voluntary program that assists growers in addressing water rights issues within a watershed. Several watersheds have elected to participate, forming Comprehensive Irrigation District Management Plans (CIDMPs). The CIDMP is a collaborative process between government and landowners and growers; the parties determine how they will ensure growers get the necessary volume of water while also guarding water quality. This structure allows for greater flexibility in implementing mitigation measures to comply with both the CWA and the ESA.

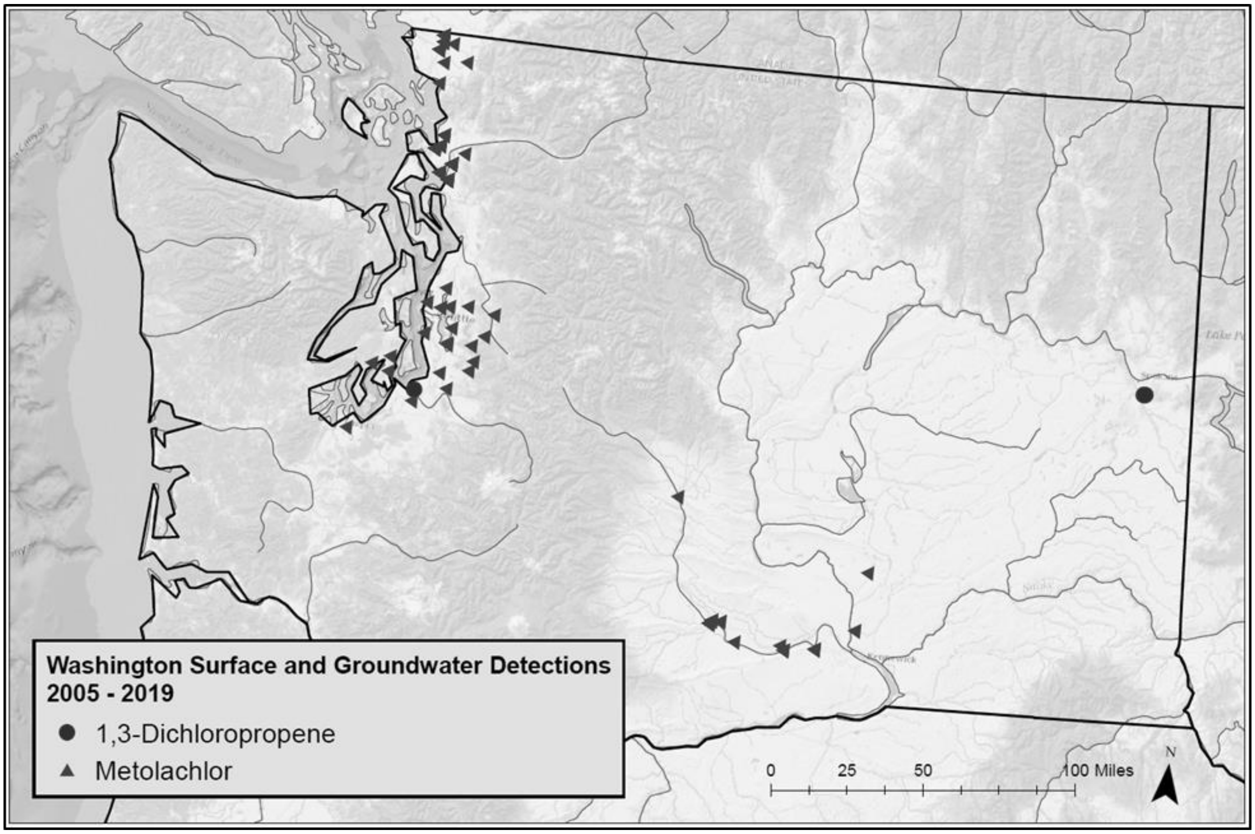


Figure 4. Water monitoring detections of 1,3-Dichloropropene and metolachlor in Washington state, 2005 to 2019. Data were accessed via the National Water Quality Portal (https://www.waterqualitydata.us/) and Washington State's Environmental Information Management System database.

Oregon

In Oregon, water quality policies related to pesticides is handled by several state agencies. An interagency team was thus formed: the Water Quality Pesticide Management Team (WQPMT). WQPMT facilitates and coordinates water quality activities such as monitoring, analysis and interpretation of data, effective response measures, and management solutions. The initial goal of the WQPMT was to develop and implement a statewide pesticide management plan (PMP), which was approved by EPA in 2011. The overall objective of the program are: 1) to identify and characterize pesticides that may pose a risk to water resources; 2) actively manage them by facilitating efforts to reduce or prevent contamination below the reference point (an established benchmark or standard); and 3) demonstrate how management efforts are keeping concentrations at acceptable levels.

The Oregon Pesticide Stewardship Partnership (PSP) Program is a cooperative, voluntary process that is designed to identify potential concerns regarding surface and groundwater affected by pesticide use within Oregon. The PSP Program began with a small number of pilot projects in north Mid-Columbia watersheds in the late 1990s and early 2000s as an alternative to regulatory approaches for achieving reductions in current use pesticides from application activities. Since 2013, the Oregon Legislature has supported the implementation and expansion of the PSP Program, that now addresses pesticides applied in watersheds that encompass applications from urban, forested, agricultural and mixed land uses (taken from the Pesticide Stewardship Partnership Program 2015 – 2017 Biennial Report; Cook and Masterson, 2018).

Between 2015 and 2017 the PSP surface water monitoring program collected samples across nine watersheds and two additional pilot studies. The program analyzes for 89 registered pesticides, 26 non-registered pesticides, and 18 pesticide metabolites. Ground water monitoring is conducted by the Oregon Department of Environmental Quality in the Walla Walla and Middle Rogue watersheds. The PSP also maintains a Waste Pesticide Collection program which, between 2015 and 2017 resulted in the removal of 152,679 pounds of unused or unusable pesticides from sensitive watersheds (Cook and Masterson, 2018). NMFS sees high potential in programs like this in aiding the recovery of listed aquatic species. Additional information on the PSP, including biennial summaries can be found at https://www.oregon.gov/ODA/programs/Pesticides/Water/Pages/PesticideStewardship.aspx.

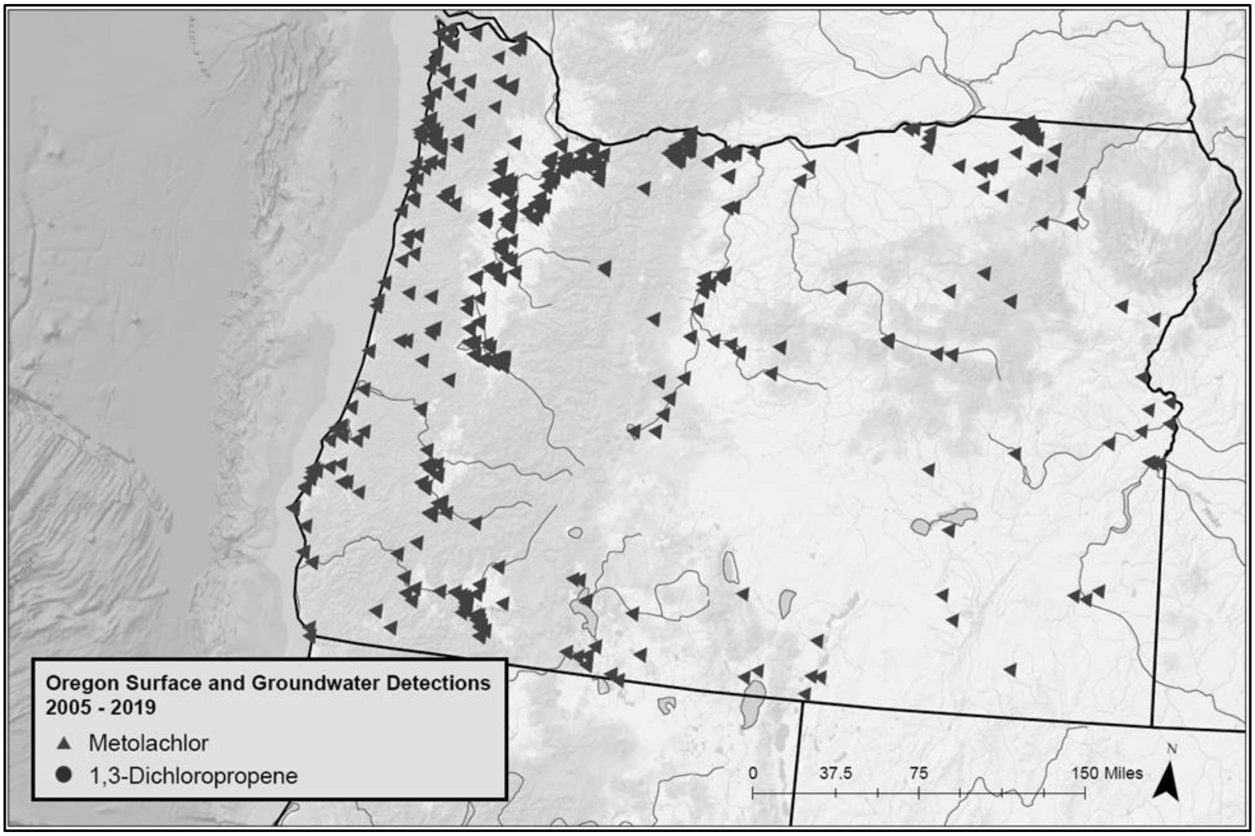


Figure 5. Water monitoring detections of 1,3-Dichloropropene and Metolachlor in Oregon, 2005 to 2019. Data were accessed via the National Water Quality Portal (https://www.waterqualitydata.us/) and the Oregon Ambient Water Quality Monitoring System data portal.

Idaho

The Idaho State Department of Agriculture (ISDA) has developed regional and local agricultural ground and surface water monitoring programs. The goal of these programs are to conduct monitoring to fill data and information gaps to effectively and efficiently monitor pesticides. ISDA conducts monitoring in partnership with the Idaho Department of Environmental Quality (DEQ), Idaho Department of Water Resources (IDWR), and many other state, local, and private agencies, organizations, businesses, and individuals. Every year, about 400 monitoring sites are sampled. Most sites are sampled once every five years. Water quality results include: bacteria, nutrients, common ions (e.g. calcium, magnesium), trace elements (e.g. iron, arsenic, lead), pesticides, volatile organic compounds, and radioactivity. Additional information on the statewide groundwater quality monitoring program, including reports, maps, and publications, can be found at https://idwr.idaho.gov/water-data/groundwater-quality/.

The Idaho State Department of Agriculture has published a Best Management Practices (BMP) guide for pesticide use. The BMPs include "core" voluntary measures that will prevent pesticides from leaching into soil and groundwater. These measures include applying pest-specific controls, being aware of the depth to ground water, and developing an Irrigation Water Management Plan.

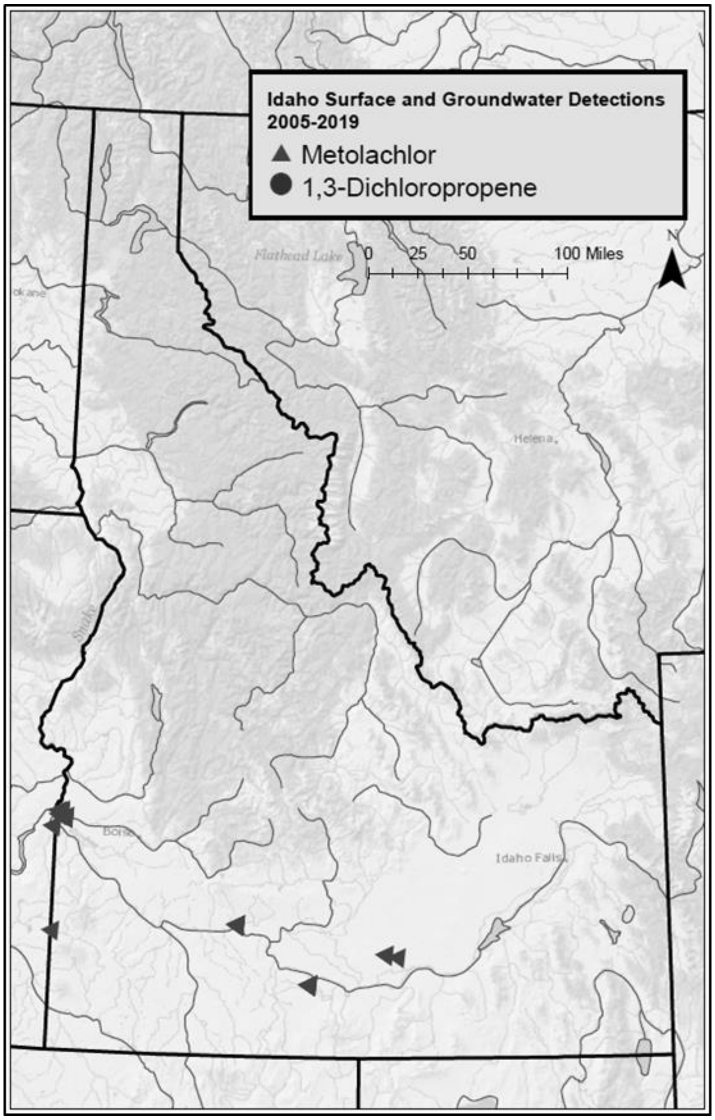


Figure 6. Water monitoring detections of 1,3-Dichloroprene and Metolachlor in Idaho, 2005 to 2019. Data were accessed via the National Water Quality Portal (https://www.waterqualitydata.us/).

Additional Highlighted Programs

The Columbia Gorge Fruit Growers Association is a non-profit organization dedicated to the needs of growers in the mid-Columbia area. The association brings together over 440 growers and 20 shippers of fruit from Oregon and Washington. It has issued a BMP handbook for pesticide use, including information on alternative methods of pest control. The mid-Columbia area is of particular concern, as many orchards are in close proximity to streams.

Stewardship Partners is a non-profit organization in Washington State that works to build partnerships between landowners, government, and non-profit organizations. In large part, its work focuses on helping landowners to restore fish and wildlife habitat while maintaining the economic viability of their farmland. Projects include restoring riparian areas, reestablishing floodplain connectivity, and removing blocks to fish passage. Another current project is to promote rain gardens as a method of reducing surface water runoff from developed areas. Rain gardens mimic natural hydrology, allowing water to collect and infiltrate the soil.

Stewardship Partners also collaborates with the Oregon-based Salmon-Safe certification program (www.salmonsafe.org). Salmon-Safe is an independent eco-label recognizing organizations who have adopted conservation practices that help restore native salmon habitat in Pacific Northwest, California, and British Columbia. These practices protect water quality, fish and wildlife habitat, and overall watershed health. While the program began with a focus on agriculture, it has since expanded to include industrial and urban sites as well. The certification process includes pesticide restrictions. Salmon-Safe has produced a list of “high risk” pesticides which, if used, would prevent a site from becoming certified. If a grower wants an exception, they must provide written documentation that demonstrates a clear need for use of the pesticide, that no safer alternatives exist, and that the method of application (such as timing, location, and amount used) represents a negligible risk to water quality and fish habitat. Over 300 farms, 250 vineyards, and 240 parks currently have the Salmon-Safe certification. Salmon-Safe has also worked with over 20 corporate / industrial sites and is beginning programs that focus on golf courses and nurseries.

9.3.5 Regional Mortality Factors

Ranching and Agriculture Ranching, agriculture, and related services in the Pacific Northwest employ more than nine times the national average (19% of the households within the basin) (NRC 2004). Ranching practices have led to increased soil erosion and sediment loads within adjacent tributaries. The worst of these effects may have occurred in the late 1800s and early 1900s from deliberate burning to increase grass production (NRC 2004). Several measures are currently in place to reduce the impacts of grazing. Measures include restricted grazing in degraded areas, reduced grazing allotments, and lowered stocking rates. Today, the agricultural industry impacts water quality within the basin. Agriculture is second only to the large-scale influences of hydromodification projects regarding power generation and irrigation. Water quality impacts from agricultural activities include alteration of the natural temperature regime, insecticide and herbicide contamination, and increased suspended sediments. During general agricultural operations, pesticides are applied on a variety of crops for pest control. These pesticides may contaminate surface water via runoff especially after rain events following application. Agricultural uses of the a.i.s assessed in this Opinion are discussed in the *Description of the Proposed Action*.

Water Diversions for Agriculture. Agriculture and ranching increased steadily within the Columbia River basin from the mid- to late-1800s. By the early 1900s, agricultural opportunities began increasing at a much more rapid pace with the creation of more irrigation canals and the passage of the Reclamation Act of 1902 (NRC 2004). Today, agriculture represents the largest water user within the basin (>90%).

Roughly 6% of the annual flow from the Columbia River is diverted for the irrigation of 7.3 million acres of croplands within the basin. The vast majority of these agricultural lands are located along the lower Columbia River, the Willamette, Yakima, Hood, and Snake rivers, and the Columbia Plateau (Hinck et al. 2004).

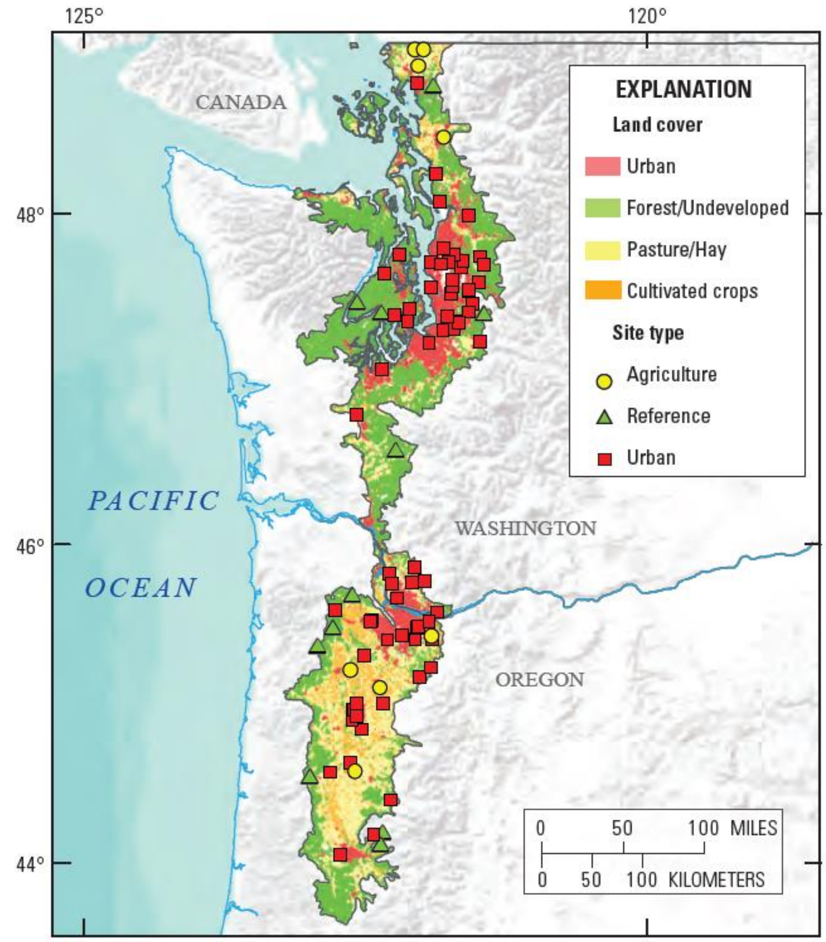
The impacts of these water diversions include an increase nutrient load, sediments (from bank erosion), and temperature. Flow management and climate changes have further decreased the delivery of suspended particulate matter and fine sediment to the estuary. The conditions of the habitat (shade, woody debris, over-hanging vegetation) whereby salmonids are constrained by low flows also may make fish more or less vulnerable to predation, elevated temperatures, crowding, and disease. Water flow effects on salmonids may seriously impact adult migration and water quality conditions for spawning and rearing salmonids. High temperature may also result from the loss of vegetation along streams that used to shade the water and from new land uses (buildings and pavement) whereby rainfall picks up heat before it enters into an adjacent stream. Runoff inputs from multiple land use may further pollute receiving waters inhabited by fish or along fish migratory corridors.

Analysis of surface and ground water contaminants were conducted for a number of basins within the Pacific Northwest Region by the NAWQA program. The USGS has a number of fixed water quality sampling sites throughout various tributaries of the Columbia River. Many of the water quality sampling sites have been in place for decades. Water volumes, crop rotation patterns, crop type, and basin location are some of the variables that influence the distribution and frequency of pesticides within a tributary. Detection frequencies for a particular pesticide can vary widely. In addition to current use-chemicals, legacy chemicals continue to pose a serious problem to water quality and fish communities despite their ban in the 1970s and 1980s (Hinck et al. 2004).

Fish and macroinvertebrate communities exhibit an almost linear decline in condition as the level of agriculture intensity increases within a basin (Cuffney et al. 1997; Fuhrer et al. 2004). A study conducted in the late 1990s examined 11 species of fish, including anadromous and resident fish collected throughout the basin, for a suite of 132 contaminants. They included 51 semi-volatile chemicals, 26 pesticides, 18 metals, 7 PCBs, 20 dioxins, and 10 furans. Sampled fish tissues revealed PCBs, metals, chlorinated dioxins and furans (products of wood pulp bleaching operations), and other contaminants.

USGS NAWQA Regional Stream Quality Assessment

In 2015, the USGA sampled 88 sites as part of the Pacific Northwest Stream Quality Assessment (Figure 7). Water samples were analyzed for about 230 dissolved pesticides and pesticide degradates. Results from the 2015 water quality assessment were considered and are available at https://webapps.usgs.gov/rsqa/#!/region/PNSQA.



Base-map image is the intellectual property of Esri and isused herein under license. Copyright © 2014 Esri and its licensors. All rights reserved. Base modified from Esri digital data, 1:70,000 (Esri, 2009) Land cover from National Land Cover Database, 2006, Web Mercator Projection, World Geodetic System of 1984 (WGS 84)

Figure 7. The Pacific Northwest Stream Quality Assessment study area. Taken from Van Metre et al. 2017: Figure 1: "Study area boundary is based on the Willamette Valley and Puget Lowlands level 3 ecological regions (ecoregions) of the United States."

NAWQA Analysis: Yakima River Basin

The regional NAWQA summary presented here represents data collected during the period 1992-2001. USGS data from 2002-2011 is provided at the national-level (Ryberg et al. 2014) and is summarized in the general overview.

The Yakima River Basin is one of the most agriculturally productive areas in the U.S. (Fuhrer et al. 2004). Croplands within the Yakima Basin account for about 16% of the total basin area of which 77% is irrigated. The extensive irrigation-water delivery and drainage system in the Yakima River Basin greatly controls water quality conditions and aquatic health in agricultural streams, drains, and the Yakima River (Fuhrer et al. 2004). From 1999 to 2000, the USGS conducted a NAWQA study in the Yakima River Basin. Fuhrer *et al.* (2004) reported that nitrate and orthophosphate were the dominant forms of nitrogen and phosphorus found in the Yakima River and its agricultural tributaries. Arsenic, a known human carcinogen, was also detected in agricultural drains at elevated concentrations.

The USGS also detected 76 pesticide compounds in the Yakima River Basin. They include 38 herbicides, 17 insecticides (such as carbaryl, diazinon, and malathion), 15 breakdown products, and 6 others (Fuhrer et al. 2004). In agricultural drainages, insecticides were detected in 80% of samples and herbicides were present in 91%. They were also detected in mixed landuse streams – 71% and 90 %, respectively. The most frequently detected pesticides were 2,4-D, terbacil, azinphos methyl, atrazine, carbaryl, and deethylatrazine. Generally, compounds were detected in tributaries more often than in the Yakima River itself.

Ninety-one percent of the samples collected from the small agricultural watersheds contained at least two pesticides or pesticide breakdown products. Samples contained a median of 8 and a maximum of 26 chemicals (Fuhrer et al. 2004). The herbicide 2,4-D, occurred most often in the mixtures, along with azinphos methyl, the most heavily applied pesticide, and atrazine, one of the most aquatic mobile pesticides (Fuhrer et al. 2004). The most frequently detected pesticides in the Yakima River Basin are total DDTs, dichloro-diphenyl-dichloroethane (DDD), and dieldrin (Fuhrer et al. 2004; Johnson and Newman 1983; Joy 2002; Joy and Madrone 2002). Nevertheless, concentrations of total DDT in water have decreased since 1991. These reductions are attributed to erosion-controlling BMPs.

Another study conducted by the USGS between May 1999 and January 2000 in the surface waters of Yakima Basin detected 25 pesticide compounds (Ebbert and Embry 2001). Atrazine was the most widely detected herbicide and azinphos methyl was the most widely detected insecticide. Other detected compounds include simazine, terbacil, trifluralin; deethylatrazine, carbaryl, diazinon, malathion, and DDE.

NAWQA Analysis: Central Columbia Plateau

The regional NAWQA summary presented here represents data collected during the period 1992-2001. USGS data from 2002-2011 is provided at the national-level (Ryberg et al. 2014) and is summarized in the general overview.

The Central Columbia Plateau is a prominent apple growing region. The USGS sampled 31 surface-water sites representing agricultural land use, with different crops, irrigation methods, and other agricultural practices for pesticides in Idaho and Washington from 1992 - 1995 (Williamson et al. 1998). Pesticides were detected in samples from all sites, except for the Palouse River at Laird Park (a headwaters site in a forested area). Many pesticides were detected in surface water at very low concentrations. Concentrations of six pesticides exceeded freshwater-chronic criteria for the protection of aquatic life in one or more surface-water samples. They include the herbicide triallate and five insecticides (azinphos methyl, chlorpyrifos, diazinon, *gamma*-HCH, and parathion).

Detections at four sites were high, ranging from 12 to 45 pesticides. The two sites with the highest detection frequencies are in the Quincy-Pasco subunit, where irrigation and high chemical use combine to increase transport of pesticides to surface waters. Pesticide detection frequencies at sites in the dryland farming (non-irrigated) areas of the North-Central and Palouse subunits are below the national median for NAWQA sites. All four sites had at least one pesticide concentration that exceeded a water-quality standard or guideline.

Concentrations of organochlorine pesticides and PCBs are higher than the national median (50^{th} percentile) at seven of 11 sites; four sites were in the upper 25% of all NAWQA sites. Although most of these compounds have been banned, they still persist in the environment. Elevated concentrations were observed in dryland farming areas and irrigated areas.

NAWQA Analysis: Willamette Basin

The regional NAWQA summary presented here represents data collected during the period 1992-2001. USGS data from 2002-2011 is provided at the national-level (Ryberg et al. 2014) and is summarized in the general overview.

From 1991 to 1995, the USGS also sampled surface waters in the Willamette Basin, Oregon. Wentz *et al.* (1998) reported that 50 pesticides and pesticide degradates of the 86 were detected in streams. Atrazine, simazine, metolachlor, deethylatrazine, diuron, and diazinon were detected in more than one-half of stream samples (Wentz et al. 1998). The highest pesticide concentrations generally occurred in streams draining predominately agricultural land. Forty-nine pesticides were detected in streams draining predominantly agricultural land. About 25 pesticides were detected in streams draining mostly urban areas.

NAWQA Analysis: Lower Clackamas River Basin

The regional NAWQA summary presented here represents data collected during the period 1992-2001. USGS data from 2002-2011 is provided at the national-level (Ryberg et al. 2014) and is summarized in the general overview.

Carpenter *et al.* (2008) summarized four different studies that monitored pesticide levels in the lower Clackamas River from 2000 to 2005. Water samples were collected from sites in the lower mainstem Clackamas River, its tributaries, and in pre- and post-treatment drinking-water. In all, 63 pesticide compounds (33 herbicides, 15 insecticides, 6 fungicides, and 9 degradates) were detected in samples collected during storm and nonstorm conditions. Fifty-seven pesticides or degradates were detected in the tributaries (mostly during storms), whereas fewer compounds (26) were detected in samples of source water from the lower mainstem Clackamas River, with fewest (15) occurring in drinking water. The two most commonly detected pesticides were the triazine herbicide simazine and atrazine, which occurred in about one- half of samples. The a.i. in common household herbicides Roundup (glyphosate) and Cross bow (triclopyr and 2,4-D) were frequently detected together.

NAWQA Analysis: Upper Snake River Basin

The regional NAWQA summary presented here represents data collected during the period 1992-2001. USGS data from 2002-2011 is provided at the national-level (Ryberg et al. 2014) and is summarized in the general overview.

The USGS conducted a water quality study from 1992 - 1995 in the upper Snake River basin, Idaho and Wyoming (Clark et al. 1998). This basin does not overlap with any of the 28 ESU/DPSs, though it does feed into the migratory corridor of all Snake River species, and eventually into the Columbia River. In basin wide stream sampling in May and June 1994, Eptam, atrazine (and desethylatrazine), metolachlor, and alachlor were the most commonly detected pesticides. These compounds accounted for 75% of all detections. Seventeen different pesticides were detected downstream from American Falls Reservoir.

Hood River Basin

The Hood River Basin ranks fourth in the state of Oregon in total agricultural pesticide usage (Jenkins et al. 2004). The land in Hood River basin is used to grow five crops: alfalfa, apples, cherries, grapes, and pears. About 61 a.i.s, totaling 1.1 million pounds, are applied annually to roughly 21,000 acres. Of the top nine, three are carbamates and three are organophosphate insecticides (*Table 14*).

Table 14. Summarized detection information from (Carpenter et al. 2008).

Active Ingredient	Class	Lbs applied
Oil	-	624,392
Lime Sulfur	-	121,703
Mancozeb	Carbamate	86,872
Sulfur	-	60,552
Ziram	Carbamate	45,965
Azinphos methyl	Organophosphate	22,294

Active Ingredient	Class	Lbs applied
Metam-Sodium	Carbamate	17,114
Phosmet	Organophosphate	15,919
Chlorpyrifos	Organophosphate	14,833

The Hood River basin contains approximately 400 miles of perennial stream channel, of which an estimated 100 miles is accessible to anadromous fish. These channels are important rearing and spawning habitat for salmonids, making pesticide drift a major concern for the area.

NAWQA Analysis: Puget Sound Basin

The regional NAWQA summary presented here represents data collected during the period 1992-2001. USGS data from 2002-2011 is provided at the national-level (Ryberg et al. 2014) and is summarized in the general overview.

The USGS sampled waters in the Puget Sound Basin between 1996 and 1998. Ebbert et al. (2000) reported that 26 of 47 analyzed pesticides were detected. A total of 74 manmade organic chemicals were detected in streams and rivers, with different mixtures of chemicals linked to agricultural and urban settings NAWQA results reported that the herbicides atrazine, prometon, simazine and tebuthiuron were the most frequently detected herbicides in surface and ground water (Bortleson and Ebbert 2000). Herbicides were the most common type of pesticide found in an agricultural stream (Fishtrap Creek) and the only type of pesticide found in shallow ground water underlying agricultural land (Bortleson and Ebbert 2000). The most commonly detected VOC in the agricultural land use study area was associated with the application of fumigants to soils prior to planting (Bortleson and Ebbert 2000). One or more fumigant-related compounds (1,2-dichloropropane, 1,2,2-trichloropropane, and 1,2,3-trichloropropane) were detected in over half of the samples. Insecticides, in addition to herbicides, were detected frequently in urban streams (Bortleson and Ebbert 2000). Sampled urban streams showed the highest detection rate for the three insecticides: carbaryl, diazinon, and malathion. No insecticides were found in shallow ground water below urban residential land (Bortleson and Ebbert 2000).

Urban and Industrial Development The largest urban area in the Columbia River basin is the greater Portland metropolitan area, located at the mouth of the Willamette River. Portland’s population exceeds 500,000 (Hinck et al. 2004). Although the basin’s land cover is about 8% of the U.S. total land mass, its human population is one-third the national average (about 1.2% of the U.S. population) (Hinck et al. 2004).

Discharges from sewage treatment plants, paper manufacturing, and chemical and metal production represent the top three permitted sources of contaminants within the lower Columbia River basin according to discharge volumes and concentrations (Rosetta and Borys 1996). Rosetta and Borys (1996) review of 1993 data indicate that 52% of the point source waste water discharge volume is from sewage treatment plants, 39% from paper and allied products, 5% from chemical and allied products, and 3% from primary metals. However, the paper and allied products industry are the primary sources of the suspended sediment load (71%). Additionally, 26% of the point source waste water discharge volume comes from sewage treatment plants and 1% is from the chemical and allied products industry. Nonpoint source discharges (urban stormwater runoff) account for significant pollutant loading to the lower basin, including most organics and over half of the metals. Although rural nonpoint sources contributions were not calculated, Rosetta and Borys (1996) surmised that in some areas and for some contaminants, rural areas may contribute a large portion of the nonpoint source discharge. This is particularly true for pesticide contamination in the upper river basin where agriculture is the predominant land use.

Water quality has been reduced by phosphorus loads and decreased water clarity, primarily along the lower and middle sections of the Columbia River Estuary. Although sediment quality is generally very good, benthic indices have not been established within the estuary. Fish tissue contaminant loads (PCBs, DDT, DDD, DDE, and mercury) are high and present a persistent and long lasting effect on estuary biology. Health advisories have been recently issued for people eating fish in the area that contain high levels of dioxins, PCBs, and pesticides.

In the 1930s, all of western Washington contained about 15.5 million acres of "harvestable" forestland. By 2004, the total acreage was nearly half that originally surveyed (PSAT 2007). Forest cover in Puget Sound alone was about 5.4 million acres in the early 1990s. About a decade later, the region had lost another 200,000 acres of forest cover with some watersheds losing more than half the total forested acreage. The most intensive loss of forest cover occurred in the Urban Growth Boundary, which encompasses specific parts of the Puget Lowland. In this area, forest cover declined by 11% between 1991 and 1999 (Ruckelshaus and McClure 2007). Projected land cover changes indicate that trends are likely to continue over the next several decades with population changes (Ruckelshaus and McClure 2007). Coniferous forests are also projected to decline at an alarming rate as urban uses increase.

According to the 2001 State of the Sound report (PSAT 2007), impervious surfaces covered 3.3% of the region, with 7.3% of lowland areas (below 1,000 ft elevation) covered by impervious surfaces. From 1991 to 2001, the amount of impervious surfaces increased 10.4% region wide. Consequently, changes in rainfall delivery to streams alter stream flow regimes. Peak flows are increased and subsequent base flows are decreased and alter in-stream habitat. Stream channels are widened and deepened and riparian vegetation is typically removed which can cause increases in water temperature and will reduce the amounts of woody debris and organic matter to the stream system.

Pollutants carried into streams from urban runoff include pesticides, heavy metals, PCBs, polybrominated diphenyl ethers (PBDEs) compounds, PAHs, nutrients (phosphorus and nitrogen), and sediment (*Table 15*). Other ions generally elevated in urban streams include calcium, sodium, potassium, magnesium, and chloride ions where sodium chloride is used as the principal road deicing salt (Paul and Meyer 2001). The combined effect of increased concentrations of ions in streams is the elevated conductivity observed in most urban streams.

Table 15. Examples of Water Quality Contaminants in Residential and Urban Areas.

Contaminant groups	Select constituents	Select example(s)	Source and Use Information
Fertilizers	Nutrients	Phosphorus Nitrogen	lawns, golf courses, urban landscaping
Heavy Metals	Pb, Zn, Cr, Cu, Cd, Ni, Hg, Mg	Cu	brake pad dust, highway and parking lot runoff, rooftops
Pesticides including- Insecticides (I) Herbicides (H) Fungicides (F) Wood Treatment chemicals (WT) Legacy Pesticides (LP) Other ingredients in pesticide formulations (OI)	Organophosphates (I) Carbamates (I) Organochlorines (I) Pyrethroids (I) Triazines (H) Chloroacetanilides (H) Chlorophenoxy acids (H) Triazoles (F) Copper containing fungicides (F) Organochlorines (LP) Surfactants/adjuvants (OI)	Chlorpyrifos (I) Diazinon (I) Carbaryl (I) Atrazine (H) Esfenvalerate (I) Creosote (WT) DDT (LP) Copper sulfate (F) Metalaxyl (F) Nonylphenol (OI)	golf courses, right of ways, lawn and plant care products, pilings, bulkheads, fences
Pharmaceuticals and personal care products	Natural and synthetic hormones soaps and detergents	Ethinyl estradiol Nonylphenol	hospitals, dental facilities, residences, municipal and industrial waste water discharges
Polyaromatic hydrocarbons (PAHs)	Tricyclic PAHs	Phenanthrene	fossil fuel combustion, oil and gasoline leaks, highway runoff, creosote-treated wood
Industrial chemicals	PCBs PBDEs Dioxins	Penta-PBDE	utility infrastructure, flame retardants, electronic equipment

Many other metals have been found in elevated concentrations in urban stream sediments including arsenic, iron, boron, cobalt, silver, strontium, rubidium, antimony, scandium, molybdenum, lithium, and tin (Wheeler et al. 2005). The concentration, storage, and transport of metals in urban streams are connected to particulate organic matter content and sediment characteristics. Organic matter has a high binding capacity for metals and both bed and suspended sediments with high organic matter content frequently exhibit 50 - 7,500 times higher concentrations of zinc, lead, chromium, copper, mercury, and cadmium than sediments with lower organic matter content.

Although urban areas occupy only 2% of the Pacific Northwest land base, the impacts of urbanization on aquatic ecosystems are severe and long lasting (Spence et al. 1996). O'Neill *et al.* (2006) found that Chinook salmon returning to Puget Sound had significantly higher concentrations of PCBs and PBDEs compared to other Pacific coast salmon populations. Furthermore, Chinook salmon that resided in Puget Sound in the winter rather than migrate to the Pacific Ocean (residents) had the highest concentrations of persistent organic pollutants (POPs), followed by Puget Sound fish populations believed to be more ocean-reared. Fall-run Chinook salmon from Puget Sound have a more localized marine distribution in Puget Sound and the Georgia Basin than other populations of Chinook salmon from the west coast of North America. This ESU is more contaminated with PCBs (2 to 6 times) and PBDEs (5 to 17 times). O'Neill *et al.* (2006) concluded that regional body burdens of contaminants in Pacific salmon, and Chinook salmon in particular, could contribute to the higher levels of contaminants in federally-listed endangered southern resident killer whales.

Endocrine disrupting compounds are chemicals that mimic natural hormones, inhibit the action of hormones and/or alter normal regulatory functions of the immune, nervous and endocrine systems and can be discharged with treated effluent (King County 2002). Endocrine disruption has been attributed to DDT and other organochlorine pesticides, dioxins, PAHs, alkylphenolic compounds, phthalate plasticizers, naturally occurring compounds, synthetic hormones and metals. Natural mammalian hormones such as 17β-estradiol are also classified as endocrine disruptors. Both natural and synthetic mammalian hormones are excreted through the urine and are known to be present in wastewater discharges.

Jobling *et al.* (1995) reported that 10 chemicals known to occur in sewage effluent interacted with the fish estrogen receptor by reducing binding of 17β-estradiol to its receptor, stimulating transcriptional activity of the estrogen receptor or inhibiting transcription activity. Binding of the 10 chemicals with the fish endocrine receptor indicates that the chemicals could be endocrine disruptors and forms the basis of concern about w effluent and fish endocrine disruption.

Fish communities are impacted by urbanization (Wheeler et al. 2005). Urban stream fish communities have lower overall abundance, diversity, taxa richness and are dominated by pollution tolerant species. Lead content in fish tissue is higher in urban areas. Furthermore, the proximity of urban streams to humans increases the risk of non-native species introduction and establishment. Thirty-nine non-native species were collected in Puget Sound during the 1998 Puget Sound Expedition Rapid Assessment Survey (Brennan et al. 2004). Lake Washington, located within a highly urban area, has 15 non-native species identified (Ajawani 1956).

PAH compounds also have distinct and specific effects on fish at early life history stages (Incardona et al. 2004). PAHs tend to adsorb to organic or inorganic matter in sediments, where they can be trapped in long-term reservoirs (Johnson et al. 2002). Only a portion of sediment-adsorbed PAHs are readily bioavailable to marine organisms, but there is substantial uptake of these compounds by resident benthic fish through the diet, through exposure to contaminated water in the benthic boundary layer, and through direct contact with sediment. Benthic invertebrate prey are a particularly important source of PAH exposure for marine fishes, as PAHs are bioaccumulated in many invertebrate species (Meador et al. 1995; Varanasi et al. 1989; Varanasi et al. 1992).

PAHs and their metabolites in invertebrate prey can be passed on to consuming fish species, PAHs are metabolized extensively in vertebrates, including fishes (Johnson et al. 2002). Although PAHs do not bioaccumulate in vertebrate tissues, PAHs cause a variety of deleterious effects in exposed animals. Some PAHs are known to be immunotoxic and to have adverse effects on reproduction and development. Studies show that PAHs exhibit many of the same toxic effects in fish as they do in mammals (Johnson et al. 2002).

Habitat Modification This section briefly describes how anthropogenic land use has altered aquatic habitat conditions for salmonids in the Pacific Northwest Region. Basin wide, critical ecological connectivity (mainstem to tributaries and riparian floodplains) has been disconnected by dams and associated activities such as floodplain deforestation and urbanization. Dams have flooded historical spawning and rearing habitat with the creation of massive water storage reservoirs. More than 55% of the Columbia River Basin that was accessible to salmon and steelhead before 1939 has been blocked by large dams (NWPPC 1986). Construction of the Grand Coulee Dam blocked 1,000 miles (1,609 km) of habitat from migrating salmon and steelhead (Wydoski and Whitney 1979). Similarly, over one third (2,000 km) of coho salmon habitat is no longer accessible (Good et al. 2005). The mainstem habitats of the lower Columbia and Willamette rivers have been reduced primarily to a single channel. As a result, floodplain area is reduced, off-channel habitat features have been eliminated or disconnected from the main channel, and the amount of LWD in the mainstem has been reduced. Remaining areas are affected by flow fluctuations associated with reservoir management for power generation, flood control, and irrigation. Overbank flow events, important to habitat diversity, have become rare as a result of controlling peak flows and associated revetments. Portions of the basin are also subject to impacts from cattle grazing and irrigation withdrawals. Consequently, estuary dynamics have changed substantially.

Habitat loss has fragmented habitat and human density increase has created additional loads of pollutants and contaminants within the Columbia River Estuary (Anderson et al. 2007). About 77% of swamps, 57% of marshes, and over 20% of tree cover have been lost to development and industry. Twenty four threatened and endangered species occur in the estuary, some of which are recovering while others (*i.e.*, Chinook salmon) are not.

Stream habitat degradation in Columbia Central Plateau is relatively high (Williamson et al. 1998). In the most recent NAWQA survey, a total of 16 sites were evaluated - all of which showed signs of degradation (Williamson et al. 1998). Streams in this area have an average of 20% canopy cover and 70% bank erosion. These factors have severely affected the quality of habitat available to salmonids. The Palouse subunit of the Lower Snake River exceeds temperature levels for the protection of aquatic life (Williamson et al. 1998).

The Willamette Basin Valley has been dramatically changed by modern settlement. The complexity of the mainstem river and extent of riparian forest have both been reduced by 80% (PNERC 2002). About 75% of what was formerly prairie and 60% of what was wetland have been converted to agricultural purposes. These actions, combined with urban development, extensive (96 miles) bank stabilization, and in-river and nearshore gravel mining, have resulted in a loss of floodplain connectivity and off-channel habitat (PNERC 2002).

Much of the estuarine wetlands in Puget Sound have been heavily modified, primarily from agricultural land conversion and urban development (NRC 1996). Although most estuarine wetland losses result from conversions to agricultural land by ditching, draining, or diking, these wetlands also experience increasing effects from industrial and urban causes. By 1980, an estimated 27,180 acres of intertidal or shore wetlands had been lost at 11 deltas in Puget Sound (Bortleson et al. 1980). Tidal wetlands in Puget Sound amount to roughly 18% of their historical extent (Collins and Sheikh 2005). Coastal marshes close to seaports and population centers have been especially vulnerable to conversion with losses of 50 - 90%. By 1980, an estimated 27,180 acres of intertidal or shore wetlands had been lost at 11 deltas in Puget Sound (Bortleson et al. 1980). More recently, tidal wetlands in Puget Sound amount to about 17 - 19% of their historical extent (Collins and Sheikh 2005). Coastal marshes close to seaports and population centers have been especially vulnerable to conversion with losses of 50 - 90% common for individual estuaries. Salmon use freshwater and estuarine wetlands for physiological transition to and from salt-water and rearing habitat. The land conversions and losses of Pacific Northwest wetlands constitute a major impact. Salmon use marine nearshore areas for rearing and migration, with juveniles using shallow shoreline habitats (Brennan et al. 2004).

About 800 miles of Puget Sound’s shorelines are hardened or dredged (PSAT 2004; Ruckelshaus and McClure 2007). The area most intensely modified is the urban corridor (eastern shores of Puget Sound from Mukilteo to Tacoma). Here, nearly 80% of the shoreline has been altered, mostly from shoreline armoring associated with the Burlington Northern Railroad tracks (Ruckelshaus and McClure 2007). Levee development within the rivers and their deltas has isolated significant portions of former floodplain habitat that was historically used by salmon and trout during rising flood waters.

Urbanization has caused direct loss of riparian vegetation and soils and has significantly altered hydrologic and erosion rates. Watershed development and associated urbanization throughout the Puget Sound, Hood Canal, and Strait of Juan de Fuca regions have increased sedimentation, raised water temperatures, decreased LWD recruitment, decreased gravel recruitment, reduced river pools and spawning areas, and dredged and filled estuarine rearing areas (Bishop and Morgan 1996 in (NMFS 2008f)). Large areas of the lower rivers have been channelized and diked for flood control and to protect agricultural, industrial, and residential development.

The principal factor for decline of Puget Sound steelhead is the destruction, modification, and curtailment of its habitat and range. Barriers to fish passage and adverse effects on water quality and quantity resulting from dams, the loss of wetland and riparian habitats, and agricultural and urban development activities have contributed and continue to contribute to the loss and degradation of steelhead habitats in Puget Sound (NMFS 2008f).

More than 100 years of industrial pollution and urban development have affected water quality and sediments in Puget Sound. Many different kinds of activities and substances release contamination into Puget Sound and the contributing waters. According to the State of the Sound Report (PSAT 2007) in 2004, more than 1,400 fresh and marine waters in the region were listed as “impaired.” Almost two-thirds of these water bodies were listed as impaired due to contaminants, such as toxics, pathogens, and low dissolved oxygen or high temperatures, and less than one-third had established cleanup plans. More than 5,000 acres of submerged lands (primarily in urban areas; 1% of the study area) are contaminated with high levels of toxic substances, including polybrominated diphenyl ethers (PBDEs; flame retardants), and roughly one-third (180,000 acres) of submerged lands within Puget Sound are considered moderately contaminated. In 2005 the Puget Sound Action Team (PSAT) identified the primary pollutants of concern in Puget Sound and their sources listed below in ***Table 16***.

Table 16. Pollutants of Concern in Puget Sound (PSAT 2005).

Pollutant	Sources
Heavy Metals: Pb, Hg, Cu, and others	vehicles, batteries, paints, dyes, stormwater runoff, spills, pipes.
Organic Compounds: Polycyclic aromatic hydrocarbons (PAHs)	Burning of petroleum, coal, oil spills, leaking underground fuel tanks, creosote, asphalt.
Polychlorinated biphenyls (PCBs)	Solvents electrical coolants and lubricants, pesticides, herbicides, treated wood.

Dioxins, Furans	Byproducts of industrial processes.
Dichloro-diphenyl-trichloroethane (DDTs)	Chlorinated pesticides.
Phthalates	Plastic materials, soaps, and other personal care products. Many of these compounds are in wastewater from sewage treatment plants.
Polybrominated diphenyl ethers (PBDEs)	PBDEs are added to a wide range of textiles and plastics as a flame retardant. They easily leach from these materials and have been found throughout the environment and in human breast milk.

While much of the coastal region is forested, it has still been impacted by land use practices. Less than 3% of the Oregon coastal forest is old growth conifers (Gregory 2000). The lack of mature conifers indicates high levels of habitat modification. As such, overall salmonid habitat quality is poor, though it varies by watershed. The amount of remaining high quality habitat ranges from 0% in the Sixes to 74% in the Siltcoos (ODFW 2005). Approximately 14% of freshwater winter habitat available to juvenile coho is of high quality. Much of the winter habitat is unsuitable due to high temperatures. For example, 77% of coho salmon habitat in the Umpqua basin exceeds temperature standards.

Reduction in stream complexity is the most significant limiting factor in the Oregon coastal region. An analysis of the Oregon coastal range determined the primary and secondary life cycle bottlenecks for the 21 populations of coastal coho salmon (Nicholas et al. 2005). Nicholas *et al.* (2005) determined that stream complexity is either the primary (13) or secondary (7) bottleneck for every population. Stream complexity has been reduced through past practices such as splash damming, removing riparian vegetation, removing LWD, diking tidelands, filling floodplains, and channelizing rivers.

Habitat loss through wetland fills is also a significant factor. Table 17 summarizes the change in area of tidal wetlands for several Oregon estuaries (Good 2000).

Table 17. Change in total area (acres2) of tidal wetlands in Oregon (tidal marshes and swamps) due to filling and diking between 1870 and 1970 (Good 2000).

Estuary	Diked or Filled Tidal Wetland	Percent of 1870 Habitat Lost
Necanicum	15	10
Nehalem	1,571	75
Tillamook	3,274	79

Estuary	Diked or Filled Tidal Wetland	Percent of 1870 Habitat Lost
Netarts	16	7
Sand Lake	9	2
Nestucca	2,160	91
Salmon	313	57
Siletz	401	59
Yaquina	1,493	71
Alsea	665	59
Siuslaw	1,256	63
Umpqua	1,218	50
Coos Bay	3,360	66
Coquille	4,600	94
Rogue	30	41
Chetco	5	56
Total	20,386	72%

The only listed salmonid population in coastal Washington is the Ozette Lake sockeye. The range of this ESU is small, including only one lake (31 km^2) and 71 km of stream. Like the Oregon Coastal drainages, the Ozette Lake area has been heavily managed for logging. Logging resulted in road building and the removal of LWD, which affected the nearshore ecosystem (NMFS Salmon Recovery Division 2008). LWD along the shore offered both shelter from predators and a barrier to encroaching vegetation (NMFS Salmon Recovery Division 2008). Aerial photograph analysis shows near-shore vegetation has increased significantly over the past 50 years (Ritchie 2005). Further, there is strong evidence that water levels in Ozette Lake have dropped between 1.5 and 3.3 ft from historic levels [Herrera 2005 *in* (NMFS Salmon Recovery Division 2008)]. The impact of this water level drop is unknown. Possible effects include increased desiccation of sockeye redds and loss of spawning habitat. Loss of LWD has also contributed to an increase in silt deposition, which impairs the quality and quantity of spawning habitat. Very little is known about the relative health of the Ozette Lake tributaries and their impact on the sockeye salmon population.

Habitat Restoration Since 2000, land management practices included improving access by replacing culverts and fish habitat restoration activities at Federal Energy Regulatory

Commission (FERC)-licensed dams. Habitat restoration in the upper (reducing excess sediment loads) and lower Grays River watersheds may benefit the Grays River chum salmon population as it has a sub-yearling juvenile life history type and rears in such habitats. Short-term daily flow fluctuations at Bonneville Dam sometimes create a barrier (*i.e.*, entrapment on shallow sand flats) for fry moving into the mainstem rearing and migration corridor. Some chum fry have been stranded on shallow water flats on Pierce Island from daily flow fluctuations. Coho salmon are likely to be affected by flow and sediment delivery changes in the Columbia River plume. Steelhead may be affected by flow and sediment delivery changes in the plume (Casillas 1999).

In 2000, NOAA Fisheries completed consultation on issuance of a 50-year incidental take permit to the State of Washington for its Washington State Forest Practices Habitat Conservation Plan (HCP). The HCP is expected to improve habitat conditions on state forest lands within the action area. Improvements include removing barriers to migration, restoring hydrologic processes, increasing the number of large trees in riparian zones, improving stream bank integrity, and reducing fine sediment inputs (NMFS 2008d).

Positive changes in water quality in the Puget Sound region are evident. One of the most notable improvements was the elimination of sewage effluent to Lake Washington in the mid-1960s. This significantly reduced problems within the lake from phosphorus pollution and triggered a concomitant reduction in cyanobacteria (Ruckelshaus and McClure 2007). Even so, as the population and industry has risen in the region a number of new and legacy pollutants are of concern.

Mining Mining has a long history in Washington. In 2004, the state was ranked 13th nationally in total nonfuel mineral production value and 17th in coal production (NMA 2007; Palmisano et al. 1993). Metal mining for all metals (zinc, copper, lead, silver, and gold) peaked between 1940 and 1970 (Palmisano et al. 1993). Today, construction sand and gravel, Portland cement, and crushed stone are the predominant materials mined. Where sand and gravel is mined from riverbeds (gravel bars and floodplains) it may result in changes in channel elevations and patterns, instream sediment loads, and seriously alter instream habitat. In some cases, instream or floodplain mining has resulted in large scale river avulsions. The effect of mining in a stream or reach depends upon the rate of harvest and the natural rate of replenishment, as well as flood and precipitation conditions during or after the mining operations.

Most of the mining in the Columbia River basin is focused on minerals such as phosphate, limestone, dolomite, perlite, or metals such as gold, silver, copper, iron, and zinc. Mining in the region is conducted in a variety of methods and places within the basin. Alluvial or glacial deposits are often mined for gold or aggregate. Ores are often excavated from the hard bedrocks of the Idaho batholiths. Eleven percent of the nation’s output of gold has come from mining operations in Washington, Montana, and Idaho. More than half of the nation's silver output has come from a few select silver deposits.

Many of the streams and river reaches in the Columbia River basin are impaired from mining. Several abandoned and former mining sites are also designated as superfund cleanup areas (Anderson et al. 2007; Stanford et al. 2005). According to the U.S. Bureau of Mines, there are about 14,000 inactive or abandoned mines within the Columbia River Basin. Of these, nearly 200 pose a potential hazard to the environment [Quigley, 1997 *in* (Hinck et al. 2004)]. Contaminants detected in the water include lead and other trace metals.

Oregon is ranked 35th nationally in total nonfuel mineral production value in 2004. In that same year, Washington was ranked 13th nationally in total nonfuel mineral production value and 17th in coal production (NMA 2007; Palmisano et al. 1993). Metal mining for all metals (*e.g.*, zinc, copper, lead, silver, and gold) peaked in Washington between 1940 and 1970 (Palmisano et al. 1993). Today, construction sand, gravel, Portland cement, and crushed stone are the predominant materials mined in both Oregon and Washington. Where sand and gravel are mined from riverbeds (gravel bars and floodplains) changes in channel elevations and patterns, and also changes in instream sediment loads, may result and alter instream habitat. In some cases, instream or floodplain mining has resulted in large scale river avulsions. The effect of mining in a stream or reach depends upon the rate of harvest and the natural rate of replenishment. Additionally, the severity of the effects is influenced by flood and precipitation conditions during or after the mining operations.

Hydromodification Projects More than 400 dams exist in the Columbia River basin, ranging from mega dams that store large amounts of water to small diversion dams for irrigation. Every major tributary of the Columbia River except the Salmon River is totally or partially regulated by dams and diversions. More than 150 dams are major hydroelectric projects. Of these, 18 dams are located on the mainstem Columbia River and its major tributary, the Snake River. The FCRPS encompasses the operations of 14 major dams and reservoirs on the Columbia and Snake rivers. These dams and reservoirs operate as a coordinated system. The Corps operates 9 of 10 major federal projects on the Columbia and Snake rivers, and the Dworshak, Libby and Albeni Falls dams. The Bureau of Reclamation operates the Grand Coulee and Hungry Horse dams. These federal projects are a major source of power in the region. These same projects provide flood control, navigation, recreation, fish and wildlife, municipal and industrial water supply, and irrigation benefits.

BOR has operated irrigation projects within the basin since 1904. The irrigation system delivers water to about 2.9 million acres of agricultural lands. About 1.1 million acres of land are irrigated using water delivered by two structures, the Columbia River Project (Grand Coulee Dam) and the Yakima Project. The Grand Coulee Dam delivers water for the irrigation of over

670,000 acres of croplands and the Yakima Project delivers water to nearly 500,000 acres of croplands (Bouldin et al. 2007).

The Bonneville Power Administration (Corps et al.), an agency of the U.S. Department of Energy, wholesales electric power produced at 31 federal dams (67% of its production) and non-hydropower facilities in the Columbia-Snake Basin. The BPA sells about half the electric power consumed in the Pacific Northwest. The federal dams were developed over a 37-year period starting in 1938 with Bonneville Dam and Grand Coulee in 1941, ending with construction of Libby Dam in 1973 and Lower Granite Dam in 1975.

Development of the Pacific Northwest regional hydroelectric power system, dating to the early 20th century, has had profound effects on the ecosystems of the Columbia River Basin (ISG 1996). These effects have been especially adverse to the survival of anadromous salmonids. The construction of the FCRPS modified migratory habitat of adult and juvenile salmonids. In many cases, the FCRPS presented a complete barrier to habitat access for salmonids. Approximately 80% of historical spawning and rearing habitat of Snake River fall-run Chinook salmon is now inaccessible due to dams. The Snake River spring/summer run has been limited to the Salmon, Grande Ronde, Imnaha, and Tuscanon rivers. Damming has cut off access to the majority of Snake River Chinook salmon spawning habitat. The Sunbeam Dam on the Salmon River is believed to have limited the range of Snake River sockeye salmon as well.

Both upstream and downstream migrating fish are impeded by the dams. Additionally, a substantial number of juvenile salmonids are killed and injured during downstream migrations. Physical injury and direct mortality occurs as juveniles pass through turbines, bypasses, and spillways. Indirect effects of passage through all routes may include disorientation, stress, delay in passage, exposure to high concentrations of dissolved gases, warm water, and increased predation. Non-federal hydropower facilities on Columbia River tributaries have also partially or completely blocked higher elevation spawning.

Qualitatively, several hydromodification projects have improved the productivity of naturally produced SR Fall-run Chinook salmon. Improvements include flow augmentation to enhance water flows through the lower Snake and Columbia Rivers [USBR 1998 *in* (NMFS 2008d)]; providing stable outflows at Hells Canyon Dam during the fall Chinook salmon spawning season and maintaining these flows as minimums throughout the incubation period to enhance survival of incubating fall-run Chinook salmon; and reduced summer temperatures and enhanced summer flow in the lower Snake River [see (Corps et al. 2007), *Appendix 1 in* (NMFS 2008d)]. Providing suitable water temperatures for over-summer rearing within the Snake River reservoirs allows the expression of productive “yearling” life history strategy that was previously unavailable to SR Fall-run Chinook salmon.

The mainstem FCRPS corridor has also improved safe passage through the hydrosystem for juvenile steelhead and yearling Chinook salmon with the construction and operation of surface bypass routes at Lower Granite, Ice Harbor, and Bonneville dams and other configuration improvements (Corps et al. 2007).

For salmon, with a stream-type juvenile life history, projects that have protected or restored riparian areas and breached or lowered dikes and levees in the tidally influenced zone of the estuary have improved the function of the juvenile migration corridor. The FCRPS action agencies recently implemented 18 estuary habitat projects that removed passage barriers. These activities provide fish access to good quality habitat.

The Corps *et al.* (2007) estimated that hydropower configuration and operational improvements implemented from 2000 to 2006 have resulted in an 11.3% increase in survival for yearling juvenile LCR Chinook salmon from populations that pass Bonneville Dam. Improvements during this period included the installation of a corner collector at Powerhouse II (PH2) and the partial installation of minimum gap runners at Powerhouse 1 (PH1) and of structures that improve fish guidance efficiency at PH2. Spill operations have been improved and PH2 is used as the first priority powerhouse for power production because bypass survival is higher than at PH1. Additionally, drawing water towards PH2 moves fish toward the corner collector. The bypass system screen was removed from PH1 because tests showed that turbine survival was higher than through the bypass system at that location.

More than 20 dams occur within the Puget Sound region's rivers and overlap with the distribution of salmonids. A number of basins contain water withdrawal projects or small impoundments that can impede migrating salmon. The resultant impact of these and land use changes (forest cover loss and impervious surface increases) has been a significant modification in the seasonal flow patterns of area rivers and streams, and the volume and quality of water delivered to Puget Sound waters. Several rivers have been modified by other means including levees and revetments, bank hardening for erosion control, and agriculture uses. Since the first dike on the Skagit River delta was built in 1863 for agricultural development (Ruckelshaus and McClure 2007), other basins like the Snohomish River are diked and have active drainage systems to drain water after high flows that top the dikes. Dams were also built on the Cedar, Nisqually, White, Elwha, Skokomish, Skagit, as well as several other rivers in the early 1900s to supply urban areas with water, prevent downstream flooding, allow for floodplain activities (like agriculture or development), and to power local timber mills (Ruckelshaus and McClure 2007).

In 1990, only one-third of the water withdrawn in the Pacific Northwest was returned to the streams and lakes (NRC 1996). Water that returns to a stream from an agricultural irrigation is often substantially degraded. Problems associated with return flows include increased water temperature, which can alter patterns of adult and smolt migration; increased toxicant concentrations associated with pesticides and fertilizers; increased salinity; increased pathogen populations; decreased dissolved oxygen concentration; and increased sedimentation (NRC 1996). Water-level fluctuations and flow alterations due to water storage and withdrawal can affect substrate availability and quality, temperature, and other habitat requirements of salmon. Indirect effects include reduction of food sources; loss of spawning, rearing, and adult habitat; increased susceptibility of juveniles to predation; delay in adult spawning migration; increased egg and alevin mortalities; stranding of fry; and delays in downstream migration of smolts (NRC 1996).

Compared to other areas in the greater Northwest Region, the coastal region has fewer dams and several rivers remain free flowing (*e.g.*, Clearwater River). The Umpqua River is fragmented by 64 dams, the fewest number of dams on any large river basin in Oregon (Carter and Resh 2005). According to Palmisano *et al.* (1993) dams in the coastal streams of Washington permanently block only about 30 miles of salmon habitat. In the past, temporary splash dams were constructed throughout the region to transport logs out of mountainous reaches. The general practice involved building a temporary dam in the creek adjacent to the area being logged, and filling the pond with logs. When the dam broke the floodwater would carry the logs to downstream reaches where they could be rafted and moved to market or downstream mills. Thousands of splash dams were constructed across the Northwest in the late 1800s and early 1900s. While the dams typically only temporarily blocked salmon habitat, in some cases dams remained long enough to wipe out entire salmon runs. The effects of the channel scouring and loss of channel complexity resulted in the long-term loss of salmon habitat (NRC 1996).

Artificial Propagation There are several artificial propagation programs for salmon production within the Columbia River Basin. These programs were instituted under federal law to lessen the effects of lost natural salmon production within the basin from the dams. Federal, state, and tribal managers operate the hatcheries. For more than 100 years, hatcheries in the Pacific Northwest have been used to produce fish for harvest and replace natural production lost to dam construction. Hatcheries have only minimally been used to protect and rebuild naturally produced salmonid populations (*e.g.*, Redfish Lake sockeye salmon). In 1987, 95% of the coho salmon, 70% of the spring Chinook salmon, 80% of the summer Chinook salmon, 50% of the fall-run Chinook salmon, and 70% of the steelhead returning to the Columbia River Basin originated in hatcheries (CBFWA 1990). More recent estimates suggest that almost half of the total number of smolts produced in the basin come from hatcheries (Beechie et al. 2005).

The impact of artificial propagation on the total production of Pacific salmon and steelhead has been extensive (Hard et al. 1992). Hatchery practices, among other factors, are a contributing factor to the 90% reduction in natural coho salmon runs in the lower Columbia River over the past 30 years (Flagg et al. 1995). Past hatchery and stocking practices have resulted in the transplantation of salmon and steelhead from non-native basins. The impacts of these hatchery practices are largely unknown. Adverse effects of these practices likely included: loss of genetic variability within and among populations (Busack 1990; Hard et al. 1992; Reisenbichler 1997; Riggs 1990), disease transfer, increased competition for food, habitat, or mates, increased predation, altered migration, and the displacement of natural fish (Fresh 1997; Hard et al. 1992; Steward and Bjornn 1990). Species with extended freshwater residence may face higher risk of domestication, predation, or altered migration than species that spend only a brief time in freshwater (Hard et al. 1992). Nonetheless, artificial propagation may also contribute to the conservation of listed salmon and steelhead. However, it is unclear whether or how much artificial propagation during the recovery process will compromise the distinctiveness of natural populations (Hard et al. 1992).

The states of Oregon and Washington and other fisheries co-managers are engaged in a substantial review of hatchery management practices through the Hatchery Scientific Review Group (HSRG). The HSRG was established and funded by Congress to provide an independent review of current hatchery program in the Columbia River Basin. The HSRG has completed its work on Lower Columbia River populations and provided its recommendations. A general conclusion is that the current production programs are inconsistent with practices that reduce impacts on naturally-spawning populations, and will have to be modified to reduce adverse effects on key natural populations identified in the Interim Recovery Plan. The adverse effects are caused by hatchery-origin adults spawning with natural-origin fish or competing with natural-origin fish for spawning sites (NMFS 2008d). Oregon and Washington initiated a comprehensive program of hatchery and associated harvest reforms (ODFW 2007; Washington Department of Fish and Wildlife (WDFW) 2005). The program is designed to achieve HSRG objectives related to controlling the number of hatchery-origin fish on the spawning grounds and in the hatchery broodstock.

Coho salmon hatchery programs in the lower Columbia have been tasked to compensate for impacts of fisheries. However, hatchery programs in the LCR have not operated specifically to conserve LCR coho salmon. These programs threaten the viability of natural populations. The long-term domestication of hatchery fish has eroded the fitness of these fish in the wild and has reduced the productivity of wild stocks where significant numbers of hatchery fish spawn with wild fish. Large numbers of hatchery fish have also contributed to more intensive mixed stock fisheries. These programs largely overexploited wild populations weakened by habitat degradation. Most LCR coho salmon populations have been heavily influenced by hatchery production over the years.

The artificial propagation of late-returning Chinook salmon is widespread throughout Puget Sound (Good et al. 2005). Summer/fall Chinook salmon transfers between watersheds within and outside the region have been commonplace throughout this century. Therefore, the purity of naturally spawning stocks varies from river to river. Nearly 2 billion Chinook salmon have been released into Puget Sound tributaries since the 1950s. The vast majority of these have been derived from local late-returning adults.

Returns to hatcheries have accounted for 57% of the total spawning escapement. However, the hatchery contribution to spawner escapement is probably much higher than that due to hatchery-derived strays on the spawning grounds. The genetic similarity between Green River late-returning Chinook salmon and several other late-returning Chinook salmon in Puget Sound suggests that there may have been a significant and lasting effect from some hatchery transplants (Marshall et al. 1995).

Overall, the use of Green River stock throughout much of the extensive hatchery network in this ESU may reduce the genetic diversity and fitness of naturally spawning populations (Good et al. 2005).

Commercial, Recreational and Subsistence Fishing Despite regulated fishing programs for salmonids, listed salmonids are also caught as bycatch. There are several approaches under the ESA to address tribal and state take of ESA-listed species that may occur as a result of harvest activities. section 10 of the ESA provides for permits to operate fishery harvest programs. ESA section 4(d) rules provide exemptions from take for resource, harvest, and hatchery management plans. Furthermore, there are several treaties that have reserved the right of fishing to tribes in the North West Region.

Management of salmon fisheries in the Columbia River Basin is a cooperative process involving federal, state, and tribal representatives. The Pacific Fishery Management Council sets annual fisheries in federal waters from three to 200 miles off the coasts of Washington, Oregon, and California. Salmon and steelhead fisheries in the Columbia River and its tributaries are co-managed by the states of Washington, Oregon, Idaho, four treaty tribes, and other tribes that traditionally have fished in those waters. A federal court oversees Columbia River harvest management through the U.S. v. Oregon proceedings. Inland fisheries are those in waters within state boundaries, including those extending out three miles from the coasts. The states of Oregon, Idaho, and Washington issue salmon fishing licenses for these areas.

Fisheries in the Columbia River basin are managed within the winter/spring, summer, and fall seasons. There are Treaty Indian and non-Treaty fisheries which are managed subject to state and tribal regulation, consistent with provisions of a U.S. v. Oregon 2008 agreement. The winter/spring season extends from January 1 to June 15. Commercial, recreational, and ceremonial subsistence fisheries target primarily upriver spring Chinook stocks and spring Chinook salmon that return to the Willamette and lower Columbia River tributaries. Some steelhead are also caught incidentally in these fisheries. The summer season extends from June 16 to July 31. Commercial, recreational, and ceremonial and subsistence fisheries are managed primarily to provide harvest opportunity directed at unlisted UCR summer Chinook salmon. Summer fisheries are constrained primarily by the available opportunity for UCR summer Chinook salmon, and by specific harvest rate limits for SR sockeye salmon and harvest rate limits on steelhead in non-Treaty fisheries. Fall season fisheries begin on August 1 and end on December 31. Commercial, recreational, and ceremonial and subsistence fisheries target primarily harvestable hatchery and natural origin fall Chinook and coho salmon. Fall season fisheries are constrained by specific ESA related harvest rate limits for listed SR fall Chinook salmon, and SR steelhead.

Treaty Indian fisheries are managed subject to the regulation of the Columbia River Treaty Tribes. They include all mainstem Columbia River fisheries between Bonneville Dam and McNary Dam, and any fishery impacts from tribal fishing that occurs below Bonneville Dam. Tribal fisheries within specified tributaries to the Columbia River are included.

Non-Treaty fisheries are managed under the jurisdiction of the states. These include mainstem Columbia River commercial and recreational salmonid fisheries at the river mouth of Bonneville Damn, designated off channel Select Area fisheries, mainstem recreational fisheries between Bonneville Dam and McNary Dam, recreational fisheries between McNary Dam and Highway 305 Bridge in Pasco, Washington, recreational and Wanapum tribal spring Chinook fisheries from McNary Dam to Priest Rapids Dam, and recreational spring Chinook fisheries in the Snake River upstream to Lower Granite Dam.

Archeological records indicate that indigenous people caught salmon in the Columbia River more than 7,000 years ago. One of the most well-known tribal fishing sites within the basin was located near Celilo Falls, an area in the lower river that has been occupied by Dalles Dam since 1957. Salmon fishing increased with better fishing methods and preservation techniques, such as drying and smoking. Salmon harvest substantially increased in the mid-1800s with canning techniques. Harvest techniques also changed over time, from early use of hand-held spears and dip nets, to riverboats using seines and gill nets. Harvest techniques eventually transitioned to large ocean-going vessels with trolling gear and nets and the harvest of Columbia River salmon and steelhead from California to Alaska (Beechie et al. 2005).

During the mid-1800s, an estimated 10 to 16 million adult salmon of all species entered the Columbia River each year. Large annual harvests of returning adult salmon during the late 1800s ranging from 20 million to 40 million pounds of salmon and steelhead significantly reduced population productivity (Beechie et al. 2005). The largest known harvest of Chinook salmon occurred in 1883 when Columbia River canneries processed 43 million pounds of salmon

(Lichatowich 1999). Commercial landings declined steadily from the 1920s to a low in 1993. At that time, just over one million pounds of Chinook salmon were harvested (Beechie et al. 2005).

Harvested and spawning adults reached 2.8 million in the early 2000s, of which almost half are hatchery produced (Beechie et al. 2005). Most of the fish caught in the river are steelhead and spring/summer run Chinook salmon. Ocean harvest consists largely of coho and fall-run Chinook salmon. Most ocean catches are made north of Cape Falcon, Oregon. Over the past five years, the number of spring and fall salmon commercially harvested in tribal fisheries has averaged between 25,000 and 110,000 fish (Beechie et al. 2005). Recreational catch in both ocean and in-river fisheries varies from 140,000 to 150,000 individuals (Beechie et al. 2005).

Non-Indian fisheries in the lower Columbia River are limited to a harvest rate of 1%. Treaty Indian fisheries are limited to a harvest rate of 5 to 7%, depending on the run size of upriver Snake River sockeye stocks. Actual harvest rates over the last 10 years have ranged from 0 to 0.9%, and 2.8 to 6.1%, respectively [see TAC 2008, Table 15 *in* (NMFS 2008d)].

Columbia River chum salmon are not caught incidentally in tribal fisheries above Bonneville Dam. However, Columbia River chum salmon are incidentally caught occasionally in non-Indian fall season fisheries below Bonneville Dam. There are no fisheries in the Columbia River that target hatchery or natural-origin chum salmon. The species' later fall return timing make them vulnerable to relatively little potential harvest in fisheries that target Chinook salmon and coho salmon. CR chum salmon rarely take the sport gear used to target other species. Incidental catch of chum amounts to a few tens of fish per year (TAC 2008). The harvest rate of CR chum salmon in proposed state fisheries in the lower river is estimated to be 1.6% per year and is less than 5%.

LCR coho salmon are harvested in the ocean and in the Columbia River and tributary freshwater fisheries of Oregon and Washington. Incidental take of coho salmon prior to the 1990s fluctuated from approximately 60 to 90%. However, this number has been reduced since its listing to 15 to 25% (LCFRB 2004). The exploitation of hatchery coho salmon has remained approximately 50% through the use of selective fisheries.

LCR steelhead are harvested in Columbia River and tributary freshwater fisheries of Oregon and Washington. Fishery impacts of LCR steelhead have been limited to less than 10% since implementation of mark-selective fisheries during the 1980s. Recent harvest rates on UCR steelhead in non-Treaty and treaty Indian fisheries ranged from 1% to 2%, and 4.1% to 12.4%, respectively (NMFS 2008d).

Despite regulated fishing programs for salmonids, listed salmonids are also caught as bycatch. There are several approaches under the ESA to address tribal and state take of ESA-listed species that may occur as a result of harvest activities. Section 10 of the ESA provides for permits to operate fishery harvest programs. ESA section 4(d) rules provide exemptions from take for resource, harvest, and hatchery management plans. Furthermore, there are several treaties that have reserved the right of fishing to tribes in the North West Region.

Management of salmon fisheries in the Puget Sound Region is a cooperative process involving federal, state, tribal, and Canadian representatives. The Pacific Fishery Management Council sets annual fisheries in federal waters from three to 200 miles off the coasts of Washington, Oregon, and California. The annual North of Falcon process sets salmon fishing seasons in waters such as Puget Sound, Willapa Bay, Grays Harbor, and Washington State rivers. Inland fisheries are those in waters within state boundaries, including those extending out three miles from the coasts. The states of Oregon, Idaho, and Washington issue salmon fishing licenses for these areas. Adult salmon returning to Washington migrate through both U.S. and Canadian waters and are harvested by fishermen from both countries. The 1985 Pacific Salmon Treaty helps fulfill conservation goals for all members and is implemented by the eight-member bilateral Pacific Salmon Commission. The Commission does not regulate salmon fisheries, but provides regulatory advice.

Most of the commercial landings in the region are groundfish, Dungeness crab, shrimp, and salmon. Many of the same species are sought by Tribal fisheries and by charter and recreational anglers. Nets and trolling are used in commercial and Tribal fisheries. Recreational anglers typically use hook and line, and may fish from boat, river bank, or docks.

Harvest impacts on Puget Sound Chinook salmon populations average 75% in the earliest five years of data availability and have dropped to an average of 44% in the most recent five-year period (Good et al. 2005). Populations in Puget Sound have not experienced the strong increases in numbers seen in the late 1990s in many other ESUs. Although more populations have increased than decreased since the last BRT assessment, after adjusting for changes in harvest rates, trends in productivity are less favorable. Most populations are relatively small, and recent abundance within the ESU is only a small fraction of estimated historic run size.

Management of salmon fisheries in the Washington-Oregon-Northern California drainage is a cooperative process involving federal, state, and tribal representatives. The Pacific Fishery Management Council sets annual fisheries in federal waters from three to 200 miles off the coasts of Washington, Oregon, and California. Inland fisheries are those within state boundaries, including those extending out three miles from state coastlines. The states of Oregon, Idaho, California and Washington issue salmon fishing licenses for these areas.

Most commercial landings in the region are groundfish, Dungeness crab, shrimp, and salmon. Many of the same species are sought by Tribal fisheries, as well as by charter, and recreational anglers. Nets and trolling are used in commercial and Tribal fisheries. Recreational anglers typically use hook and line and may fish from boat, river bank, or docks.

Non-native Species Many non-native species have been introduced to the Columbia River Basin since the 1880s. At least 81 non-native species have currently been identified, composing one-fifth of all species in some areas. New non-native species are discovered in the basin regularly; a new aquatic invertebrate is discovered approximately every 5 months (Sytsma et al. 2004). It is clear that the introduction of non-native species has changed the environment, though whether these changes will impact salmonid populations is uncertain (Sytsma et al. 2004).

9.4 California Region

9.4.1 Land Use and Population Growth

The California subregion includes parts of California, Nevada, and Oregon. The subregion totals roughly 430,000 km^2 of which about 320,000 km^2 is classified as undeveloped, 50,000 km^2 is classified as developed and about 50,000 km^2 is classified as agriculture (Figure 8).

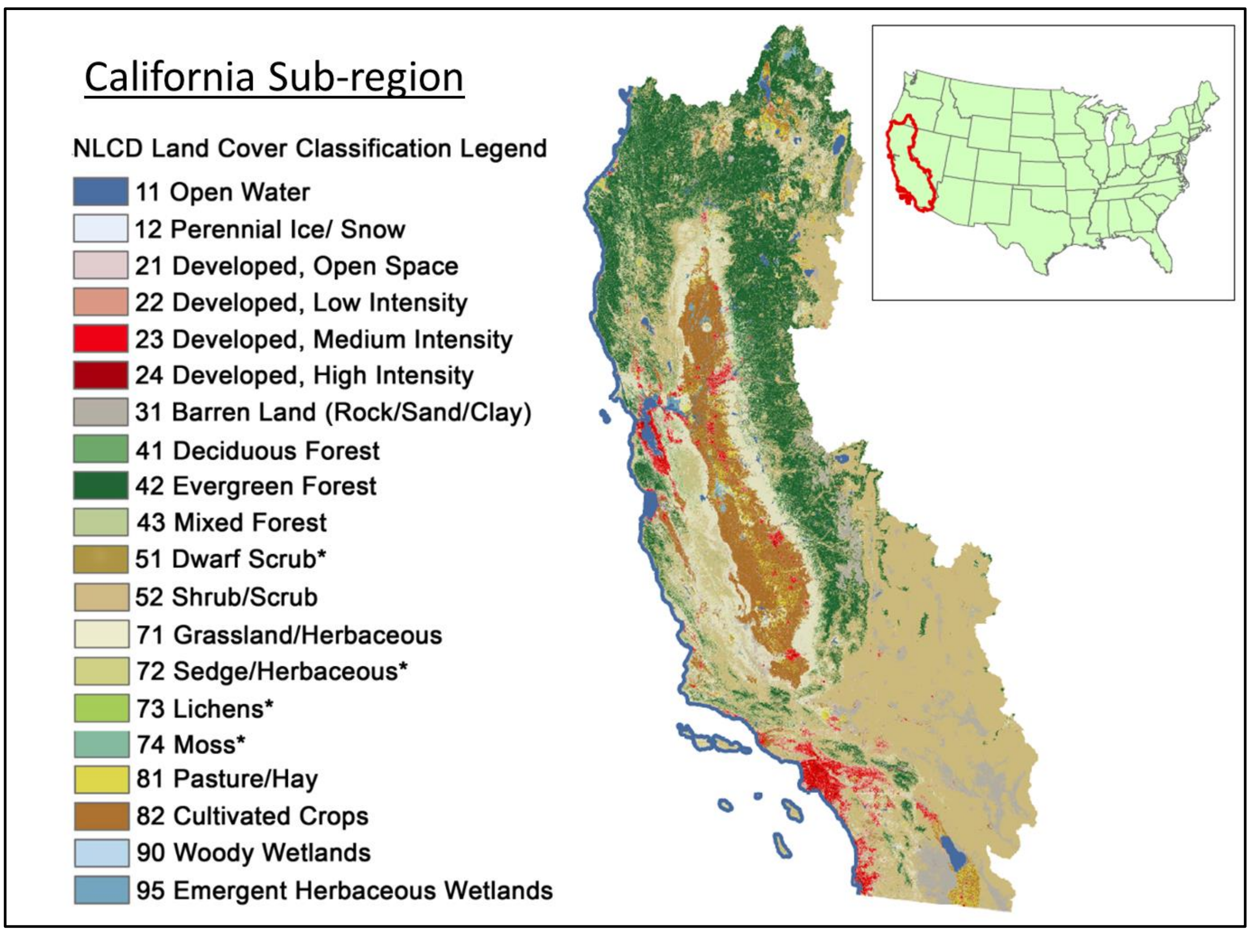


Figure 8. Landuse in the California sub-region. Data from the NLCD 2011 (www.mrlc.gov).

Ten of the 28 species addressed in the Opinion occur in this subregion. They are: chinook salmon (ESUs: Central Valley spring-run, California coastal, Sacramento River winter-run), coho salmon (ESUs: southern Oregon/northern California coastal, central California coast), steelhead salmon (DPSs: northern California, south-central California coast, central California coast, California Central Valley, southern California). ***Table 18*** and ***Table 19*** show the types and areas of land use within each of the species' ranges.

Table 18. Area of land use categories within California subregion selected salmonid ranges in km². The total area for each category is given in bold. Land cover was determined via the NLCD 2011. Land cover class definitions are available at: http://www.mrlc.gov/nlcd_definitions.php

Land Cover	Chinook			Coho	
NLCD Sub category	Central Valley spring	California Coastal	Sacramento River winter	Central California Coast	Southern Oregon/ Northern California
Water	**493**	**2,684**	**1,751**	**4,800**	**1,657**
Open Water	493	2,684	1,751	4,800	1,646
Perennial Ice/Snow	-	-	-	-	12
Developed Land	**5,119**	**1,166**	**2,426**	**3,579**	**2,063**
Open Space	2,105	793	757	1,285	1,394
Low Intensity	1,126	143	546	804	235
Medium Intensity	1,246	112	734	1,088	114
High Intensity	345	20	266	340	31
Barren Land	296	97	122	62	289
Undeveloped Land	**23,064**	**18,468**	**5,226**	**11,905**	**43,886**
Deciduous Forest	900	826	113	235	1,041
Evergreen Forest	4,349	10,258	648	5,340	27,973
Mixed Forest	427	1,494	196	1,539	2,425
Shrub/Scrub	3,815	3,757	632	1,997	9,490
Grassland/Herbaceous	12,557	1,998	2,765	2,495	2,710
Woody Wetlands	288	77	129	72	155
Emergent Wetlands	729	59	743	228	92
Agriculture	**19,298**	**476**	**5,759**	**573**	**1,228**
Pasture/Hay	2,598	243	641	63	761
Cultivated Crops	16,700	233	5,118	510	467

Land Cover	Chinook			Coho	
NLCD Sub category	Central Valley spring	California Coastal	Sacramento River winter	Central California Coast	Southern Oregon/ Northern California
TOTAL (inc. open water)	**47,975**	**22,795**	**15,162**	**20,857**	**48,834**
TOTAL (w/o open water)	**47,482**	**20,110**	**13,411**	**16,057**	**47,177**

Table 19. Area of land use categories within California subregion selected steelhead, sturgeon, sea turtle ranges in km². The total area for each category is given in bold. Land cover was determined via the NLCD 2011. Land cover class definitions are available at: http://www.mrlc.gov/nlcd_definitions.php

Land Cover	Steelhead DPS			
NLCD Sub category	Central California Coast	California Central Valley	Southern California	Northern California
Water	**3,463**	**2,075**	**3,131**	**2,558**
Open Water	3,463	2,075	3,131	2,558
Perennial Ice/Snow	-	-	-	-
Developed Land	**3,570**	**7,021**	**6,396**	**779**
Open Space	1,140	2,732	1,667	590
Low Intensity	848	1,509	1,433	55
Medium Intensity	1,165	1,756	2,390	38
High Intensity	363	549	810	6
Barren Land	54	475	96	90
Undeveloped Land	**8,599**	**30,130**	**10,826**	**15,758**
Deciduous Forest	163	954	1	744
Evergreen Forest	2,346	4,478	892	9,411
Mixed Forest	1,412	1,147	909	1,132
Shrub/Scrub	1,598	5,719	6,742	2,906
Grassland/Herbaceous	2,608	16,291	2,101	1,442
Woody Wetlands	41	318	95	67
Emergent Wetlands	430	1,223	86	56
Agriculture	**622**	**21,417**	**1,025**	**233**
Pasture/Hay	73	2,869	160	218
Cultivated Crops	548	18,548	865	16
TOTAL (inc. open water)	**16,253**	**60,643**	**21,379**	**19,328**
TOTAL (w/o open water)	**12,790**	**58,568**	**18,247**	**16,770**

Population growth within communities in areas where salmon occur will place pressures on water availability and water quality. As of 2017, California has grown at an estimated annual rate of 333,000 per year since 2010. Growth is strongest in the more densely populated counties in the Bay Area, the Central Valley, and Southern California: specifically Merced, Placer, and San Joaquin counties (California Department of Finance 2018).

9.4.2 Water Temperature

Temperature is significant for the health of aquatic life. Water temperatures affect the distribution, health, and survival of native cold-blooded salmonids in the Pacific Northwest and elsewhere. These fish will experience adverse health effects when exposed to temperatures outside their optimal range. For listed Pacific salmonids, water temperature tolerance varies between species and life stages. Optimal temperatures for rearing salmonids range from 10ºC to 16ºC. In general, the increased exposure to stressful water temperatures and the reduction of suitable habitat caused by drought conditions reduce the abundance of salmon. Warm temperatures can reduce fecundity, reduce egg survival, retard growth of fry and smolts, reduce rearing densities, increase susceptibility to disease, decrease the ability of young salmon and trout to compete with other species for food, and to avoid predation (McCullough 1999; Spence et al. 1996). Migrating adult salmonids and upstream migration can be delayed by excessively warm stream temperatures. Excessive stream temperatures may also negatively affect incubating and rearing salmonids (Gregory and Bisson 1997). ***Figure 9*** depicts waterbodies with 303(d) temperature exceedances within the California subregion.

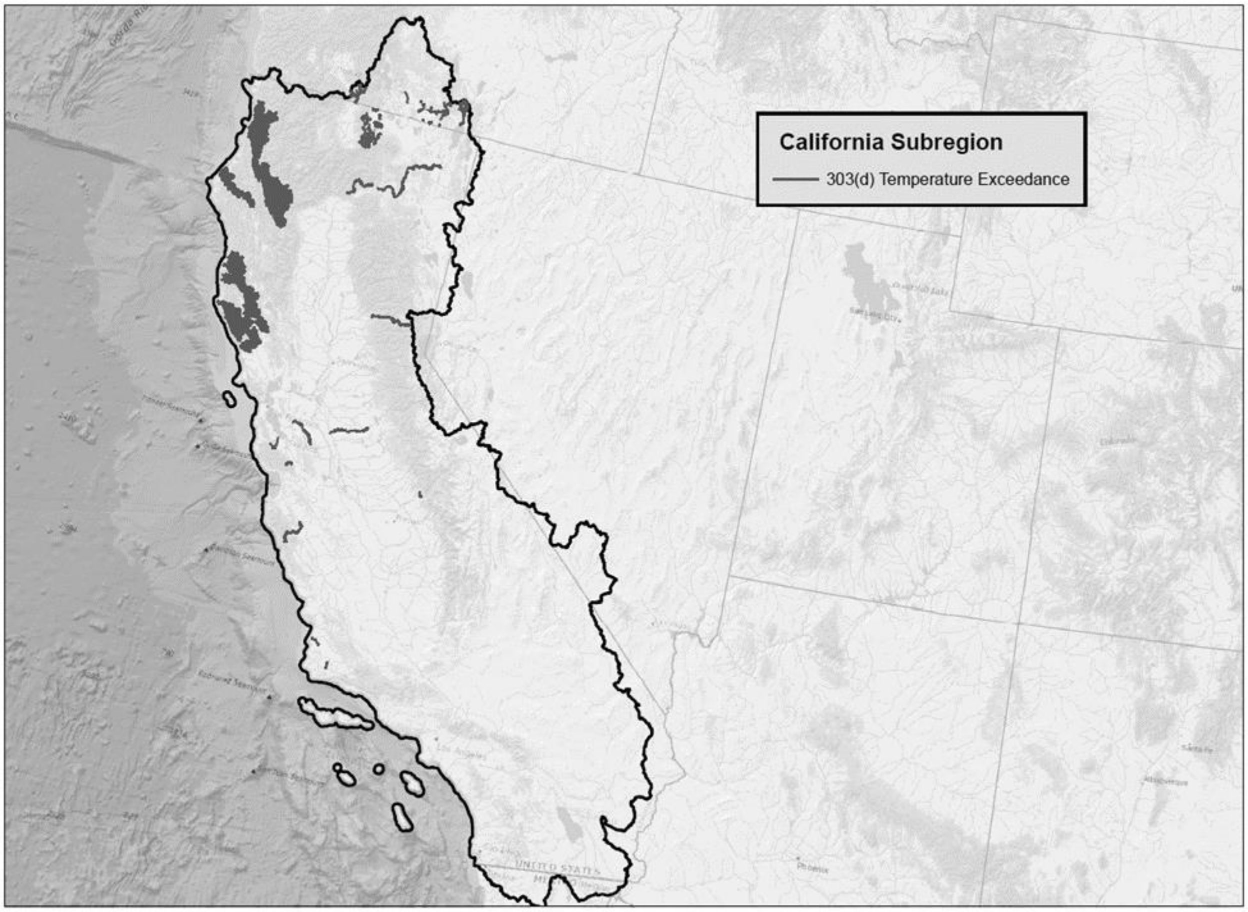


Figure 9. 303(d) temperature exceedances within the California subregion. Data downloaded from USEPA ATTAINS website; "303(d) May 1, 2015 National Extract layer".

We used GIS layers made publically available through USEPA's Assessment and Total Maximum Daily Load Tracking and Implementation System (ATTAINS) to determine the number of km on the 303(d) list for exceeding temperature thresholds within the boundaries of those species which utilize freshwater habitats (***Table 20***). Because the 303(d) list is limited to the subset of rivers tested, the chart values should be regarded as lower-end estimates. While some ESU/DPS ranges do not contain any 303(d) rivers listed for temperature, others show considerable overlap. These comparisons demonstrate the relative significance of elevated temperature among ESUs/DPSs. Increased water temperature may result from wastewater discharge, decreased water flow, minimal shading by riparian areas, and climatic variation.

Table 20. Number of kilometers of river, stream and estuaries included in ATTAINS 303(d) lists due to temperature that are located within selected California subregion species

(ESU/DPS) ranges. Data were taken from USEPA ATTAINS website: May 1, 2015 National Extract.

Species	Kilometers of recorded temperature exceedance
Chinook, Central Valley spring-run ESU	92
Chinook, California Coastal ESU	4,467
Chinook, Sacramento River winter-run ESU	No exceedances recorded[2]
Coho, Central California Coast ESU	3,272
Steelhead, Northern California DPS	3,100
Steelhead, South-Central California Coast DPS	84
Steelhead, Central California Coast DPS	1,397
Steelhead, California Central Valley DPS	92
Steelhead, Southern California DPS	29

9.4.3 Pesticide Usage

The sources of information used to characterize the occurrence of pesticide environmental mixtures include within specie habitats include: land use information, species recovery plans, status updates, listing documents, pesticide monitoring data, incident data, existing pesticide consultations, and pesticide usage information.

Sources of pesticide usage information and analyses considered in this baseline assessment include United States Department of Agriculture (USDA) National Agricultural Statistics Service (NASS) census of agriculture and chemical use programs; USGS national water quality assessment (NAWQA) project – pesticide national synthesis project; State-based surface and groundwater monitoring programs; California Department of Pesticide Regulation – Pesticide Use Reporting (PUR); as well as survey data from proprietary sources as summarized by EPA (see Attachment 1).

In 2017, pesticides were applied to over 18 million acres in California to control for insects; weeds, grass or brush; nematodes; diseases in crops and orchards; or to control growth, thin fruit, ripen, or defoliate (USDA, 2017). The previous census (2012) reported about 15.6 million acres treated for these use categories. During the period 2010-2016 an average of about 320 different active ingredients were applied annually in California to control pests on crop groups: corn, wheat, vegetables and fruit, orchards and grapes, alfalfa, pasture and hay, and other crops.

EPA has provided NMFS with national and state use and usage summaries for both metolachlor and telone which cover the years 2013-2017. The usage information within these reports come

[2] While temperature exceedances are not recorded in the 303(d) list they are anticipated within this species range.

from both direct pesticide usage reporting (e.g. California Department of Pesticide Regulation) as well as usage estimates based on market research surveys (e.g. Agricultural Market Research Data). See Table 21 and Table 22 for the available usage information for metolachlor and telone in California. Note that the consideration of pesticide usage in the environmental baseline is not limited to metolachlor and telone, rather the environmental baseline considers the usage of all pesticides within the species range. The metolachlor and telone usage tables are thus provided as an example of the type of information available.

Table 21. California 1,3-Dichloropropene Agricultural and Non-Agricultural Usage. Modified from EPA National and State Use and Usage Summary (Attachment 1).

Crop	Avg. Annual Crop Acres Grown	Avg. Annual Total Lbs. AE Applied	Min. Annual PCT	Max. Annual PCT	Avg. Annual PCT
Alfalfa	1,600,000	1,000	*	*	*
Almonds	900,000	2,300,000	*	*	*
Apples	10,000	10,000	*	*	*
Apricots	9,000	8,000	0	<2.5	<1
Artichoke	7,000	<500	*	*	*
Asparagus	9,000	10,000	<1	10	<2.5
Avocados	50,000	Surveyed but no usage reported			
Barley	80,000	Surveyed but no usage reported			
Beans, Lima	6,000	Surveyed but no usage reported			
Beans, Dry	50,000	Surveyed but no usage reported			
Beans, Snap, Bush, Pole, String	6,000	2,000	*	*	*
Beets	1,000	4,000	*	*	*
Bitter Melon	Not Surveyed[2]				
Blueberry	6,000	10,000	*	*	*
Broccoli	100,000	100,000	<1	5	<2.5
Brussel Sprouts	4,000	200,000	*	*	*
Cabbage	10,000	50,000	<2.5	10	5
Caneberries	10,000	60,000	0	35	10
Canola	Not Surveyed[2]				
Cantaloupe	30,000	20,000	0	5	<1
Carrots	70,000	1,000,000	10	20	15
Cauliflower	40,000	30,000	0	5	<2.5
Celery	30,000	<500	*	*	*
Cherries	40,000	40,000	0	<2.5	<1
Chinese Cabbage	NA	30,000	*	*	*
Corn	500,000	4,000	*	*	*
Corn, Forage-Fodder	Not Surveyed[2]				
Cotton	200,000	20,000	*	*	*
Cucumbers	9,000	Surveyed but no usage reported			

Dates	6,000	Surveyed but no usage reported			
Daikon	NA	<500	*	*	*
Eggplant	1,000	20,000	*	*	*
Figs	7,000	3,000	0	<2.5	<1
Garlic	30,000	40,000	0	5	<2.5
Grape, Table/Raisin	300,000	600,000	<1	<2.5	<1
Grape, Wine	600,000	400,000	<1	<2.5	<1
Grapefruit	10,000	1,000	*	*	*
Hazelnuts	Not Surveyed[2]				
Honeydew	10,000	10,000	0	5	5
Kale	6,000	<500	*	*	*
Kiwifruit	4,000	<500	0	<2.5	<1
Leeks	1,000	1,000	*	*	*
Lemons	50,000	20,000	0	<2.5	<1
Lettuce	200,000	1,000	0	<2.5	<1
Peppermint	2,000	Surveyed but no usage reported			
Nectarines	20,000	50,000	*	*	*
Nursery Crops	Not Surveyed[2]				
Oats	10,000	Surveyed but no usage reported			
Olives	40,000	4,000	0	<2.5	<1
Onions	50,000	20,000	<1	<2.5	<1
Oranges	200,000	30,000	0	10	5
Parsley	4,000	20,000	*	*	
Pasture	10,000,000	<500	*	*	*
Peaches	50,000	20,000	0	<2.5	<1
Peanuts	Not Surveyed[2]				
Pears	10,000	1,000	0	10	<1
Peas	Not Surveyed[2]				
Pecans	3,000	1,000	*	*	*
Peppers	30,000	90,000	0	10	5
Persimmons	NA	<500	0	<2.5	<1
Pineapple	Not Surveyed[2]				
Pistachio	200,000	10,000	*	*	*
Plums	20,000	30,000	0	<2.5	<1
Pomegranates	20,000	<500	*	*	*
Prunes	50,000	100,000	<1	5	<1
Potatoes	40,000	100,000	<1	5	<1
Pumpkins	6,000	Surveyed but no usage reported			
Rice	500,000	Surveyed but no usage reported			
Rye	5,000	3,000	*	*	*
Safflower	30,000	<500	*	*	*
Sorghum	Not Surveyed[2]				
Soybeans	Not Surveyed[2]				
Spinach	30,000	1,000	*	*	*
Squash	6,000	1,000	*	*	*
Strawberries	40,000	2,100,000	30	55	40

Sugar Beets	10,000	Surveyed but no usage reported			
Sugarcane	Not Surveyed[2]				
Sunflower	Not Surveyed[2]				
Sweet Corn	30,000	<500	*	*	*
Sweet Potato	NA	800,000	*	*	*
Tangelo	2,000	4,000	*	*	*
Tangerines	50,000	D	D	D	D
Tobacco	Not Surveyed[2]				
Tomato	300,000	100,000	0	<2.5	<1
Walnuts	300,000	500,000	*	*	*
Watermelon	10,000	20,000	0	5	<2.5
Wheat, spring	50,000	Surveyed but no usage reported			
Wheat, summer	400,000	Surveyed but no usage reported			
Golf Course	Surveyed but no usage reported – at national level				

[1]Not surveyed at national level
[2]Not surveyed for within California

Table 22. California Metolachlor Agricultural and Non-Agricultural Usage. Modified from EPA National and State Use and Usage Summary (Attachment 1).

Crop	Avg. Annual Crop Acres Grown	Avg. Annual Total Lbs. AE Applied	Min. Annual PCT	Max. Annual PCT	Avg. Annual PCT
Corn	500,000	20,000	0	5	5
Sorghum	10,000	Surveyed but no usage reported			
Sweet Corn	NA	Surveyed but no usage reported			
Tomato	300,000	50,000	5	15	10
Beans (Snap, Bush, Pole, String)	NA	Surveyed but no usage reported			
Dry Beans/Peas	50,000	3,000	0	15	5
Lima Beans	6,000	<500	0	<2.5	<1
Peanuts	Not surveyed				
Peas (Fresh, Green, Sweet)	Not surveyed				
Soybeans	Not surveyed				
Cotton	NA	Surveyed but no usage reported			
Safflower	50,000	<500	Usage has been reported, but due to a reporting issue the data are not sufficiently reliable to provide an estimate		
Sunflowers	50,000	<500	Usage has been reported, but due to a reporting issue the data are not sufficiently reliable to provide an estimate		
Potatoes	NA	Surveyed but no usage reported			

Table 23. California S-Metolachlor Agricultural and Non-Agricultural Usage. Modified from EPA National and State Use and Usage Summary (Attachment 1).

Crop	Avg. Annual Crop Acres Grown	Avg. Annual Total Lbs. AE Applied	Min. Annual PCT	Max. Annual PCT	Avg. Annual PCT
Blueberries	Not surveyed				
Currant	Not surveyed				
Elderberry	Not surveyed				
Gooseberry	Not surveyed				
Huckleberry	Not surveyed				
Strawberries	Not surveyed				
Blackberries	Not surveyed				
Raspberries	Not surveyed				
Loganberry	Not surveyed				
Chive	Not surveyed				
Garlic	Not surveyed				
Leek	Not surveyed				
Onions	Surveyed but no use reported				
Shallot	Not surveyed				
Corn	500,000	50,000	<1	25	10
Sorghum	Surveyed but no use reported				
Sweet Corn	30,000	6,000	5	30	15
Cantaloupes	Not surveyed				
Citron	Not surveyed				
Cucumbers	Not surveyed				
Muskmelon	Not surveyed				
Pumpkins	6,000	<500	0	<2.5	<1
Squash	Not surveyed				
Watermelons	Not surveyed				
Eggplant	Not surveyed				
Okra	Not surveyed				
Peppers	30,000	9,000	10	40	25
Tomatoes	300,000	300,000	60	70	65
Broccoli	Not surveyed				
Brussel Sprouts	Not surveyed				
Chinese Cabbage	Not surveyed				
Cauliflower	Not surveyed				
Cabbage	Not surveyed				
Broccoli Raab	Not surveyed				
Mustard Spinach	Not surveyed				
Rape Greens	Not surveyed				
Collards	Not surveyed				
Mizuna	Not surveyed				
Mustard Greens	Not surveyed				

Kale	Not surveyed				
Celery	30,000	<500	0	<1	<1
Cilantro	Not surveyed				
Rhubarb	Not surveyed				
Spinach	30,000	2,000	5	15	10
Swiss Chard	--	<500	Usage has been reported but due to a reporting issue the data are not sufficiently reliable to provide an estimate		
Turnip Greens	Not surveyed				
Beans (Snap, Bush, Pole, String)	8,000	900	0	25	10
Dry Beans/Peas	50,000	30,000	10	55	40
Lentils	Not surveyed				
Lima Beans	6,000	4,000	15	80	50
Peas (Fresh, Green, Sweet)	Not surveyed				
Soybeans	--	<500	Usage has been reported but due to a reporting issue the data are not sufficiently reliable to provide an estimate		
Alfalfa	Not surveyed				
Cotton	200,000	100,000	0	10	<2.5
Safflower	50,000	2,000	Usage has been reported but due to a reporting issue the data are not sufficiently reliable to provide an estimate		
Sesame	Not surveyed				
	Not surveyed				
Sunflowers	50,000	10,000	Usage has been reported but due to a reporting issue the data are not sufficiently reliable to provide an estimate		
Daikon Radish	Not surveyed				
Horseradish	Not surveyed				
Parsnip	Not surveyed				
Rutabaga	Not surveyed				
Sweet Potatoes	Not surveyed				
Sugar Beets	Surveyed but no use reported				
Garden Beets	3,000	<500	Usage has been reported but due to a reporting issue the data are not sufficiently reliable to provide an estimate		
Carrots	70,000	1,000	0	5	<1
Celeriac	--	<500	Usage has been reported but due to a reporting issue the data are not sufficiently reliable to provide an estimate		
Radish	Not surveyed				
Asparagus	Not surveyed				
Potatoes	40,000	10,000	0	55	15
Peanuts	Not surveyed				
Stevia	Not surveyed				
Rights of Way	Surveyed but no usage reported – at national level				

Agricultural Turf	Surveyed but no usage reported – at national level
Ornamental Lawns, Turf and associated Ornamentals	Surveyed but no usage reported – at national level
Institutional Turf Facilities	Surveyed but no usage reported – at national level
Golf Courses	Surveyed but no usage reported – at national level
Nursery and Greenhouse Ornamentals	Surveyed but no usage reported – at national level

9.4.4 Monitoring Data

The California Department of Pesticide Regulation (CADPR) has developed and maintained a number of excellent programs with the overall mission to "protect human health and the environment by regulating pesticide sales and use, and by fostering reduced-risk pest management". As further described on the CADPR website - The Environmental Monitoring Branch monitors the environment to determine the fate of pesticides, protecting the public and the environment from pesticide contamination through analyzing hazards and developing pollution prevention strategies. The Branch provides environmental monitoring data required for emergency eradication projects, environmental contamination assessments, pesticide registration, pesticide use enforcement, and human exposure evaluations. It also takes the lead in implementing many of DPR's environmental protection programs (https://www.cdpr.ca.gov/).

The CADPR surface water database (SURF) was developed in 1997 and currently contains data representing 58 counties, over 4,000 sample sites, and over 760,000 chemical analysis records from water samples. Access to SURF is available at: (https://www.cdpr.ca.gov/docs/emon/surfwtr/surfdata.htm).

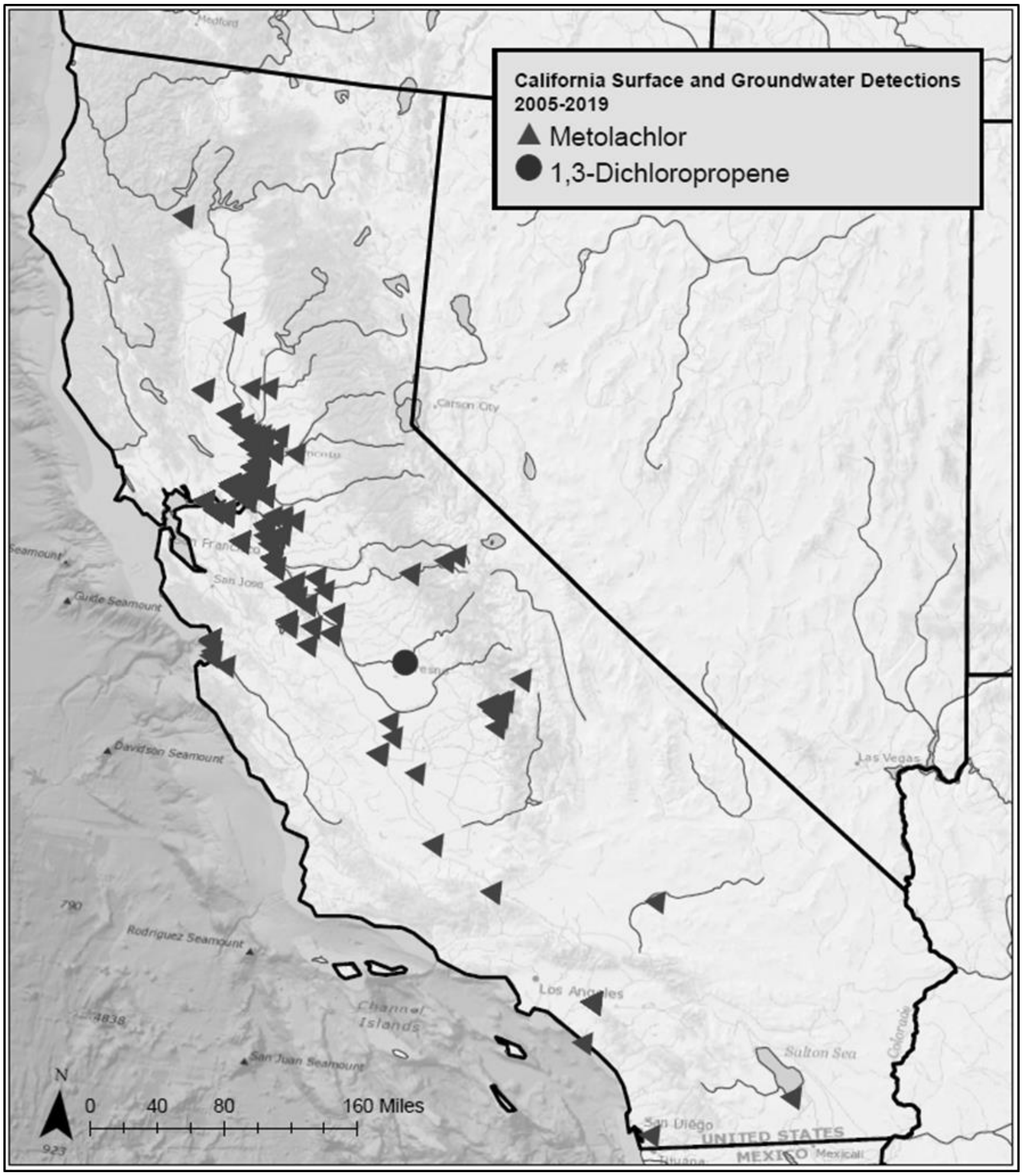


Figure 10. Water monitoring detections of 1,3-Dichloropropene and Metolachlor in California, 2005 to 2019. Data were accessed via the National Water Quality Portal (https://www.waterqualitydata.us/).

9.4.5 Pesticide Use Reports

California is the only state in the nation to require full reporting of pesticide use. Pesticide Use Reporting (PUR) has been required since 1990 and covers all agricultural uses as well as applications to parks, golf courses, cemeteries, rangeland, pastures, and along roadside and railroad rights-of-way. Pesticide reporting is not currently required for home and garden, industrial and institutional uses. PUR data for metolachlor and telone are provided as part of EPA's National and State Use and Usage Summary (Table 21 and Table 22). The PUR data can also help inform a broader picture of chemical usage in California because it provides the reported usage of all pesticides applied in crops and other use sites

9.4.6 Pesticide Reduction Programs

When using these two a.i.s, growers must adhere to the court-ordered injunctive relief, requiring buffers of 20 yards for ground application and 100 yards for any aerial application. These measures are mandatory in all four states, pending completion of consultation.

California State Code does not include specific limitations on pesticide application aside from human health protections. It only includes statements advising that applicators are required to follow all federal, state, and local regulations.

Additionally, pesticide reduction programs already exist in California to minimize levels of the above a.i.s into the aquatic environment. Monitoring of water resources is handled by the California State Water Resources Control Boards. Each Regional Board makes water quality decisions for its region including setting standards and determining waste discharge requirements. The Central Valley Regional Water Quality Control Board (CVRWQCB) addresses issues in the Sacramento and San Joaquin River Basins. These river basins are characterized by crop land, specifically orchards, which historically rely heavily on organophosphates for pest control.

In 2003, the CVRWQCB adopted the Irrigated Lands Waiver Program (ILWP). Participation was required for all growers with irrigated lands that discharge waste which may degrade water quality. However, the ILWP allowed growers to select one of three methods for regulatory coverage (Markle et al. 2005). These options included: 1) join a Coalition Group approved by the CVRWQCB, 2) file for an Individual Discharger Conditional Waiver, and 3) comply with zero discharge regulation (Markle et al. 2005). Many growers opted to join a Coalition as the other options were more costly. Coalition Groups were charged with completing two reports – a Watershed Evaluation Report and a Monitoring and Reporting Plan. The Watershed Evaluation Report included information on crop patterns and pesticide/nutrient use, as well as mitigation measures that would prevent orchard runoff from impairing water quality. Similar programs are in development in other agricultural areas of California.

As a part of the Waiver program, the Central Valley Coalitions undertook monitoring of "agriculture dominated waterways". Some of the monitored waterways are small agricultural streams and sloughs that carry farm drainage to larger waterways. The coalition was also required to develop a management plan to address exceedance of State water quality standards. Currently, the Coalitions monitor toxicity to test organisms, stream parameters (*e.g.,* flow, temperature, etc.), nutrient levels, and pesticides used in the region, including diazinon and chlorpyrifos. Diazinon exceedances within the Sacramento and Feather Rivers resulted in the development of a TMDL. The Coalitions were charged with developing and implementing management and monitoring plans to address the TMDL and reduce diazinon runoff.

The Coalition for Urban/Rural Environmental Stewardship (CURES) is a non-profit organization that was founded in 1997 to support educational efforts for agricultural and urban communities focusing on the proper and judicious use of pest control products. CURES educates growers on methods to decrease pesticide surface water contamination in the Sacramento River Basin. The organization has developed best-practice literature for pesticide use in both urban and agricultural settings (www.curesworks.org). CURES also works with California's Watershed Coalitions to standardize their Watershed Evaluation Reports and to keep the Coalitions informed. The organization has worked with local organizations, such as the California Dried Plum Board and the Almond Board of California, to address concerns about diazinon, pyrethroids, and sulfur. The CURES site discusses alternatives to organophosphate dormant spray applications. It lists pyrethroids and carbaryl as alternatives, but cautions that these compounds may impact non-target organisms. The CURES literature does not specifically address the a.i.s discussed in this Opinion.

California also has PURS legislation whereby all agricultural uses of registered pesticides must be reported. In this case "agricultural" use includes applications to parks, golf courses, and most livestock uses. The CDPR publishes voluntary interim measures for mitigating the potential impacts of pesticide usage to listed species. These measures are available online as county bulletins.

9.4.7 Regional Mortality Factors

Habitat Modification The Central Valley area, including San Francisco Bay and the Sacramento and San Joaquin River Basins, has been drastically changed by development. Salmonid habitat has been reduced to 300 miles from historic estimates of 6,000 miles (CDFG 1993). In the San Joaquin Basin alone, the historic floodplain covered 1.5 million acres with 2 million acres of riparian vegetation (CDFG 1993). Roughly 5% of the Sacramento River Basin's riparian forests remain. Impacts of development include loss of LWD, increased bank erosion and bed scour, changes in sediment loadings, elevated stream temperature, and decreased base flow. Thus, lower quantity and quality of LWD and modified hydrology reduce and degrade salmonid rearing habitat.

The Klamath Basin in Northern California has been heavily modified as well. Water diversions have reduced spring flows to 10% of historical rates in the Shasta River, and dams block access to 22% of historical salmonid habitat. The Scott and Trinity Rivers have similar histories.

Agricultural development has reduced riparian cover and diverted water for irrigation (NRC 2003). Riparian habitat has decreased due to extensive logging and grazing. Dams and water diversions are also common. These physical changes resulted in water temperatures too high to sustain salmonid populations. The Salmon River, however, is comparatively pristine; some reaches are designated as Wild and Scenic Rivers. The main cause of riparian loss in the Salmon River basin is likely wild fires – the effects of which have been exacerbated by salvage logging (NRC 2003).

Mining Famous for the gold rush of the mid-1800s, California has a long history of mining. Extraction methods such as suction dredging, hydraulic mining, and strip mining may cause water pollution problems. In 2004, California ranked top in the nation for non-fuel mineral production with 8.23% of total production (NMA 2007). Today, gold, silver, and iron ore comprise only 1% of the production value. Primary minerals include construction sand, gravel, cement, boron, and crushed stone. California is the only state to produce boron, rare-earth metals, and asbestos (NMA 2007).

California contains approximately 1,500 abandoned mines. Roughly 1% of these mines are suspected of discharging metal-rich waters into the basins. The Iron Metal Mine in the Sacramento Basin releases more than 1,100 pounds of copper and more than 770 pounds of zinc to the Keswick Reservoir below Shasta Dam. The Iron Metal Mine also released elevated levels of lead (Cain et al. 2000 in Carter and Resh 2005). Metal contamination reduces the biological productivity within a basin. Metal contamination can result in fish kills at high levels or sublethal effects at low levels. Sublethal effects include a reduction in feeding, overall activity levels, and growth. The Sacramento Basin and the San Francisco Bay watershed are two of the most heavily impacted basins within the state from mining activities. The basin drains some of the most productive mineral deposits in the region. Methyl mercury contamination within San Francisco Bay, the result of 19th century mining practices using mercury to amalgamate gold in the Sierra Nevada Mountains, remains a persistent problem today. Based on sediment cores, pre-mining concentrations were about five times lower than concentrations detected within San Francisco Bay today (Conaway et al. 2003).

Hydromodification Projects Several of the rivers within California have been modified by dams, water diversions, drainage systems for agriculture and drinking water, and some of the most drastic channelization projects in the nation. There are about 1,400 dams within the State of California, more than 5,000 miles of levees, and more than 140 aqueducts (Mount 1995). In general, the southern basins have a warmer and drier climate and the more northern, coastal-influenced basins are cooler and wetter. About 75% of the runoff occurs in basins in the northern half of California, while 80% of the water demand is in the southern half. Two water diversion projects meet these demands—the federal Central Valley Project (CVP) and the California State

Water Project (CSWP). The CVP is one of the world's largest water storage and transport systems. The CVP has more than 20 reservoirs and delivers about 7 million acre-ft per year to southern California. The CSWP has 20 major reservoirs and holds nearly 6 million acre-ft of water. The CSWP delivers about 3 million acre-ft of water for human use. Together, both diversions irrigate about 4 million acres of farmland and deliver drinking water to roughly 22 million residents.

Both the Sacramento and San Joaquin rivers are heavily modified, each with hundreds of dams. The Rogue, Russian, and Santa Ana rivers each have more than 50 dams, and the Eel, Salinas, and the Klamath Rivers have between 14 and 24 dams each. The Santa Margarita is considered one of the last free flowing rivers in coastal southern California with nine dams occurring in its watershed. All major tributaries of the San Joaquin River are impounded at least once and most have multiple dams or diversions. The Stanislaus River, a tributary of the San Joaquin River, has over 40 dams. As a result, the hydrograph of the San Joaquin River is seriously altered from its natural state. Alteration of the temperature and sediment transport regimes had profound influences on the biological community within the basin. These modifications generally result in a reduction of suitable habitat for native species and frequent increases in suitable habitat for non-native species. The Friant Dam on the San Joaquin River is attributed with the extirpation of spring-run Chinook salmon within the basin. A run of the spring-run Chinook salmon once produced about 300,000 to 500,000 fish (Carter and Resh 2005).

Artificial Propagation Anadromous fish hatcheries have existed in California since establishment of the McCloud River hatchery in 1872. There are nine state hatcheries: the Iron Gate (Klamath River), Mad River, Trinity (Trinity River), Feather (Feather River), Warm Springs (Russian River), Nimbus (American River), Mokelumne (Mokelumne River), and Merced (Merced River). The California Department of Fish and Game (CDFG) also manages artificial production programs on the Noyo and Eel rivers. The Coleman National Fish Hatchery, located on Battle Creek in the upper Sacramento River, is a federal hatchery operated by the USFWS. The USFWS also operates an artificial propagation program for Sacramento River winter run Chinook salmon.

Of these, the Feather River, Nimbus, Mokelumne, and Merced River facilities comprise the Central Valley Hatcheries. Over the last 10 years, the Central Valley Hatcheries have released over 30 million young salmon. State and the federal (Coleman) hatcheries work together to meet overall goals. State hatcheries are expected to release 18.6 million smolts in 2008 and Coleman is aiming for more than 12 million. There has been no significant change in hatchery practices over the year that would adversely affect the current year class of fish. A new program marking 25% of the 32 million Sacramento River Fall-run Chinook smolts may provide data on hatchery fish contributions to the fisheries in the near future.

Commercial and Recreational Fishing The region is home to many commercial fisheries. The largest in terms of total California landings in 2006 were northern anchovy, Pacific sardine, Chinook salmon, sablefish, Dover sole, Pacific whiting, squid, red sea urchin, and Dungeness crab (CDFG 2007). Red abalone is also harvested.

Despite regulated fishing programs for salmonids, listed salmonids are also caught as bycatch. There are several approaches under the ESA to address tribal and state take of ESA-listed species that may occur as a result of harvest activities. Section 10 of the ESA provides for permits to operate fishery harvest programs. ESA section 4(d) rules provide exemptions from take for resource, harvest, and hatchery management plans.

Management of salmon fisheries in the Southwest Coast Region is a cooperative process involving federal, state, and tribal representatives. The Pacific Fishery Management Council sets annual fisheries in federal waters from three to 200 miles off the coasts of Washington, Oregon, and California. Inland fisheries are those within state boundaries, including those extending out three miles from state coastlines. The states of Oregon, Idaho, California, and Washington issue salmon fishing licenses for inland fisheries. The California Fish and Game Commission (CFGC) establish the salmon seasons and issues permits for all California waters and the Oregon Department of Fish and Game sets the salmon seasons and issues permits for all Oregon waters.

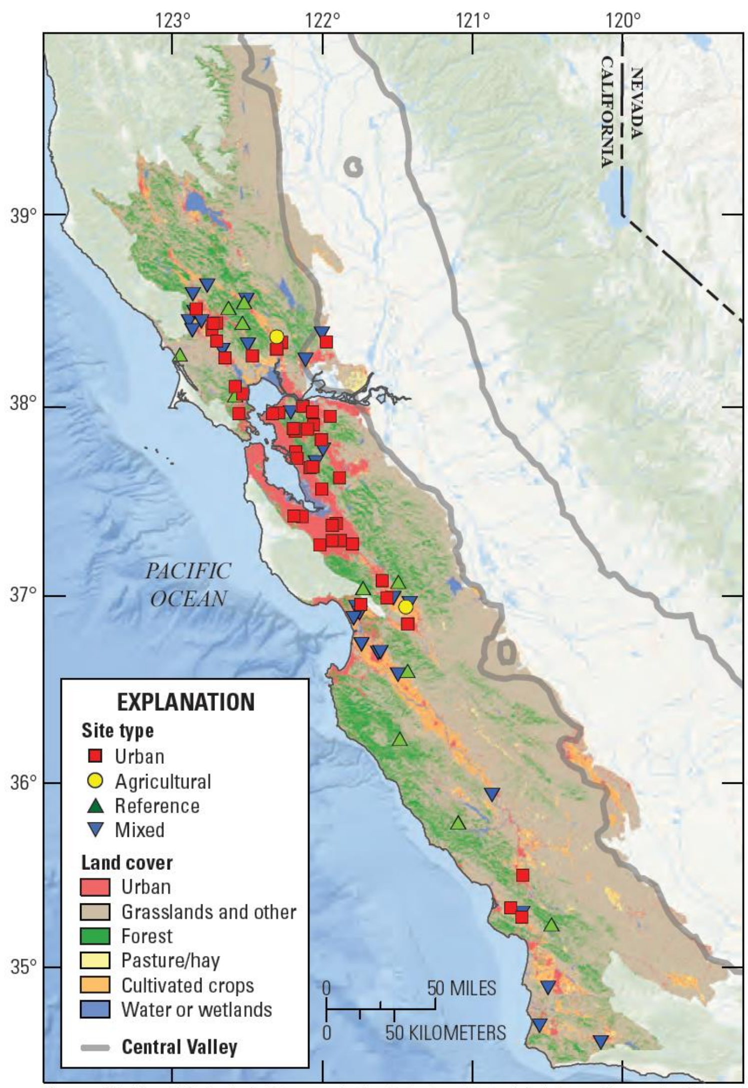
In 2008, there was an unprecedented collapse of the Sacramento River fall-run Chinook salmon that led to complete closure of the commercial and sport Chinook fisheries in California and in Oregon south of Cape Falcon. U.S. Department of Commerce Secretary Gary Locke released a 2008 West Coast salmon disaster declaration for California and Oregon in response to poor salmon returns to the Sacramento River, which led to federal management reducing commercial salmon fishing off southern Oregon and California to near zero. Secretary Locke also released $53.1 million in disaster funds to aid affected fishing communities.

Non-native Species Plants and animals that are introduced into habitats where they do not naturally occur are called non-native species. They are also known as non-indigenous, exotic, introduced, or invasive species, and have been known to affect ecosystems. Non-native species are introduced through infested stock for aquaculture and fishery enhancement, through ballast water discharge and from the pet and recreational fishing industries (http://biology.usgs.gov/s+t/noframe/x191.htm.). The Aquatic Nuisance Species Task Force suggests that it is inevitable that cultured species will eventually escape confinement and enter U.S. waterways. Non-native species were cited as a contributing cause in the extinction of 27 species and 13 subspecies of North American fishes over the past 100 years (Miller et al. 1989). Wilcove, Rothstein *et al.* (1998) note that 25% of ESA-listed fish are threatened by non-native species. By competing with native species for food and habitat as well as preying on them, non-native species can reduce or eliminate populations of native species.

Surveys performed by CDFG state that at least 607 non-native species are found in California coastal waterways (Foss et al. 2007). The majority of these species are representatives of four phyla: annelids (33%), arthropods (22%), chordates (13%), and mollusks (10%). Non-native chordate species are primarily fish and tunicates which inhabit fresh and brackish water habitats such as the Sacramento-San Joaquin Delta (Foss et al. 2007). The California Aquatic Invasive Species Management Plan includes goals and strategies for reducing the introduction rate of new invasive species as well as removing those with established populations.

USGS NAWQA Regional Stream Quality Assessment

In 2017, the USGA sampled 85 sites as part of the California Stream Quality Assessment (Figure 11). Water samples were analyzed for about 230 dissolved pesticides and pesticide degradates. Results from the 2017 water quality assessment were considered and are available at https://webapps.usgs.gov/rsqa/#!/region/CSQA.



Base modified from U.S. Geological Survey and other Federal and State digital data, various scales; Albers Equal-Area Conic projection, Standard parallels are 29° 30″ and 45° 30″, Central meridian -121°; North American Datum of 1983. Land cover modified from National Land Cover Database 2011. Base-map image is the intellectual property of Esri and is used herein under license. Copyright © 2014 Esri and its licensors. All rights reserved.

Figure 11. The California Stream Quality Assessment study area. Taken from Van Metre et al. 2017: Figure 1: "California Stream Quality Assessment study area and provisionally selected sampling sites; the boundary is based on the U.S. Environmental Protection Agency level III ecoregions of the United States"

NAWQA Analysis: Santa Ana Basin

The regional NAWQA summary presented here represents data collected during the period 1992-2001. USGS data from 2002-2011 is provided at the national-level (Ryberg et al. 2014) and is summarized in section 10.4.1.5.

The Santa Ana watershed is the most heavily populated study site out of more than 50 assessment sites studied across the nation by the NAWQA Program. According to Belitz *et al.* (2004), treated wastewater effluent is the primary source of baseflow to the Santa Ana River. Secondary sources that influence peak river flows include stormwater runoff from urban, agricultural, and undeveloped lands (Belitz et al. 2004). Stormwater and agricultural runoff frequently contain pesticides, fertilizers, sediments, nutrients, pathogenic bacteria, and other chemical pollutants to waterways and degrade water quality. The above inputs have resulted in elevated concentrations of nitrates and pesticides in surface waters of the basin. Nitrates and pesticides were more frequently detected here than in other national NAWQA sites (Belitz et al. 2004). Additionally, Belitz *et al.* (2004) found that pesticides and volatile organic compounds (VOCs) were frequently detected in surface and ground water in the Santa Ana Basin.

Of the 103 pesticides and degradates routinely analyzed for in surface and ground water, 58 were detected. Pesticides included diuron, diazinon, carbaryl, chlorpyrifos, lindane, malathion, and chlorothalonil. Diuron was detected in 92% of urban samples – a rate much higher than the national frequency of 25 % (Belitz et al. 2004). Of the 85 VOCs routinely analyzed for, 49 were detected. VOCs included methyl *tert*-butyl ether (MTBE), chloroform, and trichloroethylene (TCE). Organochlorine compounds were also detected in bed sediment and fish tissue. Organochlorine concentrations were also higher at urban sites than at undeveloped sites in the Santa Ana Basin. Organochlorine compounds include DDT and its breakdown product diphenyl dicloroethylene (DDE), and chlordane. Other contaminants detected at high levels included trace elements such as lead, zinc, and arsenic. According to Belitz *et al.* (2004), the biological community in the basin is heavily altered as a result from these pollutants.

NAWQA Analysis: San Joaquin-Tulare Basin

The regional NAWQA summary presented here represents data collected during the period 1992-2001. USGS data from 2002-2011 is provided at the national-level (Ryberg et al. 2014) and is summarized in section 10.4.1.5.

A study was conducted by the USGS in the mid-1990s on water quality within the San Joaquin-Tulare basins. Concentrations of dissolved pesticides in this study unit were among the highest of all NAWQA sites nationwide. The USGS detected 49 of the 83 pesticides it tested for in the mainstem and three subbasins. Pesticides were detected in all but one of the 143 samples. The most common detections were of the herbicides simazine, dacthal, metolachlor, and EPTC (Eptam), and the insecticides diazinon and chlorpyrifos. Twenty-two pesticides were detected in over 20% of the samples (Dubrovsky et al. 1998). Further, many samples contained mixtures of at least 7 pesticides, with a maximum of 22 different compounds. Diuron was detected in all three subbasins, despite land use differences.

Organochlorine insecticides in bed sediment and tissues of fish or clams were also detected. They include DDT and toxaphene. Levels at some sites were among the highest in the nation. Concentrations of trace elements in bed sediment generally were higher than concentrations found in other NAWQA study units (Dubrovsky et al. 1998).

NAWQA Analysis: Sacramento River Basin

The regional NAWQA summary presented here represents data collected during the period 1992-2001. USGS data from 2002-2011 is provided at the national-level (Ryberg et al. 2014) and is summarized in section 10.4.1.5.

Another study conducted by the USGS from 1996 - 1998 within the Sacramento River Basin compared the pesticides in surface waters at four specific sites – urban, agricultural, and two integration sites (Domagalski 2000). Pesticides included thiobencarb, carbofuran, molinate, simazine, metolachlor, dacthal, chlorpyrifos, carbaryl, and diazinon – as well as the three a.i.'s assessed in this Opinion. Land use differences between sites are reflected in pesticide detections. Thiobencarb was detected in 90.5 % of agricultural samples, but only 3.3% of urban samples (Domagalski 2000). This finding is unsurprising as rice is the dominant crop within the agricultural basin. Some pesticides were detected at concentrations higher than criteria for the protection of aquatic life in the smaller streams, but were diluted to safer levels in the mainstem river. Intensive agricultural activities also impact water chemistry. In the Salinas River and in areas with intense agriculture use, water hardness, alkalinity, nutrients, and conductivity are also high.