CHAPTER 10

CUMULATIVE EFFECTS

TABLE OF CONTENTS

10 CUMULATIVE EFFECTS

10.1 Introduction

Cumulative effects include the effects of future state, tribal, local, or private actions that are reasonably certain to occur in the action area considered by this Opinion. Future federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Endangered Species Act (ESA).

During this consultation, National Marine Fisheries Service (NMFS) searched for information on future state, tribal, local, or private actions that were reasonably certain to occur in the action area. NMFS conducted electronic searches of the census bureau, departments of commerce for Idaho, Washington, Oregon, and California, business journals, trade journals, and newspapers using Google and other electronic search engines. Those searches produced reports on projected population growth, commercial and industrial growth, and global warming. Trends described below highlight the effects of population growth on existing populations and habitats for all 28 ESUs/DPSs. Changes in the near-term (five-years; 2024) are more likely to occur than longer-term projects (10-years; 2029). Projections are based upon recognized organizations producing best available information and reasonable rough-trend estimates of change stemming from these data. NMFS analysis provides a snapshot of the effects from these future trends on listed species.

The information from the Cumulative Effects section is treated as a “risk modifier” in the Integration and Synthesis section (Chapters 13 and 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 certain pesticide mixtures to juvenile coho salmon (Laetz 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 were consistently found to have a high potential to modify the risk. The two factors are: 1) elevated temperatures in marine and freshwater habitats, and 2) hydrologic effects in freshwater habitats. We therefore developed two key questions to guide our synthesis of the information within the Cumulative Effects section:

1. Will future temperatures impair species aquatic habitats?

2. Will future hydrologic flows impair freshwater species habitats?

In order to assess potential changes in future aquatic temperatures and future hydrological flows, NMFS searched for information on future state, tribal, local, or private actions that were reasonably certain to occur in the action area. NMFS conducted electronic searches of business journals, trade journals, and newspapers using Google and other electronic search engines. Those searches produced reports on projected population growth, commercial and industrial growth, and climate change (see summaries below). Projections are based upon recognized organizations producing best available information and reasonable rough-trend estimates of change stemming from these data. NMFS analysis provides a snapshot of the effects from these future trends on listed Evolutionarily Significant Units (ESUs)/ Distinct Population Segments (DPS). In general, NMFS found future elevated temperatures and altered hydrologic conditions are likely to affect salmonids.

Within the Integration and Synthesis section (Chapters 13 and 16), we characterize the overall magnitude of influence of the Cumulative Effect as either “low” or “high”. This characterization includes directionality (i.e. positive influence or negative influence) as well as confidence. The magnitude, directionality, and confidence of the influence are determined primarily by answers provided to the two key questions outlined above. Confidence is determined by assessing the amount of evidence provided, as well as by further considering the species-specific implications of the two main 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 cumulative effects is not restricted to the consideration of the key questions alone. All information relevant to the cumulative effects is considered in the risk assessment.

10.2 U.S. Population Growth

The U.S. population is growing at a net rate of one person every 52 seconds (https://www.census.gov/popclock/). Population growth within communities in areas where salmon occur will place pressures on water availability, which affects hydrological conditions and water quality, which includes increases in water temperatures associated with a “built environment.” 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 San Francisco Bay Area, the Central Valley, and Southern California: specifically Merced, Placer, and San Joaquin counties (California Department of Finance 2018). 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 non-rural counties (Washington Office of Financial Management 2018).

Population growth will require greater and greater demand on resources, greater demand for food and water, and greater demand for energy. The increase in demand for these essential items are likely to extend pressures on many threatened and endangered species populations and their designated critical habitats. As many cities border coastal or riverine systems, diffuse and extensive growth will increase overall volume of contaminant loading from wastewater treatment plants and runoff from expanding urban and suburban development into riverine, estuarine, and marine habitats. Urban runoff from expanding impervious surfaces and existing and additional roadways is typically warmer than natural surface waters and may also contain oil, heavy metals, polycyclic aromatic hydrocarbons, and other chemical pollutants. Inputs of these point and non-point pollution sources into numerous rivers and their tributaries will affect water quality in available spawning and rearing habitat for salmon. Based on the increase in human population growth, we expect an associated increase in the number of National Pollution Discharge Elimination System (NPDES) permits issued and the potential listing of more 303(d) waters with impaired thermal, dissolved oxygen, and nutrient regimes and impairments by high pollutant concentrations. Continued growth into forested and other natural areas alter landscapes to the detriment of species habitat. Altered landscapes, such as the loss of riparian vegetation along rivers and increases in impervious surfaces, adversely affect the delivery of sediment and gravel and significantly alter stream hydrology and water quality.

A nationwide rise in the population necessitates a rise in agricultural output, and the potential conversion of forested and other natural lands to agriculture. As most of the coastal states have large tracts of irrigated agriculture, this rise in agricultural output is anticipated to affect coastal areas and aquatic species. Impacts from heightened agricultural production will likely result in two negative impacts on listed species. The first impact may come from a needed reliance and greater use and application of pesticide, fertilizers, and herbicides and their increased concentrations and entry into freshwater systems. Toxics and other pollutants from agricultural runoff may further degrade habitats supporting listed species. Second, increased output and water diversions for agriculture may also place greater demands upon limited water resources. Water diversions will reduce flow rates and alter habitat throughout freshwater systems. Reductions in flows could mean higher water temperatures, and as water is drawn off, contaminants will become more concentrated in these systems, exacerbating toxicity issues in habitats for protected species.

A rise in population will also require pesticide use to protect public health from disease vectors, control invasive species, and maintain public areas such as recreational waters. This can require the application of pesticides at, near, or over waters where the ESA-listed salmonids occur. The residue left by non-agricultural pesticide applications affecting waters of the US are regulated as discharges under state-issued NPDES permits in Washington, Oregon, and California.[1] In July of 2020, EPA will delegate NPDES authority to issue NPDES permits to Idaho as well. Discharges of pesticides are also expected to occur in waters not designated as waters of the US such that ESA-listed species will be exposed to pesticide residues from unregulated discharges.

The above issues are likely to pose continuous unquantifiable negative effects on listed species addressed in this Opinion, particularly freshwater and anadromous species, and those species adapted to and requiring nearshore and estuarine habitats. Each activity has negative effects on water quality. They include increases in sedimentation, increased point and non-point pollution discharges, and decreased infiltration of rainwater resulting in increased runoff into surface waters. Decreased rainwater infiltration leads to decreases in shallow groundwater recharge, decreases in hyporrheic flow (e.g., water that spreads laterally beneath river gravels outside the channel where surface flows occur), and decreases in summer base flows. For example, EPA recently released National Rivers and Streams Assessment 2008-2009 – Collaborative Survey (EPA 2016) revealed only 41.9 percent of rivers and streams in the west were in good overall biological condition. Biological condition is the most comprehensive indicator of water body health. When the biology of a stream is healthy, the chemical and physical components of the stream are also typically in good condition. The EPA assessment indicated that the overall health of the rivers and streams has declined when compared to past surveys. Nationally, the amount of stream length in good quality for macroinvertebrate condition dropped from 27.4 percent in 2004 to 20.5 percent.

10.3 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. National Oceanic and Atmospheric Administration’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.

[1] EPA has delegated NPDES permitting authority to these states with the exception of federal lands in the state of Washington and tribal lands in all three states, EPA retains authority for these discharges in Idaho until July 2020.

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 2014). 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 2014). 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 2018 IPCC Special Report on the Impacts of Global Warming (Allen et al. 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. Annual average temperatures have increased by 1.8°C across the contiguous U.S. since the beginning of the 20th century with Global warming has led to more frequent heatwaves in most land regions and an increase in the frequency and duration of marine heatwaves. 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 of precipitation and drought.

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 (Evans and Bjørge 2013; IPCC 2014; Kintisch 2006; Learmonth et al. 2006; MacLeod et al. 2005; McMahon and Hays 2006; Robinson et al. 2005). 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. These impacts will be exacerbated by sea level rise. The loss of habitat because of climate change could be accelerated due to a combination of other environmental and oceanographic changes such as an increase in the frequency of storms and/or changes in prevailing currents, both of which could lead to increased beach loss via erosion (Antonelis et al. 2006; Baker et al. 2006).

Altered ocean conditions projected with climate change include ocean acidification (IPCC 2013). The oceans have absorbed much of the carbon dioxide released from the burning of fossil fuels, and other land-use emissions, resulting in chemical reactions that lower pH (Tans 2009). This has caused an increase in hydrogen ion (acidity) of about 30 percent since the start of the industrial age. A process known as "ocean acidification." A growing number of studies have demonstrated adverse impacts on marine organisms, including: 1) the rate at which reef-building corals produce their skeletons decreases, 2) the ability of marine algae and free-swimming zooplankton to maintain protective shells is reduced, and 3) the survival of larval marine species including commercial fish and shellfish is reduced (Cohen and Holcomb 2009; Cooley et al. 2009; Kleypas and Yates 2009).

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. 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. (2013) 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.

10.3.1 Climate Change in the Pacific Northwest

Climate change is an important factor in the long-term survival and recovery of ESA listed species. Salmon and steelhead, sturgeon and eulachon throughout their respective range are likely to be affected by a changing climate both directly and indirectly with increasing water temperatures and reduced instream summer flows. Several studies have revealed that climate change has the potential to affect ecosystems in nearly all tributaries throughout the Northwest and California where abundant cold water flows are essential for the conservation of species habitats (Battin et al. 2007; Crozier and Zabel 2006; Stocker et al. 2013; Walters et al. 2013). While the intensity of effects will vary by region (ISAB 2007), climate change is generally expected to alter aquatic habitat (water yield, peak flows, and stream temperature). As climate change alters the structure and distribution of rainfall, snowpack, and glaciations, each factor will in turn alter riverine hydrographs. Given the increasing certainty that climate change is occurring and is accelerating (Battin et al. 2007), NMFS anticipates salmonid, sturgeon, and eulachon habitats will be affected. Climate and hydrology models project significant reductions in both total snow pack and low-elevation snow pack in the Pacific Northwest over the next 50 years (Zhang et al. 2009) – changes that will shrink the extent of the snowmelt-dominated habitat available to theses threatened and endangered species. Such changes may restrict our ability to conserve diverse life histories for many of these species.

Hydrologic changes in streamflow may harm the spawning and migration of sturgeon, eulachon, salmon and trout species. Continued warming of stream and lake temperatures may also affect the health of and the extent of suitable habitat for many other aquatic species. Salmonids and other species that currently live in conditions near the upper range of their thermal tolerance are particularly vulnerable to higher stream temperatures, increasing susceptibility to disease and rates of mortality. Upstream migration for thermally-stressed species may be impeded by changes in channel structure from altered low-flow regimes. Reduced glacier area and volume over the long-term, which is projected for the future in the North Cascades, may challenge Pacific salmonids in those streams in which glacier melt comprises a significant proportion of streamflow (Dalton et al. 2013).