Petition to List the Oregon Coast ESU of Spring-Run Chinook Salmon (*Oncorhynchus tshawytscha*) under the Endangered Species Act

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Center for Biological Diversity
Umpqua Watersheds

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Executive Summary

The Native Fish Society, Center for Biological Diversity, and Umpqua Watersheds petition to list an "evolutionary significant unit" ("ESU") of spring-run Chinook salmon (*Oncorhynchus tshawytscha*) on the Oregon coast as a threatened or endangered species under the Endangered Species Act.

Like other salmonids, spring Chinook are anadromous, migrating from the ocean upstream to the freshwater streams of their birth to reproduce, but differ in the timing of migration. Premature migrating, or spring-run, Chinook salmon enter freshwater from the ocean in a sexually immature state and migrate upstream in spring. They hold through the summer in deep pools, and then spawn in early fall. Juveniles emigrate after either a few months or a year in freshwater. Oregon Coast spring-run Chinook exhibit an ocean-type life-history, migrating to sea during their first year of life, normally within three months after emergence from spawning gravels. Spring Chinook spend more than half of their lives in saltwater in the ocean.

Oregon coast spring-run Chinook, which have a premature migration pattern, have formerly been treated as part of a larger Oregon coast Chinook ESU that included spring-run and fall-run Chinook. It was presumed that spring-run and fall-run Chinook were genetically similar, but new research into the genomic basis for premature migration in salmonids demonstrates significant genetic differences underlie the phenotypic distinctions. The genes for premature migration in Chinook salmon and steelhead trout appear to have arisen from a single evolutionary event within each species and were subsequently spread to distant populations through straying and positive selection. In other words, spring-run Chinook have a unique evolutionary history, are distinct from fall-run salmon found in the same watersheds, and if extirpated are unlikely to re-evolve within any kind of human timeframe. Each river's spring chinook population is distinguished by this genetically-determined capacity for early migration, coupled with a suite of additional traits that render each population closely adapted to its particular local environment.

Thus, spring-run Chinook in the Oregon coast form a population, or collection of populations, that qualify as an Evolutionarily Significant Unit, distinct from fall-run Chinook by virtue of their adult migration life history. They inhabit coastal river basins in Oregon, south of the Columbia River mouth to Cape Blanco. Historical review of fish cannery records indicates that spring Chinook were present in almost all watersheds draining the Oregon Coast range that included an estuary. Their former range and current distribution includes nine river systems between Tillamook Bay and the Coquille River: Tillamook River and tributaries, Nestucca River, Siletz River and tributaries, Alsea River and tributaries, Siuslaw River, North Umpqua River and tributaries, South Umpqua River and tributaries, Coos River, and Coquille River and tributaries. The Coos River and Siuslaw River populations, as well as a former population in the Salmon River, have been extirpated.

Spring-run Chinook have unique habitat requirements for migration, spawning, juvenile rearing, and adult residence in the ocean. Suitable spawning habitat is in mainstem rivers and tributaries, and requires cold water, cool resting pools in which to hold, clean spawning gravels, and optimal dissolved oxygen levels, water velocities, and turbidity levels. Access to spawning habitat is threatened by migration barriers, dams, and water diversions. The presence of deep cold-water pools is essential to the survival of spring-run fish in particular. During upstream migration, adult Chinook are in a stressed condition due to their reliance on stored energy to complete their journey upstream, leaving them highly susceptible to additional environmental stressors. During their ocean residence, adults need nutrient-rich, colder waters that are associated with high productivity and sufficient rates of salmonid growth and survival.

By the 1950s most Oregon coastal spring-run populations were severely depressed or extirpated due to a combination of habitat degradation, commercial fisheries, and negative impacts of artificial propagation through hatcheries. A myriad of state management plans have documented significant declines in spring-run numbers between the 1950s and present time. Oregon coast spring Chinook runs are now a very small fraction of their historical abundance. The state of Oregon does not conduct regular systematic surveys of spawning escapement for coastal spring-run Chinook, but based on limited catch information, all Oregon coastal spring-run populations are smaller than fall-run and are much smaller than historical population sizes.

All spring-run populations in every Oregon coastal basin have suffered significant declines in numbers from historical abundance. Former spring-run populations in the Siuslaw, Coos and Salmon rivers are apparently extirpated. Small, very depressed populations remain in the Tillamook, Nestucca, Siletz, Alsea, and Coquille Rivers. The North Umpqua River supports the only remaining large spring-run Chinook population in the Oregon coast ESU, with variable returns of 2,500-16,000 spawners annually. By contrast the South Umpqua River run has been severely depleted, with only 51 adults and 5 jack spawning fish returning in 2019.

Oregon coast spring-run Chinook face numerous threats. Dams, water diversions and migration barriers block suitable riverine habitat, impede migration, and reduce water quality and quantity. Habitat degradation due to logging and roads reduces stream shade, increases fine sediment levels, reduces levels of in-stream large wood, and alters watershed hydrology. Extensive logging can be particularly devastating to spring-run populations by causing depletion of summer and early fall streamflows needed for adult migration, holding, and spawning. Other ongoing anthropogenic causes of habitat degradation include gravel mining, pollutants, and stream channelization.

Fish hatcheries have negative impacts on Oregon coast spring-run Chinook by causing competition in the wild between hatchery and wild fish, supporting mixed-stock fisheries that have disproportionately harmed wild chinook, and promoting hybridization between spring and fall-run Chinook. Take of spring-run fish in ocean commercial fisheries and marine recreational fisheries may be a threat, but no data are available to directly estimate ocean harvest rates on any wild population of spring Chinook salmon in coastal Oregon. In-river sport fisheries for hatchery propagated spring-run Chinook cause incidental take of wild spring-run fish. Other threats are introduced predators such as smallmouth bass, poor ocean conditions, and climate change.

Existing federal and state regulatory mechanisms have proven unable to protect and recover Oregon coast spring-run Chinook and their habitat. Habitat protections on federal lands under the Northwest Forest Plan have been sabotaged by the Western Oregon Plan Revision, which has the express purpose of substantially increasing logging on federal lands in western Oregon, to the detriment of stream and riparian habitat. State forest management is also not adequately protective of salmon habitat. There are continued poor logging and road-use practices in State Forests, and the Oregon State Forest Practices Act fails to limit the rate of harmful clearcutting and roads in salmon habitat on private lands. There has been a succession of various state watershed and salmon management plans with lofty goals and objectives for protecting and recovering salmon, including the 1991 Coastal Chinook Salmon Plan, 1997 Oregon Coastal Salmon Restoration Initiative, Siletz and Alsea River Basin Fish Management Plans, 2006 Oregon Conservation Strategy, and 2014 Coastal Multispecies Conservation and Management Plan. Despite all of these state laws and plans, Oregon coast spring-run Chinook salmon populations have continued to decline or remain at depressed levels, and state land managers

continue to allow logging and other projects and programs that harm Oregon coast spring-run Chinook salmon and degrade their habitat.

Oregon coast spring-run Chinook suffer from chronically low abundance in a few remnant populations. Spring-run fish have very specific habitat needs and there are still numerous unaddressed threats to every Oregon coast population and their habitat. Endangered Species Act protection is required to prevent their extinction and implement recovery actions.

Notice of Petition

Petitioners Native Fish Society, Center for Biological Diversity, and Umpqua Watersheds are petitioning to list Oregon coast spring-run Chinook salmon (*Oncorhynchus tshawytscha*) as a threatened or endangered species under the Endangered Species Act. The petitioners file this petition pursuant to § 553(e) of the Administrative Procedure Act ("APA), 5 U.S.C. §§ 551-559 and § 1533(b)(3) of the Endangered Species Act, and 50 C.F.R. part 424.14, which grant interested parties the right to petition for issuance of a rule, and specifically to seek reconsideration of a prior determination where new information would lead a reasonable person conducting an impartial scientific review to conclude that delineation of a new ESU, Oregon Coast spring Chinook, and ESA listing is warranted.

With this document we are requesting that NOAA-NMFS initiate a status review of an ESU of spring-run chinook on the Oregon Coast, in coastal basins south of the Columbia River mouth through the southern portion of Cape Blanco, Oregon. We are petitioning that Oregon Coast spring Chinook, currently lumped in the Oregon Coast Chinook ESU, be evaluated independently for listing under the federal Endangered Species Act as separate from the fall Chinook component of the ESU.

A status review is warranted based on newly available information in particular concerning the genetics and phylogeny of early adult migration, the effects of forest management and likely effects of climate change on streamflow and water temperature, recent spawning escapement and catch data for these populations, and continuing lack of sufficient monitoring information and regulatory mechanisms to ensure effective conservation of these populations. We summarize the available new information below.

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Legal Background

Definition of Evolutionary Significant Unit

The Endangered Species Act (ESA) defines "species" to include "any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature." 16 USC§ 1533(16), see also California State Grange v. National Marine Fish, 620 F.Supp 2d 1111, 1121 (ED Cal 2008). The ESA does not define the term "distinct population segment." Grange at 1121.

In 1991 the National Marine Fisheries Service ("NMFS") promulgated its "Policy on Applying the Definition of Species Under the Endangered Species Act to Pacific Salmon" or "Evolutionarily Significant Unit ("ESU Policy." (56 Fed.Reg.58612 (Nov. 20, 1991)). The ESU Policy provides that a population (or particular collection of populations) of Pacific salmonids is considered to be an ESU, and therefore considered for listing under the ESA, if it meets the following two criteria: 1). The population must be substantially reproductively isolated from other nonspecific population units; and 2). The population must represent an important component in the evolutionary legacy of the species. Isolation does not have to be absolute, but it must be strong enough to permit evolutionarily important differences to accrue and to be evolutionarily maintained in different population units. The second criterion is met if the population contributes substantially to the ecological and/or genetic diversity of the species as a whole (Waples 1991). Grange at 1123-24. That is, the loss of the population(s) would constitute a material diminishment of the ecological or genetic diversity of the species as a whole.

NMFS putatively considers all available lines of evidence in applying those criteria, including specifically data from DNA or genomic analyses (" ... data from protein electrophoresis or DNA analysis can be very useful because they reflect levels of gene flow that have occurred over evolutionary time scales."), ESU Policy, 56 Fed. Reg. at 58518; see also Definition of "Species" Under the Endangered Species Act: Application for Pacific Salmon, NOAA Tech Memo NMFS F/NWC-194 (Waples 1991) at p.8 ("The existence of substantial electrophoretic or DNA differences from other conspecific populations would strongly suggest that evolutionarily important, adaptive differences also exist."). The ESU Policy is an interpretation by NMFS of what constitutes an ESA-listable "distinct population segment" (DPS), and is a "permissible agency construction of the ESA." Grange at 1124, citing Alsea Valley Alliance v. Evans, 161 F. Supp 2d 1154, 1161 (D.Or. 2001).

Listing an ESU as an Endangered or Threatened DPS

When considering whether a species or subspecies, including an ESU, is endangered or threatened, NMFS must consider:
i. The present or threatened destruction, modification, or curtailment of its habitat or range;
ii. Overutilization for commercial, recreational, scientific, or educational purposes;
iii. Disease or predation;
iv. The inadequacy of existing regulatory mechanisms; or
v. Other natural or manmade factors affecting its continued existence. 16 U.S.C. § 1533(a)(l). The species shall be listed where the best available data indicates that the species is endangered or threatened because of any one, or a combination of, those five factors. 50 CFR § 424.11 (c).

Best Available Science Supports Recognition of the Oregon Coast ESU of Spring-Run Chinook

Recently published studies (Prince et al. 2017; Davis et al. 2017; Narum et al. 2018; Thompson et al. 2018) demonstrate an underlying genetic basis for premature migration in salmonids. This information was not available when previous NMFS decisions were made regarding Chinook salmon ESU classifications and status determinations.

Prince et al. (2017) investigated the genomic and evolutionary basis of premature migration in Pacific salmon, compiling a set of 148 steelhead samples from five coastal locations across four DPSs in California and Oregon (including the Siletz and North Umpqua rivers), and a set of 250 Chinook samples from nine locations across five ESUs in California, Oregon, and Washington (including the Siletz, North Umpqua and South Umpqua rivers). These samples represent the few remaining watersheds with persistent and recognized wild premature migrating (i.e., spring- or summer- returning) populations. This study concluded that premature migration is strongly associated with the GREB1L genomic region across several populations of Chinook salmon and steelhead trout. Patterns of variation at this locus suggest that premature migration alleles arose from a single evolutionary event within each species and were subsequently spread to distant populations through straying and positive selection (Prince et al. (2017).

Prince et al. (2017) created a high-resolution genomic library from samples of spring- and fall-migrating adult Chinook and steelhead from several Pacific Northwest watersheds, including the Siletz River, North Umpqua River and South Umpqua River on the Oregon Coast. The genomic libraries generated from individual fish were compared using a probabilistic framework to discover single nucleotide polymorphisms (SNPs). Prince et al. (2017) noted that although overall population structure was consistent with current DPS and ESU delineations, the sheer volume of genomic positions in their data (nearly 10 million) allowed a thorough and novel comparison of premature and mature (fall- and winter-returning) migrating individuals. To carry out this comparison, they performed a genome-wide association study (GWAS), which revealed a single genomic region of strong association within and upstream of a gene called GREB1L. This result was then repeated in other populations. Prince et al. (2017) note that, while the exact causative mechanism is unknown, this finding makes biological sense, since this gene is implicated in foraging and fat storage in mammals. In salmon, premature migrating Chinook have a significantly higher fat content than mature migrating salmon, consistent with the fact that early migrating fish typically must often ascend higher into watersheds to hold and spawn, and always remain longer in a non-feeding state in freshwater, thus require more stored energy. Additional analyses on the GREB1L region performed by Prince et al. (2017), and subsequently replicated by Narum et al. (2018), revealed two monophyletic groups corresponding to migration phenotype. All samples, regardless of watershed of origin, separated into the appropriate migratory clade. In other words, Prince et al. (2017) determined that all premature migrating individuals evaluated grouped together in the same monophyletic group. Thus, genetic differences in this single gene explain the difference between premature- and mature-migrating phenotypes. Narum et al. (2018) found that a genomic region including GREB1L and ROCK1 was strongly associated with phenotypes for premature migration among Chinook salmon populations in the upper Columbia River basin.

Davis et al. (2017) genotyped Chinook salmon within the Siletz River, using multiple genetic markers to demonstrate that spring-run Chinook in the Siletz are genetically and phenotypically distinct from fall-run salmon in the same watershed. Davis et al. (2017) evaluated neutral microsatellite markers, single nucleotide polymorphisms and adaptive loci, associated with temporal variation in salmon migratory behavior. Davis et al. (2017) identified two genetically

distinct populations in the basin, corresponding to an early returning spring-run population that spawns above a waterfall, and a fall-run population which spawns below the waterfall. ODFW had previously recognized only one salmon population in this watershed (ODFW 2014), but previous studies of Siletz River salmon populations using data from neutral genetic variation included only samples from the fall-run (Seeb et al. 2007; Moran et al. 2013; Clemento et al. 2014). Davis et al. (2017) demonstrate that Chinook salmon life history variation and genetic differentiation is not limited to large river systems and can be found within smaller watersheds, such as those in the Oregon Coast ESU.

Davis et al. (2017) and Prince e al. (2017) caution that population structure described solely on the basis of divergence at one type of molecular marker, particularly presumably neutral ones, may fail to identify distinct populations that warrant separate management. Their findings strongly support and clearly illustrate this view. Prince et al. (2017) advise that conservation units that are devised without recognizing specific, key phenotypic traits that arise from single loci--that is, defined based on overall, aggregate measures of genetic differentiation--can result in the failure to protect evolutionarily significant variation that has substantial ecological and societal benefits. In the case of prematurely migrating Chinook salmon, this trait confers not only ecological and societal benefits, but also contributes importantly to the long-term adaptive capacity of the species as a whole.

<u>Oregon Coast Spring-Run Chinook Constitute a Distinct ESU</u>

In 1998, the National Marine Fisheries Service (NMFS) reviewed the status of west coast Chinook salmon populations. NMFS delineated an Oregon Coast Evolutionarily Significant Unit (ESU) of Chinook salmon, which included both spring- and fall-run Chinook salmon inhabiting coastal basins south of the Columbia River mouth through the southern portion of Cape Blanco, Oregon (NMFS 1998a; Myers et al. 1998). NMFS then determined that these Chinook salmon populations along the north coast of Oregon form a genetically distinct group or ESU (NMFS 1998a), but grouped spring-run fish with fall-run fish in the same ESU. NMFS also found that there is a strong genetic separation between Oregon Coast Chinook ESU populations and neighboring ESU populations (NMFS 1998a).

NMFS determined in 1998 that the combined fall- and spring-run Oregon Coast Chinook ESU did not warrant Endangered Species Act listing. Information in this petition demonstrates that spring-run Oregon Coast Chinook should be considered a distinct ESU, which does warrant Endangered Species Act listing.

The genomic research by Prince et al. (2017) and Davis et al. (2017), and Thompson (2018) makes clear that Oregon Coast spring-run Chinook should be seen to comprise their own ESU, and stand as a distinct line from fall-run Chinook. Should spring-run Chinook on the Oregon Coast continue their precipitous decline, this new information establishes that fall-run Chinook will not be able to demographically boost or re-establish spring-run life histories, nor establish any population within habitats that are inherently accessible only to the spring-run form. Rather, the premature migrating or spring-run phenotype and its distinctive life history will be permanently extirpated. In this sense, the genotypic basis for premature migration meets at least two criteria of importance in ESU determination: 1) It confers a unique element of diversity to the species as a whole by way of gaining access to specialized habitats, and increasing species-level diversity of migration times and other life history factors; 2) it reinforces its own distinct evolutionary lineage, because access to special habitats results in the effective natural reproductive isolation of a substantial fraction of spring-run from the fall-run Chinook that co-occur in the same river systems. The genomic capacity for premature migration, and the

dispersal into headwater habitats that it supports, also enhance the ecological diversity of Chinook salmon. For example these expand the time and locations at which salmon are available to predators, as well as to freshwater fisheries, and the timing and locations of subsidy of marine-derived nutrients to inland ecosystems.

In 2005, the Oregon Department of Fish and Wildlife (ODFW) conducted a review of Oregon native fish status (ODFW 2005). This review grouped populations by Species Management Unit (SMU), somewhat analogous to the ESU concept. ODFW (2005) examined coastal spring- and fall-run Chinook populations separately. SMUs are groups of populations from a common geographic area that share similar life history, genetic, and ecological characteristics. ODFW identified a Coastal spring Chinook SMU that is coterminous with the NMFS Oregon Coast Chinook ESU. The Coastal Spring-run Chinook SMU includes nine river populations between Tillamook Bay and the Coquille River: the Tillamook River and tributaries, Nestucca River, Siletz River, Alsea River, Siuslaw River, South Fork Umpqua River, North Fork Umpqua River, Coos River, and Coquille River (Jacobs et al. 2001; ODFW 2005). The Coos River and Siuslaw River populations are presumed extinct (ODFW 2005). ODFW (2005) evaluated near-term sustainability and determined that the Coastal Spring Chinook SMU was at risk and that the Coastal Fall Chinook SMU was not at risk.

<u>Human-Caused Threats that Eliminate the Spring-Run Phenotype also Eliminate the Genotype</u>

Thompson et al. (2018) investigated the widespread and dramatic changes in adult migration characteristics of wild Chinook salmon caused by dam construction and other anthropogenic activities. They found an extremely robust association between migration phenotype (i.e., spring-run or fall-run) and a single locus, and that the rapid phenotypic shift observed after a recent dam construction is explained by dramatic allele frequency change at this locus. Modeling by Thompson et al. (2018) demonstrates that continued selection against the spring-run phenotype could rapidly lead to complete loss of the spring-run allele, and an empirical analysis of populations that have already lost the spring-run phenotype reveals they are not acting as sustainable reservoirs of the allele. Analysis by Thompson et al. (2018) of ancient DNA suggests the spring-run allele was abundant in historical habitat that will soon become accessible through a large-scale restoration (i.e., dam removal) project in the Klamath River basin, but their findings suggest that widespread declines and extirpation of the spring-run phenotype and allele will challenge reestablishment of the spring-run phenotype in this and future restoration projects. These results reveal the mechanisms and consequences of human-induced phenotypic change and highlight the need to conserve and restore critical adaptive variation before the potential for recovery is lost.

A main benefit of the spring-run phenotype is that it allows access to exclusive temporal and/or spatial habitat that is partially or wholly inaccessible, or in some cases, less suited to fall-run Chinook salmon (Thompson et al. 2018). These habitats are typically situated in headwater areas where groundwater moderates stream temperature and flow conditions, creating favorable egg incubation and rearing habitat. A significant trade-off imposed by the spring-run life history is somewhat reduced gametic investment (e.g., smaller egg size) because energy must be dedicated to maintenance and maturation during prolonged fasting while holding in freshwater (Thompson et al. 2018). The historical abundance and continued persistence of spring Chinook salmon populations testifies to the long-term adaptive value of this tradeoff by spring-run Chinook salmon in those watersheds it inhabits. A profound benefit to the species (as well as to the fisheries and ecological relationships that depend on the species) is the spreading of ecological risk by increased spatial diversity, behavioral and life history diversity, productivity, and population size afforded by the presence of the spring-run form. Because of the "relatively

simple genetic architecture" that determines the spring-migration life history, the loss of the spring-run Chinook phenotype due to manifold forms of human-caused habitat alteration and biological mismanagement drives permanent loss of the genotypic variation (Thompson et al. 2018). This threatened genotypic variation should be considered as essential to the future persistence, evolution, recovery and productivity of the species as a whole.

Ecology and Biology of Oregon Coast Spring Chinook

Description

Adult Chinook salmon are the largest of all Pacific salmon, typically measuring 36 inches in length and often exceeding 30 pounds at maturity; many adults exceed 40 pounds. Chinook salmon vary in size and age of maturation, with smaller size related to longer distance migration, earlier timing of river entry, and cessation of feeding prior to spawning. As length corresponds to age, two year-old adults tend to be around 40 centimeters long, and six year-old adults often measure one meter in length (Healey 1991).

Chinook salmon have a different appearance depending on location and lifecycle. In the ocean, the Chinook salmon is a robust, deep-bodied fish with bluish-green coloration on the back which fades to a silvery color on the sides and white on the belly. Adult Chinook have black irregular spotting on the back and dorsal fins and on both lobes of the caudal or tail fin. Adults are distinguished from other sympatric salmonid species by the spotting on the caudal fin and the black coloration of their lower jaw (Moyle et al. 2008). When Chinook spawn, their physical appearance changes; colors of spawning Chinook in freshwater range from red to copper to deep gray, depending on the location and degree of maturation. Males typically have more red coloration than females, which are typically gray. Older adult males (4-7 years) are distinguished by their "ridgeback" condition and by their hooked nose or upper jaw. Females are distinguished by a torpedo-shaped body, robust mid-section, and blunt noses.

Juvenile Chinook in fresh water are camouflaged by silver flanks with parr marks (darker vertical bars or spots) which are bisected by the lateral line. Chinook fry are 30-45 mm and fingerlings are 50-120 mm in fork length (Healey 1991). When juvenile Chinook go through smoltification to prepare physiologically for life in the ocean, they change to a more silvery color and their scales and tails lengthen (Healey 1991). Smolts have bright silver sides and their parr marks recede to mostly above the lateral line.

Distribution

Oregon Coast spring-run Chinook salmon inhabit coastal river basins in Oregon, south of the Columbia River mouth through the southern portion of Cape Blanco. Their distribution includes nine river systems between Tillamook Bay and the Coquille River: Tillamook River and tributaries (Wilson River, Kilchis River, Trask River, North Fork Trask River, and formerly the Miami River); Nestucca River; Siletz River and tributaries (North Fork Siletz River, South Fork Siletz River, Gravel Creek, Sunshine Creek, Rock Creek); Alsea River and tributaries (South Fork Alsea River, Drift Creek, Five Rivers, Lobster Creek); Siuslaw River; North Umpqua River and tributaries (Little River, Rock Creek, Steamboat Creek); South Umpqua River and tributaries (Cow Creek, Jackson Creek); Coos River; and Coquille River and tributaries (North Fork Coquille River, Middle Fork Coquille River, South Fork Coquille River) (Jacobs et al. 2001; ODFW 2005). The Coos River and Siuslaw River populations, as well as a former population in the Salmon River, are presumed extinct (ODFW 2005).

Life Cycle and Physiology

Chinook salmon are anadromous, migrating from the ocean upstream to the freshwater streams of their birth; and semelparous, dying after one spawning episode. Chinook salmon grow through six basic life history stages: eggs, alevins, fry, parr, smolts, and adults. Eggs are laid in stream gravels in spawning beds, or redds. Alevins are yolk sac larvae that hatch from the eggs

and remain buried in spawning gravels until the yolk sac is absorbed. Fry are free swimming post-larvae young that emerge from spawning gravels and begin feeding in the stream or migrate from it. Parr are young salmon adapted to freshwater. Smolts are young salmon that have undergone the physiological, biochemical, morphological and behavioral changes, called smoltification, that allow them to live in salt water in the ocean. Chinook salmon reach adulthood in the ocean, typically attaining maturity at the age of 4-5 years, then migrating into freshwater to repeat the cycle.

Within this general life history Chinook display a broad array of tactics that include: variation in age at seaward migration; variation in length of freshwater, estuarine, and oceanic residence; variation in ocean distribution and ocean migratory patterns; and variation in age and season of spawning migration. Differences in Chinook salmon life history are best explained by the timing of their spawning migration (i.e., spring-run, summer-run, fall-run, late fall-run or winter-run) and by the length of their juvenile residence in freshwater (i.e., stream-type or ocean-type). These differences result in a variety of smoltification and maturation strategies.

Premature migrating, or spring-run, Chinook salmon enter freshwater from the ocean in a sexually immature state and migrate upstream in spring, hold through the summer in deep pools, and then spawn in early fall, with juveniles emigrating after either a few months or a year in freshwater.

Adult spring-run Chinook typically enter streams on the Oregon Coast from April through July (Nicholas and Hankin 1989; USBLM 1996; ODFW 1997, 1998), although timing is earlier in the Umpqua River, where spring-run adults can enter the river as early as March and continuing through June (Nicholas and Hankin 1989; Kostow 1995). Spring chinook adults enter the Alsea River from May through July (ODFW 1997).

Spring-run adults migrate high into watersheds, arrive near their eventual spawning grounds, and then hold over the summer in a fasted state in deep freshwater pools (usually greater than 2 meters depth) to allow their gonads to develop before spawning in the fall (NRC 2004). Spring-run adults require deep, cold holding pools proximate to spawning areas, where they hold and mature for 4-6 months prior to spawning; this holding period occurs during the summer, when flows are naturally the lowest and water temperatures the warmest (Kostow 1995).

Spawning of Oregon coast spring-run Chinook can occur as early as August, but primarily runs from September into mid-November (Nicholas and Hankin 1989; Kostow 1995; USBLM 1996; ODFW 1997, 1998). Spring-run chinook spawn in the North Umpqua River from late August through early October; and in the south Umpqua from late September onward (FCO and OSGC 1946). In contrast, adult fall-run Chinook enter streams on the Oregon coast from August through January, with the peak from late September through October; and spawning of fall-run fish occurs from October through February, with the peak in November (Nicholas and Hankin 1989).

Ocean-type Chinook require about 258 square feet of well oxygenated gravel per spawning pair (Burner 1951). Female Chinook defend their redd after spawning is begun. Early in the spawning period they can stay on the redds for about two weeks, while their residence late in the season is only 4-5 days. Spawning adults can be chased off redds easily by minor disturbances, which if they occur frequently enough can result in death of the adult prior to successful spawning. Eggs are laid in depressions excavated on the bottom of streams in shallow river reaches. Chinook eggs are the largest of all Pacific salmon species with a small

surface-to-volume ratio, making them more sensitive to reduced oxygen levels than other Pacific salmon.

Several months after egg deposition juvenile fish emerge from the gravel. Adequate water flows through the spawning gravels is essential for egg and alevin survival. Stream conditions, particularly those affecting subgravel flows, can have a dramatic effect on the survival of eggs to hatching and emergence. Any increases in siltation in spawning beds can cause high mortality (Healey 1991). At the time of emergence, fry generally swim or are displaced downstream, although some fry are able to maintain their residence at the spawning site.

Oregon Coast spring-run Chinook populations exhibit a predominantly ocean-type life-history, migrating to sea during their first year of life, normally within three months after emergence from spawning gravels. All but a very small fraction of Oregon coastal spring-run Chinook enter the ocean during their first summer or fall (Kostow 1995).

Downstream spring-run migrant Chinook were trapped at Winchester Dam on the North Umpqua and from the South Umpqua River, in fish traps operated by the United States Forest Service, Tiller Ranger District, from late February through July (FCO and OSGC 1946). Downstream migration of smolts peaks between May and July, depending on stream temperature (Roper 1995). Juveniles rear in estuaries or lower river mainstems, using deep riffles, woody debris and shoreline riparian vegetation for cover and feeding areas (Kostow 1995). Ocean-type Chinook salmon tend to utilize estuaries and coastal areas more extensively for juvenile rearing (Myers et al. 1998). Perhaps the most significant process in the juvenile life history of Chinook salmon is smoltification, or the physiological, morphological, and behavioral changes associated with the transition from freshwater to marine existence.

Ocean-type Chinook spend most of their ocean life in coastal waters, rarely moving far offshore while in the ocean and tending to limit their dispersal to not more than about 620 miles from the mouth of their natal stream. Chinook salmon spawned in coastal Oregon streams migrate both to the north and to the south when they disperse at sea. Stocks that spawn in central and northern Oregon streams (i.e., from the Elk River north) move to the north when they reach the ocean, appearing in fisheries from Oregon to Alaska. Stocks from southern Oregon streams move to the south and appear in fisheries off Oregon and northern California. Umpqua River spring-run Chinook migrate both north and south at sea, and are harvested in ocean fisheries from California to Alaska. In contrast to the more southerly ocean distribution pattern shown by Chinook populations from southern Oregon and southward, coded wire tag recoveries from Oregon Coast ESU Chinook in ocean fisheries predominantly appear in British Columbia and Alaska-based coastal fisheries (NMFS 1998a).

Oregon Coast spring-run Chinook mature and return to natal streams at ages 3-5 years, although occasional jack males returning at 2 years of age are not uncommon (Ratner et al. 1997). Gharrett and Hodges (1950) and Saltzman (1951) reported the predominant age at maturity for Umpqua River spring-run Chinook was then 5 years.

Habitat Requirements

Because of the variety and large array of habitats of habitats Chinook salmon utilize, they require a number of particular conditions in order to survive and reproduce. Chinook salmon habitat use and requirements are best studied for their time spent in freshwater, although estuarine and ocean conditions are also significant to survival and viability. Spring-run chinook salmon require several components of freshwater habitat, including migratory corridors,

spawning habitat, and rearing habitat. Human activities can significantly degrade freshwater and estuarine habitat suitability.

Migration and Spawning Habitat

During upstream migration, adult Chinook are in a stressed condition due to their reliance on stored energy to complete their journey upstream, leaving them highly susceptible to additional environmental stressors. Although adult upstream migration distances for Oregon Coast ESU spring-run Chinook are relatively short compared to some salmon migrations in larger river systems, migration can still require considerable effort.

Chinook salmon require access to spawning habitat in mainstem rivers and tributaries, cold water, cool pools in which to hold, clean spawning gravel, and particular dissolved oxygen levels, water velocities, and turbidity levels in order to successfully migrate and spawn. Access to spawning habitat is threatened by migration barriers, dams, and water diversions. Variability in water flows can prevent Chinook salmon access to certain streams for spawning. During migration and spawning, low water temperatures are crucial to success of Chinook salmon.

Adult spring-run Chinook migrate early before their gonads are fully developed and then hold in deep cool pools before spawning. The presence of deep cold-water pools is essential to the survival of spring-run fish in particular. Optimal adult holding habitat for spring-run Chinook is characterized by pools or runs greater than one meter deep (>2 meters deep for long-term holding) with cool summer temperatures (<20°C), all day riparian shade, little human disturbance, and underwater cover such as bedrock ledges, boulders, or large woody debris (West 1991). Dams, water withdrawals, logging, mining, and grazing can all contribute to decreased summer and fall streamflows, reduced channel stability, loss of woody structure, infilling of pools by sediment, and warming water temperatures that compromise the distribution and quality of deep pools that are essential holding habitat for spring Chinook.

During the adult holding period, spring-run Chinook are vulnerable to low flow and high water temperature, which can prevent them from reaching their destinations and significantly increase mortality during migration (Moyle et al. 1995; Trihey and Associates 1996). Spring Chinook are more sensitive to high temperatures than fall Chinook (Allen and Hassler 1986). According to McCullough (1999), adults are more sensitive to higher temperatures than juveniles, as higher temperatures can increase the adults' metabolic rate and deplete their energy reserves, weaken their immune system, increase exposure to diseases, and slow or prevent migration. Water temperatures at or above 15.6⁰C can increase the risk of onset and severity of diseases (Allen and Hassler 1986). Healthy and intact riparian vegetation is critical, as it provides much needed root strength to stabilize stream margins and floodplains, and shade to keep water cool (Moyle 2002) and help create "thermal refugia" in which migrating Chinook salmon can escape high temperatures (Berman and Quinn 1996; Torgerson et al. 1999; Gonia et al. 2006). The presence of cold water is threatened by dams, water withdrawals, and channel alterations, as well as logging and grazing which decrease riparian vegetation.

The relatively small size of the rivers used for spawning by Oregon coast spring-run Chinook limits the amount of spawning habitat available. Spawning occurs primarily in low gradient habitats with large cobbles loosely embedded in gravel and with sufficient flows for subsurface infiltration to provide oxygen for developing embryos (Healy 1991; Moyle et al. 2008). Optimal spawning temperatures for Chinook salmon are less than 13°C (McCullough 1999). Migrating adults also need dissolved oxygen levels above five mg/l, deep water (deeper than 24 cm), breaks from high water velocity, and water turbidity below 4,000 ppm (NRC 2004). Spawning

gravel also must be free of excessive sediment such that water flow can bring dissolved oxygen to the eggs and newly hatched fish. With too much sediment, incubating eggs are smothered and reproductive success rate declines significantly. Logging, mining, and grazing can increase inputs of fine sediment in Chinook spawning habitat and significantly reduce fry emergence rates and embryo survival.

<u>Juvenile Rearing Habitat</u>

During rearing and juvenile out-migration, Chinook require certain temperatures, habitat diversity, and water quality characteristics. After hatching, juvenile Chinook require rearing habitat before making their migration to the estuary and onto the ocean. Ideal fry rearing temperature is estimated at 13ºC and temperatures above 17ºC are linked with increased stress, predation, and disease. High water temperatures can prevent smoltification, an essential process that prepares fish to leave freshwater habitat (McCullough 1999).

During juvenile rearing and downstream dispersal, spring-run chinook are vulnerable to low flow and high temperature conditions, which can prevent them from reaching their destinations and significantly increase mortality during migration (Moyle et al. 1995; Trihey and Associates 1996). Stream temperature during out-migration is critical, as prolonged exposure to temperatures of 22-24ºC has resulted in high mortality for migrating smolts, and juveniles who transform into smolts above 18ºC may have low survival odds at sea (Baker et al. 1995; Myrick and Cech 2001). Hence, where and when necessary, juvenile Chinook salmon also seek out and exploit localized coolwater refugia that offer relief from warm ambient water temperatures in summer (Sauter et al. 2001; Belchik 2003; Ebersole et al. 2003; Sutton et al. 2007)

Riparian vegetation provides relief for juvenile Chinook from high temperatures, as well as shelter from predators (Moyle 2002). Logging, mining, and grazing can all reduce streamside vegetation. Habitat diversity is important for juvenile Chinook survival, as juveniles face predation by fish and invertebrates, as well as competition for rearing habitat from other salmonids, including hatchery Chinook and steelhead trout (Healey 1991; Kelsey et al. 2002). Chinook require the correct grades of gravel, the right depths and prevalence of deep pools, the existence of large woody debris, and the right incidence of riffles (Montgomery et al. 1999). This allows for a variety of habitats which are required by Chinook at different life stages. Chinook fry may compete for shallow water rearing habitat with hatchery fish and steelhead. Increased river flows mitigate this competition and help Chinook survival by increasing habitat on the river's edge, where fry (under 50 mm) feed and hide from predators (NRC 2004).

As juvenile Chinook migrate down river, they prefer boulder and rubble substrate, low turbidity and water velocity slower than 30 cms-1 (Healey 1991). These conditions allow juveniles to use the faster-moving water in the center of the river for drift feeding, while resting in the slower areas (Trihey and Associates 1996). Smaller fish tend to stay in the slower-moving water near the banks of the river. Logging and grazing can increase turbidity, and climate trends increase the frequency and size of flood peaks scouring redds and/or prematurely displacing fry and young parr.

Juvenile Chinook require high levels of dissolved oxygen (DO). Low DO levels decrease alevin and fry survival; decrease successful Chinook egg incubation rates; decrease the growth rate for surviving alevins, embryos, and fry; force alevins and juveniles to move to areas with higher DO; and negatively impact the swimming ability of juvenile Chinook (NCWQCB 2010). If DO levels average lower than 3-3.3 mg/L, 50% mortality of juvenile salmonids is likely, while in water above 20°C, daily minimum DO levels of 2.6 mg/L are required to avoid 50% mortality

(NCWQCB 2010). Logging, agriculture, diversions, and dams can contribute to suboptimal DO levels.

Chinook salmon also require pH levels that are not too high. Even high pH levels which are not directly lethal to salmonids can cause harm, including decreased activity levels, increased stress responses, a decrease or cessation of feeding, and a loss of equilibrium (NCWQCB 2010). Few studies directly examine the effects of high pH values on Chinook salmon, however rainbow trout are stressed by pH values above 9 and generally die if the pH value rises above 9.4 (NCWQCB 2010). Nutrient loading of stream systems from agricultural runoff can lead to higher and diurnally fluctuating pH in river systems (NCWQCB 2010).

Once juvenile Chinook reach the estuary, spring-run smolts prefer near shore areas near the mouth of the river (Healey 1991). Juveniles change location with the tide as the salinity of the water changes. Larger Chinook smolts seek out deeper pools to avoid light.

Ocean Habitat

Once Chinook enter the ocean, most reside at depths of 40-80 meters (Healey 1991). Some research suggests that spring-run Chinook migrate further offshore, while fall Chinook tend to stay near the shore and close to their river (Allen and Hassler 1986). In the marine environment, Chinook salmon require nutrient-rich, cold waters associated with high productivity and higher rates of salmonid survival. Warm ocean regimes are characterized by lower ocean productivity which can affect salmon by limiting the availability of nutrients regulating the food supply and increasing the competition for food. Climate and atmospheric circulation conditions can affect these conditions (NMFS 1998c). In order to survive in the marine environment, Chinook salmon also require favorable predator distribution and abundance. This can be affected by a variety of factors including large scale weather patterns such as El Niño. NMFS (1998c) cites several studies which indicate associations between salmon survival during the first few months at sea and factors such as sea surface temperature and salinity.

The role of changing ocean conditions in influencing survival of Oregon coast spring-run Chinook and other salmon is considerable. However, predictive understanding of marine survival of wild Oregon Coast spring-run Chinook salmon is elusive, in part due to fluctuating ocean conditions, but also because few data are collected on marine survival of wild populations.

Sharma and Liermann (2010) concluded that change in sea surface temperature anomalies reflected in the El Niño phenomenon in recent decades have produced ocean conditions increasingly hostile to Chinook salmon. Kilduff et al. (2015) reported that survival rates of Chinook and coho salmon released from hatcheries along the Pacific coast of North America have shifted coherence from the Pacific Decadal Oscillation (Mantua et al. 1997) to a geographically different sea surface anomaly, the North Pacific Gyre Oscillation. Inter-annual El Niño events are still seen as the proximal event influencing ocean survival, but the expression of El Niños in relation to North Pacific circulation has apparently changed since the 1980s. These changes also are reflected in the status of other marine species (Kilduff et al. 2015). Changing ocean currents are also reflected in the changing behavior and influence of in large-scale atmospheric circulation, which further influences marine food web productivity through advection and ocean deposition of continental dust that changes nutrient dynamics in the North Pacific Gyre (Letelier et al. 2019). Increasingly synchronous marine survival among numerous widely distributed salmon stocks suggests that more volatile Pacific-coast-wide fluctuations in salmon abundance are occurring (Kilduff et al. 2015).

The lack of marine survival and growth data for most wild stocks, including all Oregon Coast spring-run Chinook, precludes a fuller understanding of the role their diverse life histories play in conferring resilience to fluctuations in ocean conditions. We do know as a rule that diversity of life history in salmon populations affords a critical buffer against such large-scale environmental variation (Schindler et al. 2010; Moore et al. 2010; Carlson and Satterthwaite 2011; Satterthwaite and Carlson 2015; Brennan et al. 2019).

Diet

Chinook salmon diet varies depending on growth stage. As alevins, young Chinook rely on nutrients provided by the yolk sack attached to the body until leaving the redd after a few weeks. After emerging from the gravel, young Chinook fry begin to feed independently. Juveniles feed in streambeds before gaining strength to make the journey to the ocean. During this time, fry feed on terrestrial and aquatic insects and amphipods. As juveniles migrate toward the ocean, they may spend months in estuarine environments feeding on plankton, small fish, insects, or mollusks. Small fry feed primarily on zooplankton and invertebrates, while larger smolts feed on insects and other small fish (i.e. chironomid larvae, chum salmon fry and juvenile herring; Healey 1991). At sea, where the bulk of feeding and growth is done, adult Chinook typically feed on small marine fish, crustaceans, and mollusks (i.e., squid). Adult Chinook grow quickly in the estuary and gain body mass during their time at sea, building fat reserves that are required for upstream migration and spawning. During the upstream migration and holding in fresh water, adult Chinook do not feed or properly digest food, and thus they rely on stored energy.

Natural Mortality

Coastal spring Chinook salmon, like other salmon are preyed upon by a wide variety of predators in freshwater and saltwater. However, their presence in freshwater as large-bodied adults during relatively low streamflow conditions makes them especially vulnerable to inland predators. Other natural mortality factors about which little is known include disease, and natural catastrophes such as large natural landslides, earthquakes, and volcanic eruptions.

Taxonomy

Chinook salmon (*Oncorhynchus tshawytscha*) are in the genus Oncorhynchus (order Salmoniformes, family Salmonidae), which contains all Pacific salmon.

Population Structure and Significance of Life History Variation

In large coastal Oregon streams, Chinook salmon consist of distinct early (premature migrating) and late returning (mature migrating) populations that have been classed as spring-run and fall-run Chinook (Nicholas and Hankin 1988). In Oregon, all premature migrating salmon are termed spring-run Chinook (even though some "spring" runs do not return until July). Chinook salmon return to their natal streams which results in a distinct population within and among specific rivers or stocks. Chinook salmon can be subdivided based on distinctive life history traits such as run-timing and spawn-timing that have a strong genetic basis. Historical abundance data has been collected, reported, and analyzed to support management decisions for specific chinook salmon stocks that spawn in specific geographic locations (in some instances data is available for 40 or more years).

Spring- and summer-run populations represent a major contribution to life history variation in Chinook salmon at the species level, but also at the level of river-specific stocks. Life history variation within species, and both among and within populations, is now widely recognized as a critical factor in determining salmon viability, productivity, and resilience in the face of environmental fluctuations. Diversity of life history in salmon populations affords a critical buffer against both large-scale and local environmental variation (Schindler et al. 2010; Brennan et al. 2019). The loss of life history diversity in Chinook salmon, whether by decline or extirpation of local populations, or by demographic dominance of hatchery-reared fish, leads to increasing synchronicity of population fluctuations, hence reduced resilience and productivity, and increasing risk of local extinctions (Moore et al. 2010; Carlson and Satterthwaite 2011; Satterthwaite and Carlson 2015).

Among the known and strongly suspected specific ecological and evolutionary benefits of inclusion of the spring- and summer- migration genotype in Chinook salmon population groups are:
1) Access is afforded to headwater habitats that often lie above natural falls or cascades, or reaches of intermittent flow that are commonly not passable by fall-run Chinook salmon.
2) The greater range of spatial and temporal habitat occupation afforded by spring-and summer-run life histories confers resilience to Chinook salmon in the face of extreme events and environmental catastrophe, through spreading of risk of mortality. Conversely, such diversity increases the likelihood of some population segments finding favorable habitat in seasons and years when others are suffering.
3) Early migration allows spring-run Chinook to ascend to spawning habitat before the onset of problematic or lethal water temperature, streamflow, and migration barriers that adversely affect fall Chinook salmon in years of fall season drought.
4) Earlier spawning and longer fall periods of egg incubation are possible, which is likely an important adaptation to colder, groundwater-dominated and other headwater habitats.
5) In part because of their spatial concentration of spawning nearer headwater areas, offspring of spring-run Chinook may have more options to express variety in timing and location of freshwater rearing, downstream migration, and smolting; for example, they often include stronger representation of stream-type, as well as ocean-type life histories, and may express a greater diversity of seasonal timing of movement and ocean entrance across all life history forms.
6) Increased spatial dispersion of adult Chinook salmon means that the marine nutrient subsidy incorporated in their body mass is well-distributed throughout the stream network, including into near-headwater areas. This can benefit the salmon themselves, as well as other species.

The presence of spring Chinook in headwater zones of basins could protect them in the face of catastrophic mortality events such as natural catastrophes or toxicant spills that could widely affect downstream-distributed fall Chinook populations (Good et al. 2008). By ascending migration barriers, spring Chinook escape the presence of several other fish species. Hence they may be less vulnerable to potential pathogen outbreaks that spread horizontally among species, and less affected by interspecific competition for limited food and habitat. And in the face of future climate change, downstream habitats principally inhabited by fall Chinook in coastal rivers could become so warm and flow-depleted (Luce and Holden 2009; Isaak et al. 2012; Dalton et al. 2013) as to become marginally inhabitable by early fall spawning and rearing juvenile Chinook salmon, whereas habitat conditions for headwater-adapted salmonids might remain within tolerable limits (Crozier and Zabel 2006; Isaak and Rieman 2012; Muñoz et al. 2015,). Early- and late-returning Chinook salmon also face different conditions in the marine environment, so may be affected much differently by effects of changes in marine currents and predation. Moore et al. (2004) identified early and late adult return timing as one of several life

history variations that contributed to dampening fluctuations in population abundances and biomass via portfolio effects in steelhead populations in British Columbia. This observation constitutes a specific example of the "portfolio effect" of within-basin diversity that confers stability, spreads risk of stresses and threats, and sustains the productive capacity of salmon populations (Brennan et al. 2019).

The role of adult salmon carcasses in spawning areas in transferring important marine nutrients to often nutrient-limited freshwater and inland riparian ecosystems is today well-recognized (Cederholm et al. 1999; Gresh et al. 2000; Zabel and Williams 2002; Peery et al. 2003; Scheuerell et al. 2005; Schindler et al. 2010). The increased spatial and temporal dispersion of Chinook salmon furthered by the presence of spring-run ecotypes, particularly in wild populations, supports this natural ecosystem enrichment function. An integral part of this nutrient transfer is the role that spawning and post-spawning spring- and summer-run Chinook play in providing a reliable natural food resource for other animals: guilds of predators and scavengers, including many birds, mammals, fishes, and invertebrates (Cederholm et al. 1999; Minikawa et al. 2002; Peery et al. 2003; Schindler et al. 2010; Field and Reynolds 2013). Some northeast Pacific orcas are strongly selective foragers on Chinook salmon (Ford and Elli 2006), such that the contribution of spring-run Chinook salmon to overall stability and abundance of the species at sea could play a significant role in orca health and survival.

Status

Meengs and Lackey (2005) estimated the historical Chinook salmon run size along the Oregon coast (excluding the Columbia River), using estimates of aboriginal harvest and extrapolating salmon cannery pack data into numbers of fish. Meengs and Lackey (2005) concluded that the aggregate Oregon coastal Chinook population was most likely on the order of 290,000-517,000 Chinook in the late 1800s, with fall-run fish likely the majority of the run size. By the 1950s Oregon coast spring Chinook runs constituted a very small fraction of their historical abundance (Gharrett and Hodges 1950). While in-river commercial harvest likely played a significant role in depleting initial populations, declines continued after regulations were put in place to address that concern. Between 1953 and 1969 spawning surveys targeting spring Chinook across four coastal Oregon basins noted a decline from as high as 18 fish per mile to as low as 4 fish per mile (Skeesick 1969).
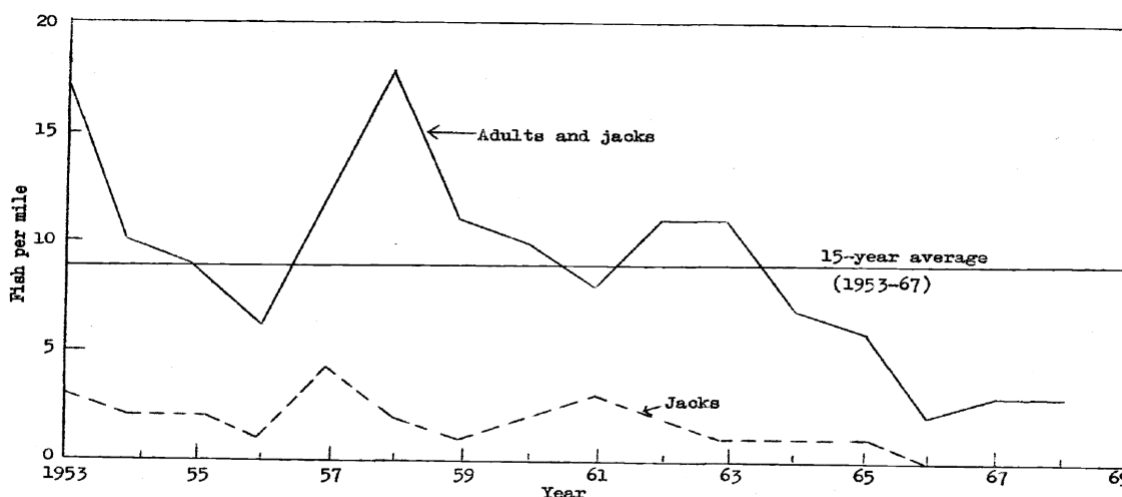

Figure 2. Average numbers of spring chinock per mile in standard survey areas of four coastal rivers, 1953-68

Nicholas and Hankin (1989) noted that, based on limited catch information, all Oregon coastal spring-run populations were smaller than fall-run and much smaller than historical population sizes. Nickelson et al. (1992) noted that coast-wide fall and spring Chinook salmon production had declined by 30% to 50% from the estimated 300,000 to 600,000 fish present in 1900. Similarly, Kostow (1995) noted that the spring-run populations in these groups are not well monitored and have remained depressed compared to historical levels.

The state of Oregon, through the Oregon Plan for Salmon and Watersheds, monitors fall-run Chinook on the Oregon coast, but does not monitor spring-run Chinook (Jacobs et al. 2001). Limited monitoring does occur for some populations through the ODFW Coastal Multispecies Plan, but this is limited to resting pool counts for returning adults on the Siletz, South Umpqua, and North Umpqua populations. Limited monitoring and incidental observations of current populations indicate that all Oregon coastal populations of immature migrating Chinook are small and have remained depressed compared to historical levels. We summarize below more specific information on population status in basin-by-basin summaries.

Basin Summaries of Population Status and Threats

Nehalem River

The Nehalem River spring Chinook is the subject of conflicting information among ODFW documents. The 1991 Coastal Chinook Salmon plan lists a small but increasing spring-run population in the Nehalem (ODFW 1991). In the Biennial report on the Status of Wild Fish in Oregon completed in 1995, no Nehalem spring Chinook populations were acknowledged, but a "summer run" was listed (ODFW 1995). Based on research completed in the Rogue River (Thompson et al. 2018), this population could be evidence of an extirpated spring Chinook population which has hybridized with the fall run yielding an intermediate summer run-timing. More information is needed to resolve the question of the status and origins of Nehalem River early-migrating Chinook.

Tillamook Bay Watersheds

Spring-run Chinook occur in the Tillamook River and its tributaries Wilson River, Kilchis River, and Trask River. Spring-run Chinook formerly occurred in the Miami River tributary, but are now considered to be extirpated there.

Historical spring-run abundance information in the Tillamook River basin is not available (Nicholas and Hankin 1989; Kostow 1995). Meengs and Lackey (2005) estimated a late 1800s run size of 51,000 Chinook salmon in the Tillamook River basin, with fall-run likely the majority of the run size. By the mid twentieth century, Tillamook Bay spring Chinook runs were much smaller than they had been in the past (Hodges and Gharrett 1949). In the early 1970s, spring Chinook spawners in the Tillamook River basin were estimated at 6,120 fish annually; 3,150 in the Trask River, 1,800 in the Wilson River, 540 in the Tillamook River, 540 in the Kilchis River, and 90 in the Miami River (Percy et al. 1974).

The presence of small but persistent populations of spring-run Chinook salmon in the major tributaries of Tillamook Bay is supported by historical accounts and persistent records of in-river sport and commercial cannery catch (Nicholas and Hankin 1988). While the relationship between hatchery origin and wild spring Chinook in the Tillamook system and nearby Nestucca River has been debated, recent spawning surveys confirm the presence of mostly-wild spawning populations of spring Chinook in the uppermost accessible reaches of the Wilson and Nestucca Rivers (Rasmussen and Nott 2019). Comparable survey data are apparently not available for other Tillamook tributaries, at least for recent years when fin-marked hatchery fish can be distinguished in the field from unmarked wild fish. Inter-annual population trends of wild spring Chinook in the Tillamook system cannot be reliably estimated because until very recently no data were available to distinguish wild from hatchery adults (ODFW 2005).

Nicholas and Hankin (1989) noted that Tillamook Bay spring Chinook were much depleted from historical sizes indicated by catch records. Judging from commercial landings of spring-run fish in Tillamook Bay in the 1920s and 1930s, Nicholas and Hankin (1989) regarded the run as "very depressed compared with historic populations." Nicholas and Hankin (1989) reported that from 1923-1946, commercial landings records for Tillamook Bay indicated a relatively stable catch ranging from 12,000-31,000 Chinook (fall- and spring-run) and averaging about 17,000 fish annually. The timing of these landings indicated that Chinook salmon were probably entering Tillamook Bay during every month of the year.

From the late 1970s through the mid-1980s (1977-1985) the average total run size of spring-run Chinook to the Tillamook River basin (hatchery and wild fish) was 2,800 (Nicholas and Hankin 1989). During this time period the average spring-run population in the Wilson River was 1,400 fish and the Trask River run averaged 4,600 fish (Nicholas and Hankin 1989).

By the 1990s the proportion of hatchery to wild fish spawning in the Tillamook River basin had become a concern. Chilcote et al. (1992) reported that there was too high a proportion of hatchery fish spawning in the Trask River. Nickelson et al. (1992, 1993) classified the Tillamook River, Wilson River, and Kilchis River spring-run populations as "special concern" due to the influence of hatchery strays.

Kostow et al. (1994) reported a Tillamook basin spring-run natural spawning population of 1,492 fish; 697 of which were wild fish (47%) and 795 hatchery fish raised the Trask River hatchery (53%). Kostow et al. (1995) reported a Wilson River spring run population of 956 fish, and estimated that 50% (478) were hatchery fish. Kostow et al. (1995) reported a Kilchis River spring run population of 165 fish, and estimated that 65% were of Trask River hatchery origin.

The ongoing Chinook hatchery program including the Trask Hatchery and associated satellites, with stocking in several rivers (see below), likely harms wild spring Chinook in the Tillamook Basin by way of several threats, including interbreeding of wild and hatchery fish on the spawning grounds, competitive ecological interactions or behavioral disruption or displacement of wild by hatchery fish in the lower river and estuary, and incidental catch and illegal and mortality of wild fish in the in-river sport fishery promoted by hatchery stocking. In addition to in-river catch estimates reported below, a significant sport fishery for spring Chinook exists in Tillamook Bay.

Tillamook Bay tributaries have all been subject to extensive logging, including intensive post-fire logging and extensive, high-density railroad and road systems, prior to forest practices legislation on private industrial forest lands. The legacy of logging and related log transportation, landslide, and debris flow impacts on these rivers almost certainly dramatically reduces their carrying capacities for early-run Chinook salmon, compared to their historical conditions, when summer shade and large-wood-formed pools were more abundant. Short-rotation logging of second-and third-growth stands on private and state forest lands in recent decades has contributed to keeping forest cover in all of these catchments in a state dominated by stands less than 50 years of age, where evapotranspiration demand is maximal and summer low flows are likely greatly depleted compared to historical flows under forest mosaics dominated by a large area of mature stands. Forests managed on such short rotations do not produce the very large trees that historically shaped habitat and provided cover for salmon.

Lower alluvial and floodplain reaches of the Tillamook Bay rivers that were once likely important rearing habitat for migrating juvenile Chinook salmon have been greatly degraded by agriculture and intensive dairy farming. Much of the estuary fringe has been similarly impacted by agriculture, roads, and other development, and the estuary itself has likely lost productivity for salmon rearing due to large-scale sedimentation that followed agricultural clearing and channelization and clearance of natural wood debris accumulations, followed by fires and intensive high-impact logging and subsequent massive erosion in the uplands.

The state of Oregon's 2005 Oregon Native Fish Status Report gave the Tillamook River spring-run Chinook population a failing grade due to low abundance (ODFW 2005b).

Kilchis River

Nicholas and Hankin (1988) estimated mean annual in-river sport catch of Kilchis River spring Chinook between 1969 and 1985 at 21 fish, ranging from 0 to 94.

Wilson River

Nicholas and Hankin (1988) reported that the Wilson River supports spring- and fall-run Chinook salmon. While they found no life history or catch information for spring-run fish, they suggested the Wilson run was dominated by wild rather than hatchery fish. They estimated mean annual in-river sport catch of Wilson River spring Chinook between 1969 and 1985 at 368 fish, with a range of 10 to just over 1,000.

Rasmussen and Nott (2019) reported spawning ground and resting pool counts of spring Chinook in the Wilson River. With five years of reported data between 2005 and 2018, peak spawner counts, averaged across surveyed reaches, ranged from 1 to 9 fish per mile. Although marked hatchery fish comprised a large proportion of spring Chinook carcasses surveyed in the lower Wilson, counts in the uppermost reaches were comprised predominantly of unmarked wild fish with few hatchery fish present (Rasmussen and Nott 2019). Rasmussen and Nott (2019) reported that DNA samples were taken in their 2017-2018 surveys, but have not yet been analyzed.

In conclusion, it appears a small wild population of spring Chinook salmon exists in the Wilson River, but it may be threatened by large releases of hatchery spring Chinook smolts in the Tillamook system, resulting in hatchery-origin adults straying and spawning in at least the lower and middle reaches of the Wilson River. Harm could result from interbreeding of wild and hatchery fish on the spawning grounds, competitive ecological interactions or behavioral disruption or displacement of wild by hatchery fish in the lower river and estuary, and incidental catch added mortality of wild fish in the in-river sport fishery promoted by hatchery stocking.

Miami River

Persistent returns and catch indicated the Miami River may support a small population of spring Chinook salmon. This possibility needs to be confirmed by carcass and genetic surveys to determine the hatchery or wild origin of fish on the spawning grounds.

Trask River

Nicholas and Hankin (1989) estimated mean annual in-river sport catch of Trask River spring Chinook between 1977 and 1985 at 1,150 fish, with an adult run size estimate of 4,600 fish. Between 1983 and 1999 in-river sport catch of spring Chinook in the Trask averaged over 1,000 fish, ranging from 446 to just over 2000 (ODFW 2016b). Hatchery returns for the period ranged from 176 to 1126, indicating a high in-river catch rate that, while desirable for a hatchery stock intended to support harvest, could pose grave consequences for overharvest of the co-occurring wild population. At that time the catch included wild as well as hatchery fish, but since then hatchery fish are fin-clipped and in-river take of unmarked spring Chinook has been prohibited.

More recent catch data are not available, and if data are available to ascertain the effect of new catch restrictions in protecting wild origin fish in the system, they apparently have not been

reported. Spring Chinook spawning surveys did not begin in the Tillamook Basin until 2005; population, survival and catch, and pHOS (percent of hatchery strays observed in the population) estimates were not yet available when the HGMP was finalized in 2016 (ODFW 2016b). In 2018 fisheries managers had to limit freshwater fisheries in order to secure enough spring Chinook to meet Trask Hatchery broodstock goals (ODFW 2018d). Returns of spring Chinook in 2019 were again so low that state officials worried egg take would be insufficient to maintain the stock; low returns and expected high water temperatures prompted the state to close the Trask River to all fishing in holding areas in the vicinity of Trask Hatchery (ODFW 2019).

Trask Hatchery spring Chinook releases 365,000 smolts annually as sub-yearlings as an attempt to minimize residualism of smolts and in hopes of reducing ecological interactions with wild juvenile spring Chinook in the system (ODFW 2016b). However, no monitoring data are available to account for spawning in the wild or pHOS of Trask Hatchery Chinook releases in areas that wild spring Chinook spawn in the system (ODFW 2016b), which would be the minimum data necessary to determine the effectiveness of these management measures to protect a wild population. An additional 110,000 eyed spring Chinook salmon eggs initially incubated at Trask Hatchery are reared and released at Whiskey Creek Hatchery (ODFW 2016c). Whiskey Creek releases 35,000 smolts annually released into the Lower Trask River, with an additional 65,000 fingerling transferred for rearing at and eventual release from Trask and Cedar Creek hatcheries. No monitoring data are available to account for spawning in the wild or pHOS of Whiskey Creek spring Chinook releases (ODFW 2016c).

Unmarked (presumed natural origin) spring Chinook adults are captured in the Trask Hatchery trap (ODFW 2016b); unmarked fish are released, but it appears no data are available on their survival to spawn. ODFW (2016b) proposes to collect "a minimum of 127 males and 127 females" from the Trask River trap for broodstock annually. In the 2016 HGMP, ODFW (2016b) speculated that the wild population might benefit from "supplementation" by hatchery-origin spawners, but no data or analysis are available to support this speculation, and it stands in conflict with the available literature on the net effects of hatchery-origin spawners on survival, recruitment and population productivity in Chinook salmon populations (Araki et al. 2008; Chilcote et al. 2011, 2013). Therefore the status of wild spring Chinook in the Trask system remains unresolved, except for general knowledge that returns are few.

Tillamook River

Nicholas and Hankin (1988) estimated mean annual in-river sport catch of Tillamook River spring Chinook between 1969 and 1985 at 3 fish, ranging from 0 to 28. Persistent returns and catch indicated the Tillamook River may support a very small population of spring Chinook salmon. This possibility needs to be confirmed by carcass and genetic surveys to determine the hatchery or wild-origin of fish on the spawning grounds.

Nestucca River

Meengs and Lackey (2005) estimated a late 1800s run size of 29,000 Chinook in the Nestucca River basin, with fall-run likely the majority of the run size. In the early 1970s, spring Chinook spawners in the Nestucca River were estimated at 1,890 fish annually (Percy et al. 1974). From the late 1970s through the mid-1980s (1977-1985), the average spring-run spawning population in the Nestucca River was 2,800 fish (Nicholas and Hankin 1989), noted to be a high average abundance level. Nicholas and Hankin (1988) reported that the Nestucca River supported spring-, summer-, and fall-run Chinook salmon. They reported scales samples taken from 87

early-run adults in 1957-1958 showed that these fish all entered the ocean as subyearling smolts. Based on sparse data, they speculated the stock is north-migrating at sea. Early-run Chinook enter the Nestucca beginning in April, and most return to spawn as 4- and 5-year-olds. Nicholas and Hankin (1988) estimated mean annual in-river sport catch of Nestucca River spring Chinook between 1969 and 1985 at 712 fish, ranging from 99 to 1,308.

By the 1990s the proportion of hatchery to wild fish spawning in the Nestucca River had become a concern. Nickelson et al. (1992) classified the Nestucca River spring-run population as "special concern" due to the influence of hatchery strays. Kostow et al. (1994) reported that Nestucca River spring Chinook spawning escapement was 1,042 fish, 62% wild and 38% hatchery. The state of Oregon's 2005 Oregon Native Fish Status Report gave the Nestucca River spring-run Chinook population a failing grade due to low abundance (ODFW 2005b).

Rasmussen and Nott (2019) reported spawning ground and resting pool counts of spring Chinook in the Nestucca River. With five years of reported data between 2005 and 2018, peak spawner counts, averaged across surveyed reaches, ranged from about 5 to 9 fish per mile. It is important to note that although marked hatchery fish comprised a large proportion of spring Chinook carcasses surveyed in the lower Nestucca, counts in the uppermost reaches were comprised predominantly of unmarked wild fish with few hatchery fish present (Rasmussen and Nott 2019). Rasmussen and Nott (2019) reported that DNA samples were taken in their 2017-2018 surveys, but have not yet been analyzed.

In conclusion, it appears a small wild population of spring Chinook salmon exists in the Nestucca River, but is likely threatened by annual releases of 200,000 spring Chinook smolts annually into the lower Nestucca River system. Harms could result from interbreeding of wild and hatchery fish on the spawning grounds, competitive ecological interactions or behavioral disruption or displacement of wild by hatchery fish in the lower river and estuary, and incidental catch adds mortality of wild fish in the in-river sport fishery promoted by hatchery stocking.

Salmon River

In the early 1970s, spring Chinook spawners in the Salmon River were estimated at 180 fish annually (Percy et al. 1974). This population is now reported to be extirpated.

Siletz River

Historical cannery pack records show a strong run of Chinook salmon entered the Siletz River starting in June of each year, though commercial catch of early-returning Chinook had declined by the mid-1930s (Nicholas and Hankin 1988). Meengs and Lackey (2005) estimated a late 1800s run size of 30,000 Chinook in the Siletz River basin, with fall-run likely the majority of the run size.

In the early 1970s, spring Chinook spawners in the Siletz River were estimated at 775 fish annually (Percy et al. 1974). From the late 1970s through the mid-1980s (1977-1985), the average spring-run spawning population in the Siletz River was 350 fish (Nicholas and Hankin 1989), considered to be depressed compared with pre-1935 populations. Chilcote et al. (1992) reported 315 spring Chinook during peak spawner counts in the Siletz River, which included strays from a private fish hatchery (OreAqua, Inc., Rogue Stock, no longer in operation).

Chinook salmon begin appearing in the Siletz Falls trap, at river mile 64.5, in June, with returns continuing through July and August (Weinrich and Pattni 2016). The trap is located at Siletz

River Falls, which is thought to have historically been passable only at summer low flow conditions. This historic passage constriction is conceivably the impetus for the establishment of endemic summer steelhead and spring Chinook populations in the Upper Siletz River. Returns of what ODFW considers "early Chinook" peak in September, but this peak could entail some overlap of spring-and fall-returning fish. All unmarked Chinook returning are assumed wild and passed above the trap and falls in recent years (Weinrich and Pattni 2016). Some of the earliest-returning Chinook salmon might have entered the estuary and lower Siletz River prior to June, but little is reported of the timing of estuary entrance or residence in the lower river of returning adults.

Spring Chinook in the Siletz River spawn primarily in the mainstem below Siletz Falls (RM 64.5), and in the North and South Fork of the Siletz River above the falls. Spawning habitat for spring Chinook also includes Drift Creek, Cedar Creek, Euchre Creek, Rock Creek, Sunshine Creek, and the mainstream Siletz River above Moonshine Park. Some spring Chinook do pass the falls and inhabit the Upper Siletz watershed. Spring Chinook inhabit approximately 10.8 miles of stream within the Upper Siletz watershed; 4.5 miles of mainstem NF Siletz River; 4.5 miles of SF Siletz River; and 2 miles of Warnick Creek, a tributary of the North Fork. (USBLM 1996)

For four decades after construction of a fish ladder at Siletz Falls in 1952, steelhead, and presumably Chinook salmon, indiscriminately passed above the falls without regard to wild or hatchery origin or month of return. This change in access that presumably relaxed selection for early run timing is thought to have contributed to collapse of the native Siletz summer steelhead run (Weinrich and Pattni 2016). It similarly could have resulted in demographic and/or genetic displacement of spring Chinook by fall Chinook in the upper river, as has been postulated for other systems (Thompson et al. 2019).

Counts of "early Chinook" to or through the Siletz Falls trap are reported in Weinrich and Pattni (2016, p. 17) for the years 1998 through 2015. ODFW (2005, p. 148) provides additional data for 1994-1997, and ODFW (2018, unpublished data) provides counts for 2016-2018. During this period, returns to the trap ranged from about 100 total Chinook or fewer in 1994, 1998 and 2007, to over 800 in 2014, with a median of roughly 300. Some additional early-returning Chinook spawn in the river below the Siletz Falls trap (ODFW 2018, unpublished spawner count data); peak counts downstream are correlated with trap counts, and add an additional roughly 30% to the total population counts. This suggests the Siletz spawning population annually has ranged from less than 150 adults to just over 900 over the past 20 years. The peak return in 2014 has been followed by three years of decline, returning to a low of 261 fish captured at the trap in 2017.

In sum, the Siletz spring-summer Chinook population is thought to range generally below 1,000 fish, but more than 100, with moderate interannual variability.

Of concern with regard to population productivity is that the percentage of adults returning as jacks has progressively increased, from around 15% early in the period to approaching 30% in recent years. Persistently declining age at maturity can be associated with reduced productivity, adaptive capacity, and can increase the risk of population decline (Lewis et al. 2015). Notably, ODFW's (2005) Native Fish Status Assessment did not consider changes in life history or life history diversity among its criteria for assessing stock conservation status.

Nicholas and Hankin (1988) provided estimated in-river sport catch estimates for the Siletz River for the years 1969 through 1985. Estimated annual mean catch of spring Chinook for this period was 72, ranging from 18 to 237. ODFW (2018, unpublished data) estimated in-river sport

harvest of harvest of spring Chinook in the Siletz for the years 1971 through 2016, and it ranged from a low of 15 fish in 1973 to a high of 586 in 2015. Calculated harvest rates in the in-river fishery for this time span range from 6 percent to 63 percent. The median in-river harvest rate for recent brood cycles spanning 2010 through 2017 is 26 percent, but harvest apparently approached or exceeded 50 percent in 2017 (the latter harvest rate is uncertain because of the absence of spawner count data after 2015). This time series appears to show a recurring lag or overshoot effect, with the highest harvest rates occurring in years following years of the highest returns and catch. This suggests in those years high angler effort inspired by the previous year's catch is occurring on a population of declining abundance that is thus hit disproportionately hard by harvest. It is doubtful these "overshoot" years represent sustainable harvest rates for any but the most robust and productive spring Chinook population.

Hence inadequate regulation of in-river sport harvest under current management appears to be a threat to the Siletz population. This population is on the dangerous cusp of being small enough that long-term persistence is at risk, but large enough in some years to attract substantial targeted angling effort. Notably, ODFW's (2005) Native Fish Status Assessment did not consider harvest rate among its criteria for assessing stock conservation status. Given the high concern around harvest, it is concerning that ODFW's sampling programs for harvest and spawner counts for the Siletz spring Chinook population appear to have diminished since 2015. As noted elsewhere in this petition, ocean exploitation of this and other of Oregon's coastal spring Chinook stocks is not directly measured by state and federal fishery management authorities. Therefore total exploitation rates and their sustainability are not assessed, except in the crudest sense that the still extant stocks are observed to have not diminished to extinction under recently prevailing harvest regimes.

About 78 percent of the Siletz River basin land ownership lies in private industrial forest land ownership (ODFW 2018 DRAFT). This land, together with most of BLM's 7.7 percent of the basin, has been clearcut logged at least once or twice in recent decades. As a result, the basin has extremely high road densities, extensive forest disturbance in riparian areas, and widespread erosion and debris flows associated with roads and cutover lands. Because the majority of the basin has transitioned to and maintained in a second-growth forest state in recent decades, it is likely that summer low flows are reduced compared to historical low flows prior to logging. Water withdrawals at the town of Siletz for municipal and industrial uses likely impact juvenile Chinook rearing habitat in summer and early fall in the lowermost river miles.

The distribution of early spring Chinook that return to the Siletz River tend to migrate to the upper basin to hold over the summer for up to four months before the onset of spawning. The upper Siletz Basin above Moonshine Park is dominated by volcanic geology, which provides good habitat to support adult spring Chinook, specifically large pools for holding, gravel riffles for spawning and a sufficient supply of cool water during the summer. Consequently, the current core area for holding and spawning of spring Chinook is in the upper Siletz Basin above Moonshine Park, with the greatest concentrations of fish spawning in the mainstem upstream of Siletz Falls into the lower reaches of the North and South Forks and also downstream from the falls to Buck Creek.

However, there appears to be diversity within the population as spring-run Chinook also spawn at lower abundances in the middle and lower reaches of mainstem Siletz River as far downstream as Morgan Park (approximately river mile 25). The lower reaches of the river are dominated by sedimentary geology and are of a lower gradient. The lower mainstem spawning spring Chinook may represent a later component of the population, possibly entering the estuary in August and holding for a shorter period in upper tidewater and the lower river before

spawning. There is some speculation that this group may constitute a discrete 'summer' run; however, there are currently no data available to verify this (Davis et al. 2017), and thus they are considered as spring Chinook for the purposes of this plan. Alternatively, this could represent a hybridized population segment that carries genes of both the fall and spring-run populations, likely a byproduct of human alterations of the ecosystem (Thompson et al. 2019).

There are several sources of abundance data available for the Siletz spring Chinook population. The most reliable data is from counts made at the Siletz Falls fish trap (hereafter referred to as the trap) from 1994 to the present. The trap provides 14 years of continuous data for all of the fish going above the falls. Additionally, 34 years of data from 1952 to the present is available from spawning surveys conducted below the falls in the mainstem Siletz River from Buck Creek to Sunshine Creek However, the data is not continuous, with large data gaps when surveys were not conducted. Additionally, there is some overlap between spring and fall Chinook on this spawning survey. Misidentification is probable based on the fact that they were distinguished, based on visual observations and monitoring efforts that considered fish most likely to be fall-run based on an arbitrary date. Finally, in river sport harvest records derived from punch card data is available from 1971 to 2005.

In general it appears that the abundance of spring Chinook in the Siletz Basin has decreased from historic abundances observed in the early 1900s. Gill net records indicate that between 1923 and 1946 the numbers of fish caught (in pounds) in the month of July (peak river entrance) ranged from a high of 29,683lbs in 1923 to a low of 63lbs in 1946. (Cleaver, 1951).

From the year 2000-2017, abundance of adult spring Chinook captured at the Siletz trap, combined with supplemental spawning surveys, has shown variability with fish numbers ranging from a low of 189 to a high of 934 fish; however, in general there has been an increasing trend from 2007 to 2014, followed by a crash in abundance starting in 2016. In 2018 only 252 adults returned to the Siletz falls trap, with an additional 68 jacks. The 320 total is below the 10 year average of 415 (ODFW, personal communication).

The in-river sport harvest records derived from punch card data are a fair long term index of abundance for Siletz spring Chinook, but is confounded by ocean fisheries. Where the monitoring data and harvest time series overlap, the harvest records show a more robust but similar pattern to the spawning survey data.

Alsea River

Historical cannery records document a large catch of early-run Chinook in the Alsea River through the mid-1930s, declining rapidly thereafter (Nicholas and Hankin 1988). Meengs and Lackey (2005) estimated a late 1800s run size of 38,000 Chinook in the Alsea River basin, with fall-run likely the majority of the run size. Based on catch records from commercial net fisheries during the early 1900s, the historical Alsea River spring-run Chinook population was at least several thousand spawners per year (ODFW 1997, p. 47).

Nicholas and Hankin (1989) reported that from 1923-1935 an average of 62% of the total in river commercial Chinook catch in the Alsea River was taken from May through July, indicating the presence of a significant run (several thousands) of spring- or summer-run Chinook. Kostow (1995) also noted that a significant proportion of the historical commercial harvest of Chinook in the Alsea River (1,000-14,000 fish annually) were spring-run. The Alsea River May-July catch declined rapidly after 1934 until the fishery closed in 1948 (Nicholas and Hankin 1989; Kostow 1995).

In the early 1970s, spring Chinook spawners in the Alsea River were estimated at 300 fish annually (Percy et al. 1974). From the late 1970s through the mid-1980s (1977-1985), the average spring-run spawning population in the Alsea River was 400 fish (Nicholas and Hankin 1989), considered very depressed compared with pre-1935 populations.

Nicholas (1989) estimated the average Alsea River spring Chinook run size at 400 and indicated that all spring-run fish were probably wild. Nehlsen et al. (1991) classified Alsea River spring Chinook as "of special concern." Chilcote et al. (1992) indicated that it was unknown whether the Alsea River spring Chinook population exceeded 300 fish and noted that the 1990 run was affected by strays from a private fish hatchery at Newport (OreAqua). In the 1990s spring Chinook escapement to the Alsea River basin was estimated to average only a few hundred fish annually (ODFW 1997, p. 47). The spring Chinook population has shown little evidence of increase since Nicholas and Hankin (1988) declared it to be at an "extremely depressed level of abundance for the past 30-40 years."

The 1997 Alsea River Basin Fish Management Plan (ODFW 1997) noted that the status of spring-run Chinook in the Alsea River basin was "depressed' due to poor habitat conditions, hatchery salmon strays, and competition with fall Chinook. The plan characterized spring-run Chinook as "self-sustaining at a low level" but also described an apparently small, "precarious run." The plan noted escapement of only a few hundred spring-run fish annually compared to at least several thousand fish per year in the early 1900s. The plan noted that possible limiting factors included lack of suitable holding water for adults, disturbance of adults in holding and spawning areas, warmer water temperatures, and competition with fall Chinook during juvenile rearing. The plan noted that the sport catch of spring Chinook in the Alsea River basin averaged about 50 fish per year, but that overall ocean and in-river harvest rate was unknown for Alsea spring-run Chinook. The plan stated that additional angling regulations to eliminate any directed spring Chinook harvest were warranted, and that angling regulation proposals would be submitted to eliminate any spring Chinook harvest except for incidental catch during the early part of the fall Chinook fishery.

ODFW's plan proposed a fish management approach in the Alsea River Basin directed at protecting and restoring self-sustaining populations of all fish species native to the basin, with various policies as described in the Regulatory Mechanisms section of this petition. The plan's goal for spring-run Chinook was to manage for wild production only, except for hatchery programs specifically designed to recover the wild population. Pivotal to the plan's objectives for spring-run Chinook was to achieve an annual spring Chinook escapement of at least 300 adults with population components in both the lower and upper parts of the basin. Some of the identified field surveys have been completed under this plan.

The state of Oregon's 2005 Oregon Native Fish Status Report noted chronically low numbers of spring Chinook in the Alsea River and gave the population a failing grade due to low abundance (ODFW 2005b).

ODFW data include spawner counts available for the years 2000 through 2014 (ODFW unpublished data, obtained from Spangler in 2019), which indicate a persistent but not large return of spring Chinook salmon occurs in the Alsea River each year. For this time period, aggregate counts of early-returning Chinook ranged from 82 to 466 fish, with a median just under 200 adults. Low returns were observed 2001 and 2007, with high returns in 2004 and 2013. In-river harvest estimates from ODFW (unpublished data) are relatively low for this stock, ranging from 4 to 72 fish, or in-river harvest rates of 2-12% of total return. Ocean harvest rates

are unknown. The absence of spawner counts and harvest data for years after 2013-2014 are concerning, as they suggest flagging commitment by Oregon to fund the conservation plan and monitor stock status and regulate fisheries accordingly.

Siuslaw River

The historical presence of early-returning spring Chinook is indicated by the Siuslaw River reported cannery catch during the 1920s through 1940s or 1950s of Chinook in August (Nicholas and Hankin 1988). Meengs and Lackey (2005) estimated a late 1800s run size of 23,000 Chinook in the Siuslaw River basin, with fall-run likely the majority of the run size. Nicholas and Hankin (1989) noted that the Siuslaw River apparently supported a population of spring- or summer-run Chinook in the early 1900s.

The current status of spring Chinook in the Siuslaw is the subject of conflicting information, but if any are present, they are few. Percy et al. (1974) suggested that there were no longer spring-run Chinook spawning in the Siuslaw River By the early 1900s. Nicholas and Hankin (1989) noted that the Siuslaw River Chinook run consisted "almost entirely" of fall-run fish. Nickelson et al. (1992) classified the status of Siuslaw River spring Chinook as "unknown," commenting that it "may not be a viable population." Kostow (1995) reported that the Siuslaw River spring-run population appeared to be "very small." The state of Oregon's 2005 Oregon Native Fish Status Report presumed that the Siuslaw River spring Chinook population is extinct (ODFW 2005b).

North Umpqua River

The North Umpqua River spring run Chinook population is the only large population within the Oregon coast ESU (ODFW 2005b). Nevertheless, this population has declined dramatically from historical estimates. The spring Chinook run once contributed strongly to seasonal cannery and gill net catches in the Umpqua River. Meengs and Lackey (2005) estimated a late 1800s run size of 21,000 Chinook in the Umpqua River basin, with fall-run likely the majority of the run size.

The spring Chinook population size in the Umpqua River was at a "very low level" by the 1940s (OFGC 1946; OGC 1949). The 1946 spring-run estimate was 4,400 fish, 935 of which were jacks (FCO and OSGC 1946).

Spring-run Chinook have been counted at Winchester Dam on the North Umpqua since 1947, with variable returns and unclear trend over the years. Winchester counts indicated that the spring run population increased from the late 1940s to the 1960s, to more than 5,000 fish annually (Kostow 1995). In the early 1970s the spring Chinook population in the Umpqua River basin was estimated at 12,600 fish annually (Percy et al. 1974). From 1977-1985 the average spring-run size in the North Umpqua River (hatchery and wild) was 8,500 fish (Nicholas and Hankin 1989). Winchester Dam counts stabilized with no trend until the 1980s (Kostow 1995), with an El Nino effect reducing the 1983-1984 returns (Nicholas and Hankin 1989). The annual average of 1965-1988 spring run returns was 14,000 fish (Nicholas and Hankin 1989). Nickelson et al. (1992) classified the Umpqua River spring Chinook run as "healthy" but subsequently Winchester Dam counts in the 1990s declined to low levels not seen since the 1950s (Kostow 1995).

Spring Chinook today well outnumber fall Chinook in the North Umpqua River, though local observers and landowners report the two populations appear to overlap in spawning location

and to a somewhat lesser extent in timing in the reaches in the vicinity of Idelyld Park to Glide, OR (C. Frissell, personal communication with K. Konecny).

Winchester Dam returns have been relatively stable in the past two decades, with a low count of 2,430 in 2007 and a high count of 8,927 in 2011. Thus the North Umpqua run remains demographically robust. Unfortunately, it is the only coastal Oregon spring Chinook population that can be unequivocally judged to not stand in immediate jeopardy from existing threats. Considering the diminished and precarious status of all other populations encompassed by this petition, protecting the North Umpqua population is of utmost importance for conserving early-migrating Chinook salmon in coastal Oregon region.

The Rock Creek hatchery releases 342,000 spring Chinook smolts annually to supplement angler harvest in the mainstem and North Umpqua Rivers (ODFW 2016a). This release returns an average escapement of about 4,300 adult hatchery spring Chinook annually above Winchester Dam, although hatchery returns fluctuate much more year to year than wild returns. In most years over the past two decades, hatchery returns have exceeded wild returns over Winchester Dam, by nearly two-fold at the greatest. Hatchery spring Chinook are released at or below the hatchery at Rock Creek, but ODFW carcass counts show that many hatchery fish stray upriver, such that the proportion of hatchery-origin spring Chinook salmon spawners (pHOS) in the North Umpqua, above Rock Creek, was estimated at 11.5% on average over the 12 years prior to 2016 (ODFW 2016a). Previous estimates put the pHOS estimate at 17% (ODFW 2005). Both values are higher than the maximum pHOS of 10 percent most often adopted by NMFS as the threshold for reducing harm to wild fish populations—and considerably higher than the 1-5% pHOS level many or most scientists identify as the likely threshold of harm.

Spring Chinook from the Rock Creek hatchery are known to contribute to ocean fisheries off of Oregon and California primarily, with catch also reported in BC and southeast Alaska fisheries (Nicholas and Hankin 1989; Williams 2001). It is generally presumed, though not proven, that the wild North Umpqua source population for this stock exhibits the same pattern. Ocean exploitation rates are not available for the hatchery stock, nor for the wild North Umpqua population.

Nicholas and Hankin (1988) estimated in-river catch of North Umpqua spring Chinook for the years 1971 through 1985. The mean annual catch in the North Umpqua during this period was 916, with an additional 1,020 caught in Winchester Bay and the main Umpqua River (a small but unknown proportion of the latter was South Umpqua fish). Catch within the North Umpqua for this period ranged between 532 and nearly 4,000. Following something of a comeback after low returns in the 1940s and 1950s and closure of the in-river commercial fisheries, in-river sport catch in the mainstem and North Umpqua again declined precipitously from about 11,000 fish in 1972 to about 2,000 annually after 1978 (Nicholas and Hankin 1988).

ODFW provides comparable data expanded from angler punch cards for 2013 through 2017 on its web site (https://www.dfw.state.or.us/resources/fishing/sportcatch.asp). During this period harvest of spring Chinook in the North Umpqua, mainstem Umpqua and Winchester Bay declined from highs exceeding 4,000 fish to fewer than 2,400 after 2014.

The North Umpqua ecosystem has been altered by roads, dams and flow diversion and flow regulation in the headwaters, and extensive logging on private industrial forest, BLM, and USFS lands over the past 50 years. However, despite the wide scope of activity, the North Umpqua retains a far larger proportion of its catchment in unlogged, unroaded blocks of primary old

growth and mature forest cover than any other spring Chinook river in western Oregon--with the possible exception of the Upper Rogue River. Both catchment forest cover and hydrogeologic factors creating a flow regime strongly influenced by deep groundwater sources likely play key and converging roles in conferring continuing high ecological integrity and resilience to spring Chinook habitat In the North Umpqua. Owing to its generally higher elevation, contiguous blocks of federal forest ownership, and distance from major urban markets for wood products, the North Umpqua watershed was not logged as heavily and extensively in early years of the previous century—prior to the advent of laws regulating forest practices—as most other Oregon rivers were.

Two FERC-licensed hydroelectric projects affect North Umpqua spring-run Chinook. Winchester Dam on the lower North Umpqua near Roseburg, Oregon, ceased generating hydroelectric power in 1923. In 1982, a previous owner of the dam obtained a FERC permit to reestablish power generation, but litigation led to the project losing its status as a small-scale hydro project exempt from FERC relicensing requirements. Hydroelectric generation ceased in 1985 and the project was abandoned. Subsequently the Oregon state legislature prohibited any new water rights for power generation on that reach of the North Umpqua River (ORS section 541.875(3)). In 2010 the current dam owner, Coastal Hydropower LLC, submitted a permit application with FERC for hydroelectric power generation. NMFS, state agencies and conservation groups intervened and the dam owner withdrew the FERC application in 2011. Oregon state law makes it unlikely there will be any new FERC permit given for hydroelectric power at Winchester Dam, so there will likely not be any FERC mechanism for addressing fish passage. Winchester Dam has a functioning fish ladder and counting station staffed by ODFW personnel, but the fish ladder does not meet NMFS standards. Spring-run Chinook and other salmonids migrate through the ladder to pass the dam (NMFS 2018a). The ladder suffers from inadequate maintenance and inconsistent staffing (WaterWatch of Oregon and others, 2019).

The 185.5-megawatt North Umpqua Hydroelectric Project consists of 8 dams constructed between 1947 and 1956 on the North Umpqua River and two of its tributaries, each with a powerhouse and a dam. For more than 50 years, the dams blocked access to historical habitat and degraded downstream habitat for salmonids. In particular the project dam furthest downriver, Soda Springs Dam, blocks upstream and downstream salmonid passage, disconnects most of the North Umpqua mainstem from its tributary of Fish Creek, substantially reduces sediment and spawning gravels to downstream areas, inundates one of the largest and highest-value salmon spawning areas, and adversely affects water quality.

The original FERC license for the project expired in 1997; the dam owner PacifiCorp filed an application for a new FERC license in 1995. NMFS, USFWS, USBLM, and Oregon's Departments of Environmental Quality, Fish and Wildlife, and Water Resources intervened, as did conservation and fishing groups. Conservation groups advocated for removal of Soda Springs Dam; and sound scientific evidence supported removal of the Soda Springs Dam as the highest priority for improvement of habitat connectivity and restoring hydrologic processes in the North Umpqua River. Dam removal was the only alternative consistent with the Umpqua Forest Plan and the Aquatic Conservation Strategy of the Northwest Forest Plan. Although state and federal agencies originally supported dam removal, the Forest Service changed its position after PacifiCorp withdrew from the negotiations over this issue in 1999, ignoring the recommendations of a watershed analysis undertaken by PacifiCorp and the Forest Service.

Federal and state agencies reached a settlement agreement with PacifiCorp in 2001, and NMFS issued a biological opinion regarding impacts to coho salmon in 2002. FERC issued a new 35-year license in 2003. The 2003 FERC license included protection, mitigation, and

enhancement measures for coho salmon, including fishway prescriptions (and fish passage into blocked habitat above Soda Springs Dam), construction of tailrace barriers, increased streamflows, reduced ramping, and habitat restoration. The license also included mitigation funds to offset project impacts on fish and wildlife. The mitigation funds include a tributary enhancement program (for ODFW-approved habitat enhancement projects in the vicinity of the North Umpqua Project); a long-term monitoring and predation control fund (to formulate, implement, and monitor plans related to protection and reintroduction of anadromous fish populations); and a mitigation fund to be administered by the Forest Service to offset adverse impacts of the project on natural resources. However, the FERC license did not address the negative impacts of leaving Soda Springs Dam in place. The FERC license will not be revisited until 2038.

Construction of tailrace barriers was completed in 2007 at Soda Springs Dam and in 2012 at Slide Creek powerhouse. In 2012, PacificCorp completed construction of downstream fish screens and bypass facilities for downstream passage, and an upstream fish ladder for passage at Soda Springs Dam. Shortly after completion, the juvenile fish screens at Soda Springs Dam collapsed due to excessive debris loading and were shut down for repairs and upgrades. The adult fish ladder remained functional but did not have the full attraction flow because the juvenile screens were shut down. In 2014, repairs and upgrades to the juvenile screens were completed and since then the screens and ladder have been undergoing testing and evaluations. Since 2012 PacificCorp completed construction of the Rock Creek tributary adult fish ladder and juvenile fish screens. (NMFS 2018b)

In recent decades, residential and commercial development within the river corridor associated with substandard or damaged sewage drainage systems could be adversely affecting spring and summer habitat conditions for adult and juvenile salmonids. Runoff from residential and commercial roads that have proliferated near the North Umpqua also threatens water quality from poorly controlled delivery of nutrients and sediment. This poses a potential threat to later-returning spring Chinook adults, especially in years of low spring runoff and low early summer flows.
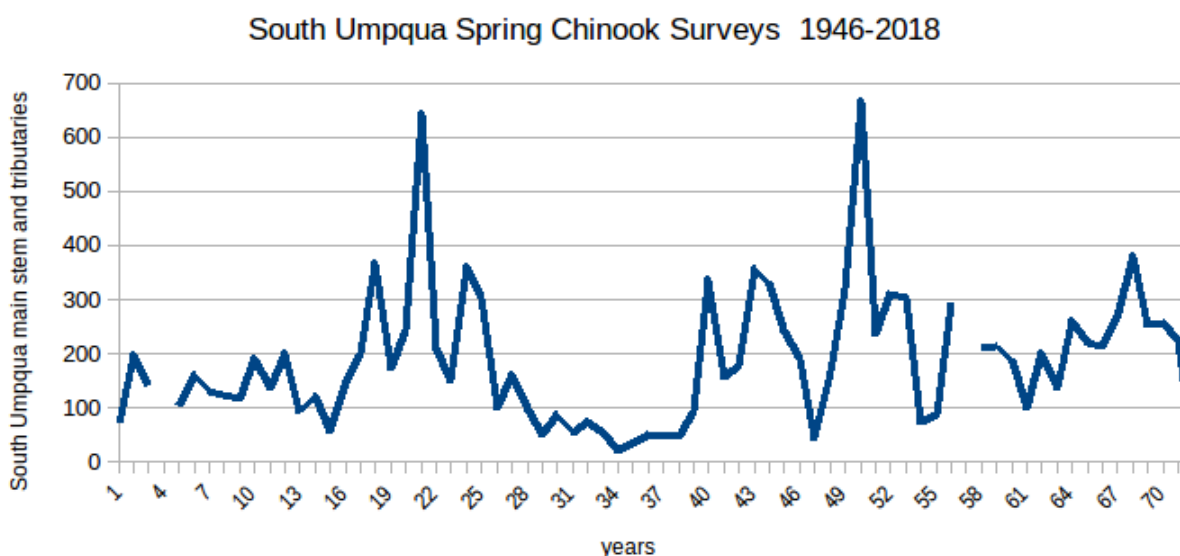
South Umpqua River

The Oregon Coastal Management Plan (CMP) identified only two independent spring Chinook populations for the Oregon Coastal ESU – both in the upper Umpqua Basin. ODFW has identified North and South Umpqua early returning Chinook as independent spring Chinook populations due to their spatial and temporal separation from fall-run Chinook and differing juvenile life-histories. These two populations are considered a separate SMU. The South Umpqua River spring Chinook run is unique in the Oregon Coastal ESU. The first distinct feature of this clade is that its spawning grounds are located in the upper reaches of the Umpqua basin watershed located in the Cascade mountain range, some 200 plus miles from the Oregon coast. It is also ecologically distinct from the North Umpqua in that the South Umpqua is a transiently snowmelt-fed system without a large body of runoff or groundwater sustaining summer streamflow. The summer flow is supplied by aquifer recharging during the winter months.

Historical estimates of this run are in the range of 5,000 spring Chinook in the South Umpqua River (USFS 1966). The upper river system contains 29 large and deep index pools that provide ideal over summering conditions for the run (Ratner et al. 1997). Unfortunately, these pools are easily accessible to the general public and frequented as a result of well-used Umpqua National Forest camping areas in riparian areas of the pool sites. The pools are called "dynamite holes"

by residents in the area as a result of the historical practice of dynamiting the pools for the purpose of harvesting the fish. The USFS, in cooperation with local non-governmental organizations, hires annual surveillance services to protect the Chinook from poaching. Fish counts have shown the spring Chinook also utilizing summer pool habitats in several major tributaries of the upper South Umpqua River until recent years, including Jackson Creek and Elk Creek.

Early-return Chinook were noted as "almost extinct" in the South Umpqua by the early 1900s (Van Dusen 1903). As a result extensive fish counts surveys have been conducted over the last 72 years. The population count is erratic from year to year, but generally low. The South Umpqua spring-run population was estimated at 643 fish in 1966 (USFS 1966). The South Umpqua spring Chinook population was "very small" in the 1970s and 1980s, with average estimated escapement less than 100 fish from 1977-1985 (Nicholas and Hankin 1989). The count was as low as 22 in 1979 and 28 in 2018 (USFS). The average count for recent years is about 170 fish.

South Umpqua Spring Chinook Surveys 1946-2018

An effort was made to "rehabilitate" the South Umpqua spring Chinook population using hatchery-reared North Umpqua stock, and the estimated number of returning adults increased to an average of 528 fish between 1985 and 1991, possibly due to first generation hatchery returns (Ratner et al. 1997), but continuing low returns, including the very low count in 2018, substantiate that hatchery supplementation did not boost medium- and long-term population abundance.

Nehlsen et al. (1991) rated South Umpqua River spring Chinook at a high risk of extinction. Kostow et al. (1994) reported that the South Umpqua spring Chinook population had again declined to only a few hundred wild fish; and further declined to less than 100 fish (Kostow 1995). Viability assessments for all four VSP parameters (abundance, productivity, spatial structure, and diversity) were completed for North and South Umpqua populations. North Umpqua spring Chinook were viable, though with a decreasing trend over the data period (1972- 2010). South Umpqua spring Chinook had an extinction risk that indicated viability (<5%; McElhany et al. 2006). This population is currently so small and the estimate of carrying capacity (Neq) was less than the Minimum Equilibrium Threshold (MET = 500), the PVA results did not pass the viability threshold and the population was considered non- viable.

Threats to South Umpqua Spring Chinook

Currently, the South Umpqua population's status is precarious with indications that it is not very productive. Proximal threats to this population include manifold factors causing the persistent loss of suitable habitat, and high harvest rates.

Management of the spring Chinook SMU is complicated by the fact that the North Umpqua population consists of thousands of returning wild adults (trending downward) but the South Umpqua population consists of less than 200. While efforts are underway to improve the habitat in the South Umpqua for spring Chinook, it will be a long process for improved habitat to develop sufficiently to increase the productivity of the wild spring Chinook population.

The fishery for spring Chinook in the Umpqua Basin occurs from the lower mainstem river upstream into the North Umpqua. The majority of harvest occurs in the mainstem Umpqua below the confluence of the North and South Forks. The South Umpqua is currently closed to Chinook harvest year-round. It is not possible to visually differentiate the two Umpqua wild spring Chinook populations, which leaves the South Fork Spring Chinook vulnerable to fishery impacts in the mainstem Umpqua - in effect a classic mixed-stock fishery problem.

Nicholas and Hankin (1988) reported estimated in-river catch of South Umpqua spring Chinook for the years 1971 through 1985, when the mean annual catch was 12, ranging between 0 and 57. An additional 1,020 spring Chinook on average were caught in Winchester Bay and the main Umpqua River. The largest but unknown proportion of the lower Umpqua catch was North Umpqua fish, but even a small fraction of the lower river and bay catch could easily represent a very proportionate catch of South Umpqua fish. In other words, the lower Umpqua presents a severe mixed stock fishery risk to the South Umpqua population because the more robust North Umpqua population supports a popular and aggressive fishery.

Required release of unmarked wild fish caught in the mainstem Umpqua River and Winchester Bay could protect South Umpqua fish from harvest if effectively enforced, but until recent years ODFW has been reluctant to restrict harvest of the wild North Umpqua population, much of which occurs in the lower river. ODFW has instead imposed a bag limit of no more than 2 wild fish per day and 10 per year in aggregate, with no more than 5 per year harvested from the mainstem North Umpqua (http://www.eregulations.com/oregon/fishing/southwest-zone-regulations-map/). Although this limit might reduce harvest of South Umpqua spring Chinook somewhat compared to past levels, it certainly comes nowhere near eliminating it. The number of guides and anglers participating in the mainstem Umpqua fishery remains very high, and could increase; as a result, total catch is not in fact regulated. As pressure on the fishery increases, even if unclipped wild fish are released, they may still be subject to increased stress and mortality from hooking. Whether ODFW's constraints on kill reduces harvest-related mortality of South Umpqua spring chinook enough to increase spawning escapement remains uncertain, though recent counts (see below) are not particularly encouraging.

In 2018 ODFW South Umpqua pool counts reported only 28 fish, the second-lowest return of spring Chinook in the 40-year record (Seattle Times 2018). It appears the 2019 count may be only marginally higher. ODFW provides comparable catch data expanded from angler punch cards for 2013 through 2017 on its web site (https://www.dfw.state.or.us/resources/fishing/sportcatch.asp). Harvest of spring Chinook in the South Umpqua River has been illegal for some years. Therefore it is somewhat troubling that

ODFW's own estimates show from 6 to 18 spring Chinook harvested in the South Umpqua annually from 2013 through 2017.

Ratner and Lande (1996) concluded after a formal viability analysis that that the South Umpqua spring Chinook at this population size remains at moderate risk of extinction. Their analysis indicated the future extinction risk of the population was highly dependent on improvement or degradation of habitat quality in spawning and rearing habitat. Despite substantial investment in habitat restoration in the upper South Umpqua by federal land management agencies, count data indicate the demographic status and viability of the population have not improved, and in fact may have deteriorated. It appears likely that climate change and the catchment scale hydrologic effects of logging have largely offset any gains that localized habitat modification, beaver reintroduction, and riparian forest protection measures have produced in this ecosystem. However, it is possible that habitat deterioration for this population would have been worse had not restoration measures been implemented in the past two decades.

Considering the precarious demographic status of the South Umpqua population, stray hatchery fish that are likely to reduce population productivity could pose proportionally very large adverse effects. The risk is significant given the very large numbers of hatchery salmon released from Rock Creek Hatchery on the North Umpqua. According to ODFW (2016a), based on snorkel counts in resting pools during the summer, "the stray rate (of hatchery spring Chinook salmon, most likely from Rock Creek Hatchery on the North Umpqua) for the South Umpqua above Tiller, OR from 2010-2014…has averaged 2.4%. It is assumed that these percentages translate into pHOS values due to the fact these fish spawn near where they hold throughout the summer." However, the accuracy of underwater observation of hatchery fish fin clips is variable and often low, and the magnitude of observation bias is seldom quantified. For this reason, carcass counts are the principal reliable method for estimating the percentage of hatchery strays in a wild population. While resting pool observations do have their value, the lack of carcass count data, or ODFW's failure to rely on them in this case, is troubling, considering the dire status of the South Umpqua population.

Fall Chinook salmon abundance in the South Umpqua River apparently increased after the early 1970s (Nicholas and Hankin 1988). If such an increase results in either overlap of spawning location and time with spring Chinook in the South Umpqua River, or competition for juvenile rearing habitat space, the outcome could be problematic for persistence of the spring population (Thompson et al. 2018). While not an immediate threat, this is a potential threat that bears close monitoring.

Juveniles and out-migrating smolts in the South Umpqua River face a gauntlet of environmental hazards. The entire Umpqua River is listed under 303D of the Clean Water Act for elevated water temperature, and supports an enormous population of smallmouth bass. Efforts to reduce the impact of the bass population by removing fishery regulations have had little consequence since most bass anglers are catch and release. Large bass have been seen far enough into spring Chinook spawning and rearing habitat to be considered a serious threat to early migrating Chinook juvenile populations. The South Umpqua River currently has a permanent Oregon State health advisory posted as a result of an annual cyanobacteria algae bloom.

The legacy of logging and related log transportation impacts in the South Umpqua Basin almost certainly dramatically reduces the carrying capacity for early-run Chinook salmon, compared to historical conditions, when summer shade and large-wood-formed pools were more abundant. Dose and Roper (1994) documented long-term channel changes in the South Umpqua stream system associated with logging and road impacts. They found the most extreme changes in

upper-basin streams where spawning and rearing are concentrated, and postulated that these habitat impacts still play an important role in the decline and continuing depression of the South Umpqua spring Chinook population. Short-rotation logging of second-and third-growth stands on private and state forest lands in recent decades has contributed to keeping forest cover in all of these catchments in a state dominated by stands less than 50 years of age, where evapotranspiration demand is maximal and summer low flows are likely greatly depleted compared to historical flows under forest mosaics dominated by a large area of mature stands (see previous section on forestry effects on low flows).

Coos River

Meengs and Lackey (2005) estimated a late 1800s run size of 55,000 Chinook in the Coos River basin, with fall-run likely the majority of the run.

The state of Oregon's 2005 Oregon Native Fish Status Report presumed that the Coos River spring Chinook population is extinct (ODFW 2005b). Little additional information is available.

Coquille River

Meengs and Lackey (2005) estimated a late 1800s run size of 14,000 Chinook in the Coquille River basin, with fall-run likely the majority of the population. Declines of Chinook salmon on the Coquille were noted by the early 1900s; the river "used to be frequented to a great extent by the Chinook variety of salmon, but of late years very few Chinook enter the river" (Van Dusen 1903).

By the 1970s spring Chinook spawners in the Coquille River were estimated at only 50 annually, with a "remnant run" found mainly in the South Fork Coquille River (Percy et al. 1974). From the late 1970s through the mid-1980s (1977-1985), the average spring-run spawning population in the Coquille River was 200 fish (Nicholas and Hankin 1989), considered depressed compared with pre-1935 populations. Nehlsen et al. (1991) rated Coquille River spring Chinook at a high risk of extinction. Nickelson et al. (1992) also classified the Coquille River spring Chinook population as "depressed." Kostow (1995) noted that two very small spring-run populations remained in the Coquille basin, probably less than 200 fish each.

The state of Oregon's 2005 Oregon Native Fish Status Report noted chronically low numbers of spring Chinook in the Coquille River and gave the population a failing grade due to low abundance (ODFW 2005b).

The Coquille River Fall Chinook HGMP (ODFW 2017) asserts that "a single population of wild Chinook Salmon is present in the Coquille River Basin." The WFMP status review (Kostow, 1995) places Coquille Chinook into the Mid-South Coast Gene Conservation Group. Coquille Chinook are further divided into the South Fork Coquille and Coquille (remainder of the Coquille forks) and spring and fall runs. Early-returning spring Chinook are found primarily in the South Fork Coquille (Kostow 1995). ODFW (2017 HGMP) considers the Coquille spring Chinook population status to be "depressed due to marginal habitat and historic poaching." According to ODFW (2017 HGMP), "the broodstock program targets fall Chinook, and as a result of the migration of spring Chinook to upper river holding pools well prior to broodstock collection, few if any spring Chinook are collected as part of the broodstock program." However, it appears that no genetic or other rigorous data are collected to assure and verify that spring and fall Chinook stocks are not intermingled in the hatchery broodstock.

The proportion of hatchery-origin Chinook spawners (pHOS) in the Coquille system is not available and cannot be estimated for available data, for either fall or spring Chinook (ODFW 2017 HGMP). Specific management measures to monitor and mitigate potential adverse effects of hatchery fall Chinook salmon releases in the Coquille River basin have not been determined by ODFW.

American shad, striped bass, smallmouth bass, and largemouth bass occur in the Coquille River estuary (ODFW 2017 HGMP). Possible interactions of these introduced species with Chinook salmon are unknown, other than that spring migrant fall Chinook are known to feed on eggs of shad and striped bass (ODFW 2017 HGMP).

The South Fork Coquille River basin has been heavily impacted by logging activity on private lands since at least the 1920s, and on federal lands since at least the 1960s. As a result, the watershed forest cover today is far less than 50% by area mature and old growth forest. Under current federal forest management plans, both BLM and the U.S. Forest Service have reduced-- and are scheduled to further diminish--the area of mature and old growth forest across the watershed as a whole and within many of its principal tributaries. Many areas of older second growth forest are undergoing repeated clearcutting or heavy thinning in recent years. Concurrent with the extensive logging history is a large, permanent, high-density network of forest roads, and relatively dense distribution of landslides and debris flows.

The legacy of logging and related log transportation impacts in the Coquille Basin almost certainly dramatically reduces its carrying capacity for early-run Chinook salmon, compared to historical conditions, when summer shade and wood-formed pools were more abundant. Short-rotation logging of second-and third-growth stands on private and state forest lands coupled with mature forest logging on federal lands in recent decades has contributed to keeping forest cover in this basin in a state dominated by stands less than 50 years of age, where evapotranspiration demand is maximal and summer low flows are likely greatly depleted compared to historical flows under forest mosaics dominated by a large area of mature stands.

<u>Summary of Spring-Run Population Trends, by Basin</u>

Tillamook River:	Declining (extirpated from Miami River tributary)
Nestucca River:	Declining
Salmon River:	Extirpated
Siletz River:	Declining
Alsea River:	Declining
Siuslaw River:	Extirpated
North Umpqua River:	Stable
South Umpqua River:	Declining, near extinction
Coos River:	Extirpated
Coquille River:	Declining, near extinction

Threats to the Species

Current threats can be characterized into 5 main categories: (1) Present or threatened destruction, modification, or curtailment of its habitat or range; (2) Overutilization for commercial, recreational, scientific, or educational purposes; (3) Disease or predation (4) Inadequacy of existing regulatory mechanisms and (5) Other natural or anthropogenic factors affecting its continued existence. Among the most significant of other manmade factors, and a subject of new published scientific information, is actual or potential hybridization of fall-run and spring-run Chinook salmon where they coexist in the same river basin.

Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range

Habitat related alterations in Oregon's coastal watersheds have affected the abundance, stability, and accessibility of mainstem gravel bars used for spawning and juvenile rearing. The deep, cold, over-summer holding pools required by adult spring Chinook have been filled in by sedimentation, decreasing habitat availability in the lower basins including the loss of mainstem islands and channel complexity. Water quality impairments occur in almost every coastal watershed including temperature, sediment, turbidity, and in some cases toxins. Populations of spring Chinook spend portions of their lives in 303(d) listed streams throughout their range. Water quantity is also affected by municipal water withdrawal, agricultural, and industrial use. Estuarine habitats have been reduced in quantity by an average of 68% in many coastal basins and sea-level rise threatens to reduce available estuarine habitat in some areas including eelgrass beds (Good 2000). Most of the upland impacts have been caused by historical and ongoing logging practices, while lower basins and estuaries have been impacted by agricultural practices, channelization, nitrification, and urbanization.

New Information on Low Flow Depletion

<u>Effects of Logging and Forest Land Use on Summer and Early Fall Streamflow</u>

Perry and Jones (2017, following Jones and Post 2004) concluded, after an extensive study of long-term flow records in experimental watersheds, that an initial 10-15 year period of increased stream baseflows (late spring, summer and early fall) after logging is closely followed by a period in which stream flows are reduced to about half of their pre-logging state for a period lasting from 15 through at least 50-years post-logging. Baseflow depletions of roughly 50% were observed in all study watersheds in western Oregon in which less than half of their area remained in mature and old growth forest, or conversely, in which greater than half of catchment area was logged. The hydrologic basis for this flow depletion appears to be increased evapotranspiration in second-growth forests—that is, greatly reduced water use efficiency—and possibly increased physical evaporation (from soil, or from condensation on the outside of foliage, etc.) in second-growth compared to mature and old growth conifer forests. The ultimate time frame for return to the higher stream base flow conditions observed before logging remains unknown. It could be 60 years, or it could be 120 years, or more—if the recovering forests are left to grow that long.

The research results of Perry and Jones (2017) and Jones and Post (2004) are derived from a set of relatively small experimental watersheds having perennial flows. However, most streamflow in larger-order streams where spring Chinook salmon occur derives from surface water contributed by small tributaries. Therefore, the flow depletion effects almost certainly scale up to produce substantial flow depletion in third or fourth-order streams where juvenile

spring Chinook salmon hold, spawn, and rear. What is known about streamflow source areas and routing in Pacific Northwest watersheds gives us every reason to believe that most larger streams (except in rare cases of streams with unusual deep groundwater sources, lake outlets, or tidal influence) will directly reflect flow reductions seen in their tributaries. However, no research has been conducted to date of sufficient design to directly validate or invalidate flow depletion related to forest condition in higher-order, larger streams. It is important to recognize that Luce and Holden (2009) reported a widespread pattern of streamflow decline over 30 years of record at streamflow gauges across the Pacific Northwest (most of these longer-term records are from larger streams). Luce and Holden's study was not designed to distinguish between effects of land use (or forest cover) and climate on the observed streamflow declines. Progressive logging that resulted in increased area of second growth forest cover could be either a primary driver or a contributor to such widely observed summer stream flow declines.

As Perry and Jones (2017) make clear, their results should be considered applicable to Douglas-fir dominated forests. Dominant conifer species in the forest type could play a significant role in the degree of streamflow depletion in second-growth thinned forests; ponderosa pine, for example, show much different, more conservative stomatal behavior and water utilization in the face of water stress then Douglas-fir. Nevertheless, the freshwater habitat of all coastal spring Chinook salmon populations in Oregon is associated with forests dominated by Douglas-fir—and most, but not all of these have been extensively logged in the past 80-120 years.

Importantly, Perry and Jones (2017) studied some watersheds that experienced thinning of previously clear-cut tree plantations, and found that thinning did not alleviate water use or increase stream baseflows. This finding suggests that growth release of leave trees and the understory flush immediately following thinning increases the demand for soil water in proportion to the decrease associated with the removal of some stems. Shrubs often grow vigorously following canopy removal and soil disturbance caused by logging, including thinning, and some of these shrubs are capable of exploiting soil water sources at depth (Zwieniecki, and Newton 1996).

It is also important to note that the presence or relative size of riparian forest buffers appears to have little or no effect on observed flow depletions in the experimental watersheds. The experimental watershed record analyzed by Perry and Jones (2017) includes both clearcuts and patch cuts with uncut riparian areas, as well as partial cut riparian areas, but these variations recorded no difference in magnitude and duration of base flow depletion. The proportion of watershed area and of total soil water contained within riparian buffer areas is a small fraction of the total for the watershed. In view of these factors, there are both empirical and theoretical grounds to dismiss riparian forest buffers as ineffective in mitigating the whole-watershed effect of higher evapotranspirative water losses in upslope second-growth forests.

Critically complicating recovery or mitigation of streamflow depletion is that we still do not know the actual time frame for hydrologic recovery, or the stand age at which evapotranspiration water loss returns to the more conservative state characteristic of mature and old growth forest. Sustained low flow depletion occurred in all catchments that were more than 50 percent harvested within the 40-50-year time frame of observations (Perry and Jones 2017). All we know for certain is that hydrologic recovery has not occurred at 50 years; it might suddenly set in at 60 or 70 years, but it might not be consummated until stand ages reach 80, 100, or 150 years, or more. Because the flow deficit effect persists for at least 4-5 decades with no measured recovery, staggering logging within this time frame cannot generally be assumed effective to remediate streamflow depletion effects.

The time frame of >50 years for recovery of pre-logging baseflow conditions is critical because any forest harvest rotation age of 50 years or less, typical for private industrial forest lands of western Oregon, results in the vast portion of the landscape existing in permanently depleted base flow conditions. That is, while recently logged patches will generate higher base flows for ca.10-15 years post logging in localized areas, the majority of the landscape will remain perpetually in the second growth-dominated state that is associated with higher water loss and lower stream base flow. Because such a tiny fraction of the private industrial forest landscape remains in mature and old growth condition, stream low flow depletion is likely already widely, if not maximally expressed across these watersheds.

By contrast, on federal lands, and some checkerboard federal-private landscapes, there is sufficient mature and old growth forest remaining that many watersheds hover just below that 50% logged condition. In these watersheds, cutting even a small fraction of remaining mature and old growth forest could push them well beyond the 50% threshold, into a state where stream base flow depletion could be dramatically expressed, or much more widely expressed. From a restoration point of view, many watersheds with federal ownership where a significant area of unlogged mature and old growth forest persists could be returned to a natural higher baseflow condition by allowing present second-growth forests to advance to mature condition, rather than clear cutting or thinning them prior to that stage. Such circumstances might prevail today in, for example, the catchment for habitat used by spring Chinook in the South Umpqua basin. Preservation of existing extensive mature forest cover in catchments that provide habitat to still-robust populations of spring Chinook salmon is of more imminent importance, but in Oregon that circumstance applies only to the North Umpqua spring Chinook population. Recent federal efforts to relax constraints on logging of mature and old growth forests on a large scale across BLM and National Forest lands pose a threat of habitat deterioration for the North Umpqua population, and could indefinitely delay recovery of other populations where some federal lands exist in the catchment.

Importance of Summer and Fall Streamflow for Spring Chinook

Summer and fall streamflow conditions are particularly important for early migrant Chinook salmon, because most juvenile spring Chinook salmon exhibit a "stream type" life history—that is they rear in freshwater over many months, extending through the summer and into the fall near rearing areas, and often through the subsequent winter before they enter the marine environment as smolts. Spring Chinook salmon juvenile growth, survival, and migration behavior during freshwater rearing can be influenced by streamflow and water temperature (Sauter et al. 2001; Richter and Kolmes 2005; Sykes et al. 2009; Walters et al. 2013,). Reduction of summer streamflows also adversely affects volume and temperature of summer holding habitat for migrating adult salmon (Berman and Quinn 1991; Quinn and Adams 1996; Torgerson et al. 1999; Crozier et al. 2008).

Mature forests in coastal Oregon now can be understood to play an important role in regulating suitability of streamflows and stream temperature for spring Chinook salmon. Crozier and Zabel (2006) examined a suite of environmental factors relating to stream flow and water temperature in streams in the Salmon River basin of Idaho and evaluated their relation to survival among populations of spring-summer Chinook salmon. They found that some populations were more strongly correlated with fall streamflow (during the period when juveniles move to seek freshwater overwintering habitats), while others were more strongly (inversely) correlated with summer water temperature. Crozier and Zabel (2006) predict that climate change in the form of atmospheric warming would differentially affect these two population groups, because they

reside in habitats with differential sensitivity to warming climate. Some streams are relatively resistant to warming from atmospheric forcing by nature of their groundwater hydrology (Arismendi et al. 2015; Fullerton et al. 2015; Isaak et al. 2018), but in those cases, declining summer flows may limit juvenile Chinook growth and survival by other means, including reducing food supply, crowding that increases intra-and inter-specific competition for food, space, and shelter, trapping of juveniles in stream reaches or pools isolated by increasing intermittent low flows, and increased vulnerability to predation.

Forest Land Use and Climate Change Co-Influence Streamflow Conditions

By increasing evapotranspiration, forest land use that produces extensive areas of second growth forest likely both reduces stream flow in summer and early autumn (prior to fall rainstorms) and increases summer water temperature by way of streamflow depletion. These effects move in the same direction as the projected effects of climate change. Luce and Holden (2009) demonstrated declining streamflows in recent decades in most longer term streamflow records they examined from the Pacific Northwest. To date, it appears no published research has examined the interactive causal influences on low flow depletion by logging versus forcing by climate change; we know that both factors can contribute to summer low flow declines. Therefore it seems abundantly clear that extensive areas of logging in catchments supporting spring Chinook habitat are likely to aggravate and worsen the effects of climate change. Conversely, protecting or allowing restoration of mature forest cover over expansive areas of these catchments could benefit habitat conditions for spring Chinook and in part offset the expected harms from climate change. In view of these relations, it appears to be a matter of no mere coincidence that the sole remaining demographically robust spring Chinook salmon population in coastal Oregon resides in the North Umpqua basin, where large expanses of unlogged, mature and old growth forest remain on federal lands in the catchment.

Even under future climate warming scenarios, the thermal regime of some rivers is expected to remain with thermal tolerances of Chinook and other salmon species (Isaak et al. 2018). An expected general upstream shift of suitable habitat caused by summer warming, as projected by Isaak et al. (2018) and other forecasts, is likely to affect spring Chinook less than some other species, because spring Chinook already spawn and rear in habitats in more headwater habitats. However, where physical barriers do not preclude fall Chinook migration, overlap in spawning and rearing habitats between fall and spring Chinook could increase in response to stream warming at lower elevations. Under these circumstances, increased redd superimposition and competitive or other ecological interactions among increasingly overlapping distributions of juveniles could adversely affect spring Chinook, and increased gene flow between fall and spring populations, jeopardizing the persistence of the early-migrating life history (Thompson et al. 2018). Overlap could be further increased should flow depletions render headwater tributaries less inhabitable or less accessible to spring Chinook. Further reduction or extended imposition of summer and early fall streamflow depletion as a result of logging and loss of diverse and mature forest cover can only further exacerbate these ecological stresses when Chinook salmon become more restricted to a narrower range of headwater habitats.

Dams

Large dams significantly reduce the amount of spawning and rearing habitat accessible to migrating Chinook salmon. Dams create physical barriers to fish passage, confound salmonid migration cues, and change downstream river flow and temperature regimes.

Dams and the slack water reservoirs they create can seriously impede migration of salmonids, even where upstream passage is at least partially provided. Significant delays in the migration of spawning adults can occur while fish search for the opening to passage facilities. Dams can also pose passage problems for juvenile downstream migrants, with timely downstream movement stymied by the lack of current in reservoirs.

Smaller dams and diversions for municipal, industrial, irrigation, livestock and rural uses can block or hinder upstream and downstream passage of migrating salmon and, if diversions are unscreened, can divert young salmon onto croplands along with irrigation water. The slack water impounded behind dams and diversions of all sizes can alter downstream water temperature and provide artificial habitats suitable for exotic and predatory gamefish. Unless dams are operated as run-of-the-river, they can modify downstream flow regimes, altering both seasonal and daily flow patterns.

In the Umpqua River watershed there are 9 dams and reservoirs, all in the North Umpqua. There are no dams in the lower river.

Winchester Dam has a semi-functioning fish ladder and ODFW fish-counting station that does not meet NOAA Fisheries standards, but passes fish with some evidence of injury and delay, and spring Chinook migrate past the dam (NMFS 2018a). Winchester Dam has not generated electricity since 1923, and Coastal Hydropower LLC withdrew a FERC application for hydropower in 2011.

The 77-foot Soda Springs Dam on the North Umpqua River is 160 miles from the river mouth, and is the lowest dam of the North Umpqua Hydroelectric Project, a 194-megawatt system of 8 dams, canals, penstocks and generators. Six miles above Soda Springs Dam is Toketee Falls, a natural obstruction. For more than 50 years, the eight-dam hydroelectric project blocked salmonid access to historical habitat and degraded downstream fish habitat (NMFS 2018b). The dam is operated by PacifiCorp on U.S. Forest Service land. It was relicensed in 2003 for 35 years. The new license required providing fish passage into blocked habitat above Soda Springs Dam, construction of tailrace barriers, increased streamflows, reduced ramping, and habitat restoration. A 600-foot fish ladder was installed at Soda Springs Dam in 2012, as well as fish screens. PacifiCorp is also conducting spawning gravel enhancement woody debris placement downstream of the dam. Soda Springs Dam was recommended for removal by the U.S. Forest Service and by a cooperative stakeholder watershed analysis contracted and paid for by PacifiCorp. The North Umpqua Foundation, Umpqua Watersheds, Steamboaters, Umpqua Valley Audubon, Native Fish Society, Trout Unlimited, WaterWatch, Pacific Rivers Council, Oregon Natural Resources Council, Sierra Club, Earthjustice and other conservation groups are calling for removal of Soda Springs Dam.

In the South Umpqua River, Galesville Dam completely blocks chinook migration into the Cow Creek tributary (Kostow 1995, p. 32). In the 1960s there was a proposal to build Tiller Dam on the South Umpqua, which would have inundated 25 miles and blocked another 58 miles of chinook spawning habitat (USFS 1966). Tiller Dam was never built.

In the Tillamook and Nestucca watersheds, Shivley et al. (2016) identified 270 fish passage barriers on salmonid streams, including road crossing culverts, small dams and tide gates. Most of these barriers are on tributary streams, not mainstem rivers.

Water Diversions

Water diversion structures, as well as the slack water reservoirs they create, can seriously impede upstream passage of adults (and the later downstream migration of juveniles) both by creating physical barriers to passage and by confounding migration cues and exceeding biological tolerances through changes in river flow and temperature regimes.

FCO and OSGC (1946) noted that unscreened gravity water diversions and water removal by pumping for irrigation, industrial and municipal use had contributed to the decline of spring-run Chinook salmon in the Umpqua River basin. Bottom et al. (1985) cited low streamflows and high summer temperatures exacerbated by water withdrawals as problems for many streams (notably Tillamook Bay tributaries and Alsea, Siletz, Siuslaw, and Umpqua Rivers). There have been extensive water withdrawals and water diversion development in the upper Umpqua River basin (Kostow 1995). In the Umpqua River basin, diversion of water for agriculture reduces base stream flow and may result in higher summer stream temperatures (NMFS 2011).

Migration Barriers

FCO and OSGC (1946) noted multiple splash dam, mill dams, hydroelectric dams, log jams and other impediments to upstream migration of salmon that had contributed to the decline of spring-run Chinook salmon in the Umpqua River basin.

In Oregon Coast watersheds, fish passage has been blocked in many streams by improperly designed road culverts; and restricted in many estuary areas by tide gates (NMFS 2011).

Spring chinook in the Siletz River spawn primarily in the mainstem below Siletz Falls (RM 64.5), although construction of a fish ladder the falls in the 1950s allowed chinook access to the habitat above the falls and some fish do pass the falls and inhabit the Upper Siletz watershed (USBLM 1996).

Logging

The mechanical processes involved in timber harvest and associated road construction alter many components and processes of aquatic ecosystems. Soil and site disturbance often results in increased rates of erosion and sedimentation, direct modification and destruction of aquatic and terrestrial habitats, changes in water quality and quantity, and disturbance of nutrient cycles within aquatic ecosystems (NMFS 2011). Physical changes from timber harvest affect runoff events, bank stability, sediment supply, large woody debris retention and temperature (NMFS 2011). Timber harvest can cause slope instability, erosion, and introduction of debris into stream channels; timber harvest practices such as roadcast burning and machine scarification and piling can increase sedimentation and thermal heating of streams and have the potential to damage habitat of anadromous fish (Chamberlin 1982; Everest and Harr 1982).

In Oregon Coast watersheds, historical and ongoing timber harvest and road building have reduced stream shade, increased fine sediment levels, reduced levels of instream large wood, and altered watershed hydrology (NMFS 2011).

Talberth and Fernandez (2015) evaluated timber harvest on state and privately managed forestlands in Oregon, discussing the prevalence of overcutting (cutting at a rate in excess of forest regrowth), conversion of natural forests to industrial tree plantations, loss of forestlands to roads and other infrastructure, and loss of long-term site productivity. From 2000-2015, Oregon

lost nearly 522,000 acres of forest cover on state and privately managed forestlands in western Oregon, primarily due to rapid clearcutting at rates that far exceed regrowth (Talberth and Fernandez 2015). Forest loss to clearcutting exceeded forest regrowth by 45% between 2000 and 2013 (Talberth and Fernandez 2015). Over 4 million acres of Oregon's natural forests have been converted to industrial tree plantations; and the logging road network on state and private forestlands in Oregon has taken another 110,000 to 150,000 acres out of production (Talberth and Fernandez 2015). Landslides, erosion, and short rotations are depleting soils and soil productivity. One of the most concentrated areas of net forest cover loss is in northwestern Oregon in the coast range (Talberth and Fernandez 2015). In terms of acreage, 3 of the 5 watersheds most affected by net forest cover loss were on the Oregon Coast: the Middle Fork Coquille (17,212 acres lost), Trask River (15,552 acres lost) and the Wilson River (15,168 acres lost) (Talberth and Fernandez 2015).

Historical logging practices along the mid- to north- Oregon coast have negatively impacted freshwater habitat for chinook salmon (Kostow 1995, pp. 29-30). Extensive salvage logging in Tillamook State Forest after severe forest fires between 1918 and 1951 deforested most of the Wilson and Trask river basins, and impacted substantial portions of the Kilchis and Miami river basins (Kostow 1995, p. 30). This logging destabilized streambanks, caused severe erosion and sedimentation, and scoured and channelized lower mainstem reaches. The area has been recovering since the 1960s and uplands, streambanks and stream channels are stabilizing. Although habitat conditions are improving for fall-run chinook, the deep holding pools needed by spring-run chinook have been lost and have not reestablished (Kostow 1995, p. 30). Extensive logging on private lands along the Oregon coast has had similar impacts, with splash dams causing significant habitat damage until they were discontinued in the 1960s. Although mainstem spawning habitat for fall-run chinook has improved on private lands, deep holding pools for spring chinook are still inadequate (Kostow 1995, p. 30). Although less extensive, similar logging impacts have occurred on National Forest lands along the central and southern Oregon Coast (Kostow 1995, p. 30).

Historical logging practices in the Umpqua River basin scoured many chinook spawning reaches to bedrock, widened and channelized the lower mainstem, and eliminated holding pools for spring chinook (Kostow 1995, p. 32). Dose and Roper (1994) documented changes in stream channel characteristics in the South Umpqua River watershed due to timber harvest and road construction, which were detrimental to Chinook salmon. Dose and Roper (1994) compared 1989-1993 stream survey data throughout the South Umpqua basin to 1937 data from the same stream segments, showing changes in low-flow wetted stream width in areas with timber harvest; whereas tributaries with headwaters in wilderness areas with no logging did not increase in width. Dose and Roper (1994) noted simplification of stream channel habitats, and reduction of large woody debris due to timber harvest impacts.

A BLM watershed analysis evaluated past timber harvest activities in the Siletz River watershed, which has increased landslide and general sedimentation rates beyond natural levels, and adversely impacted water quality and aquatic species habitat, specifically anadromous fish habitat (USBLM 1996). Timber harvest removal of riparian vegetation, large woody debris and complex structure has adversely impacted fisheries habitat and water quality; riparian area microclimates have been altered; and many riparian areas are deficient in the large conifers which are future sources of large woody debris (USBLM 1996). Modifications of hillslopes and riparian areas from timber harvest may have contributed to altering the timing, duration, and quantity of stream flows in the Upper Siletz watershed (USBLM 1996). Habitat problems resulting from timber harvest include stream sedimentation, lack of large woody debris, lack of quality pools and spawning gravels, reduced stream flows, elevated water temperatures, and

low dissolved oxygen levels (USBLM 1996). Sedimentation and high stream temperatures are concerns throughout the watershed but especially in the South Fork Siletz sub-watershed, where these factors potentially affect salmon spawning conditions and early smolt survival (USBLM 1996).

Amaranthus et al. (1985) linked logging and forest roads to increased debris slides in southwestern Oregon. Erosion rates on forest roads and landings were 100 times those on undisturbed areas, while erosion on harvested areas was 7 times that of undisturbed areas (Amaranthus et al. 1985).

Roads

Roads alter streamflow, sediment loading, sediment transport and deposition, channel stability and shape, substrate composition, stream temperatures, water quality and riparian conditions within a watershed (NMFS 2011). Roads contribute more sediment to streams than any other land management activity (NMFS 2011). Serious degradation of fish habitat can result from poorly planned, designed, constructed or maintained roads (NMFS 2011). Roads affect water quality through applied road chemicals and toxic spills (NMFS 2011). Roads are correlated with increased landslides, debris flows and other mass movements (NMFS 2011). Road/stream crossings can be a major source of sediment (NMFS 2011). Plugged culverts and fill slope failures are frequent and often lead to catastrophic increases in stream channel sediment (NMFS 2011). Poorly designed culverts also can create a barrier to up and downstream movement of fish (NMFS 2011). Construction of roads adjacent to stream channels often precipitates riprapping of stream banks (NMFS 2011).

A BLM watershed analysis evaluated road construction in the Siletz River watershed, which has contributed to increased landslide and general sedimentation rates beyond natural levels, and adversely impacted water quality and aquatic species habitat, specifically anadromous fish habitat (USBLM 1996). Modifications of hillslopes and riparian areas from road construction may have contributed to altering the timing, duration, and quantity of stream flows in the Upper Siletz watershed (USBLM 1996). Habitat problems resulting from road construction include stream sedimentation, lack of quality pools, reduced stream flows, elevated water temperatures, and low dissolved oxygen levels (USBLM 1996). Sedimentation and high stream temperatures are concerns throughout the watershed but especially in the South Fork Siletz sub-watershed, where these factors potentially affect salmon spawning conditions and early smolt survival (USBLM 1996).

Gravel Mining

Gravel mining occurs in various areas throughout the freshwater range of Oregon coast spring-run Chinook, but is most common in the South Fork Umpqua, South Fork Coquille, Nestucca, Trask, Kilchis, Miami, and Wilson rivers (NMFS 2011, 2015b). Although gravel mining has ceased in some areas occupied by this ESU, gravel mining in the South Fork Coquille and Tillamook basins is of particular concern (NMFS 2015 b). Improperly managed gravel mining can have a range of adverse effects on freshwater salmon habitat, including: a deeper and less complex streamed with reduced refuge areas for juvenile salmon; altered salmonid food webs and reduced prey available for juvenile salmonids; increased bank and channel erosion; disturbance of riparian vegetation; exposure of bare soil to erosive forces; and spills or releases of petroleum-based contaminants (NMFS 2011). NMFS has found through ESA and Magnuson-Stevens Fishery Conservation and Management Act consultations that, in some cases, the measures governing sand and gravel mining are inadequate to protect coho salmon habitat in

the Oregon Coast ESU (NMFS 2015b). Instream and off-channel gravel mining in Oregon Coast watersheds has removed natural stream substrates and altered floodplain function (NMFS 2011).

Pollutants

In Oregon Coast watersheds, stormwater and agricultural runoff reaching streams is often contaminated by hydrocarbons, fertilizers, pesticides, and other contaminants (NMFS 2011).

Toxic pollutants from mining affect the spring Chinook population in the South Umpqua River (ODFW 2014).

Channelization

Wetlands, marshes and braided channels in the lower reaches of many Oregon coastal rivers have been straightened, channelized, diked, drained and deforested by agricultural and logging practices (Kostow 1995, p. 30). Channelization decreases habitat complexity and productivity of juvenile chinook rearing areas, decreases summer flows and water quality, and increases water temperatures (Kostow 1995, p. 30). River channelization in the lower mainstem Umpqua River has decreased juvenile chinook survival (Kostow 1995, p. 3). Many of the estuaries of Oregon coast rivers have been dredged and jetties constructed, likely decreasing salmonid productivity (Kostow 1995, p. 30).

Other Habitat Degradation

Physical alteration of stream channels, restriction of floodplains, and removal of riparian vegetation and large woody debris has adversely impacted fisheries habitat and water quality in the Siletz River watershed (USBLM 1996). Low levels of large woody debris is a problem especially in the South Fork Siletz sub-watershed (USBLM 1996).

Oregon coastal freshwater habitats generally are in poor condition, with numerous problems such as low summer flows, high temperatures, loss of riparian cover and detrimental streambed changes (NMFS 2011).

Christy (2004) estimated that 82% of freshwater wetland and saltwater marsh habitat has been lost or converted to other habitat types in basins within the Oregon Coast ESU since 1850.

Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

Harvest in Ocean and Recreational Fisheries

Oregon Coast spring Chinook are encountered in direct take commercial fisheries occurring off the coast of Oregon, Washington, and British Columbia. These fisheries are conducted without management to limit the impact to sensitive Oregon Coast spring Chinook populations. Commercial fisheries targeting other species also incidentally take Oregon Coast spring-run Chinook as bycatch. The management of ocean fisheries is conducted by the Pacific Marine Fisheries Commission (PFMC), which is tasked with making pre-season forecasts, estimating total allowable catch, and setting fishing seasons in consultation with state and federal fisheries managers. Due to the mixed stock nature of these fisheries, it is extremely difficult to differentiate Oregon coast spring Chinook with other Chinook stocks that co-inhabit marine

waters. However, genetic mixture analysis research currently being conducted on these fisheries is improving assignment accuracy regarding population origin (Moran et al. 2018).

Co-occurring with commercial fisheries, marine recreational fisheries also incidentally intercept and directly take Oregon Coast spring Chinook. These marine fisheries occur throughout Oregon, Washington, and British Columbia and are primarily managed by state and provincial fish and wildlife agencies. Due to the mixed stock nature of these fisheries, it is extremely difficult to differentiate Oregon coast spring Chinook with other Chinook stocks that co-inhabit marine waters. Oregon Coast spring Chinook are currently not factored into the development and management of recreational marine fishing seasons.

Ocean fisheries for Chinook are managed by the Pacific Fishery Management Council and the U.S. – Canadian Pacific Salmon Commission. However, the essential problem is that no data are available to directly estimate harvest rates on any wild population of spring Chinook salmon in coastal Oregon. Harvest rates estimated from tag recoveries from hatchery fish are assumed to be representative exploitation rates of wild populations, even though evidence suggests the greatly diminished wild populations remaining in most rivers are constrained by habitat conditions forcing relatively low productivity. Reisenbichler (1987) estimated based on stock-recruit relations for Chinook salmon populations from the Pacific Coast that total harvest should not exceed 60-70% to avoid overfishing and maintain stock resilience. Unfortunately total harvest fraction still remains unknown for most wild spring Chinook stocks in Oregon. Small population size and the lack of persistent recovery or sustained increase of these populations despite conservation measures in recent decades suggest they could be relatively low in productivity under current habitat conditions, and therefore vulnerable to overfishing.

Harvest data for the Siletz River (ODFW unpublished, see Siletz basin summary) indicates that the in-river fishery alone killed greater than 40-50% the returning adults in some recent years (it exceeded 60% in 2017). Small populations of spring Chinook returning to smaller rivers are highly vulnerable to targeted fishing effort. Moreover they are highly vulnerable to illegal fishing as well, and poaching mortality remains unquantified.

On the basis of estimated spawner-recruit relations for populations of Chinook salmon from British Columbia to California, harvest fractions of 60-70% may be reasonable for stocks for which the productivities are uncertain. Care should be taken to detect and to avoid excessive harvest from stocks with low productivity.

It has been well-known for decades that crude regional estimates of salmon harvest cannot serve to ensure the conservation integrity of numerous small stocks that are harvested in mixed-stock ocean fisheries (e.g. Ricker 1973, Hillborn 1985). The Pacific Marine Fisheries Commission (PFMC) monitors ocean harvest of salmon and advises agencies on the regulation of ocean fisheries toward conservation objectives. Although PFMC (2018) concludes that north-migrating Oregon coast Chinook salmon were not overfished in recent years, their conclusions rely on a grossly aggregated regional analyses that lump small, less productive with large, more productive populations (or rather, entirely ignores small stocks as they do not offer sufficient data to inform the statistics). The analysis also does not distinguish between spring Chinook and fall Chinook populations. Moreover, the North Umpqua spring Chinook stock is known to migrate both north and south at sea, splitting its exposure to Oregon and California ocean fisheries with British Columbia and southeast Alaska fisheries (other central Oregon stocks may also comport with this pattern, but data are lacking). But no analysis of ocean exploitation for stocks with this widespread (or mixed) pattern of exposure to ocean fisheries has been provided

by PFMC. Hence ocean exploitation rates--therefore total harvest rates and their sustainability--remain unknown for coastal Oregon spring Chinook populations.

Recreational Chinook fisheries occur in freshwater or estuarine habitats in Oregon coastal watersheds where hatchery augmentation is taking place, and on wild Chinook in the Siletz basin. Catch card data returned from recreational fishermen and other scattered data indicate that harvest rates can be quite high (e.g., See Siletz basin summary). However, monitoring and assessment of freshwater harvest by the state is generally lax due to limited fiscal support, so while potentially high, freshwater harvest rates for most populations remain largely unknown.

Disease or Predation

It is unknown to what extent predation affects Oregon coast spring Chinook, but the Oregon Department of Fish and Wildlife's Coastal Multispecies plan (ODFW 2013) does note avian, marine mammal, and non-native fishes as having the potential to negatively affect the abundance of both adult and juvenile salmonids. Smallmouth bass (*Micropterus dolomieu*) are of particular concern in the Umpqua watershed, as they have been shown to prey extensively on juvenile Chinook salmon in rivers and reservoirs (Carey et al. 2011, Fritts and Pearsons 2006). A smallmouth bass population in the lower mainstem Umpqua River has decreased juvenile chinook survival (Kostow 1995, p. 3). Predation by non-native bass is a primary limiting factor for spring Chinook in the South Umpqua River (ODFW 2014).

Smallmouth bass is a non-native freshwater fish species in Pacific coastal streams, introduced widely for sport fish purposes. Smallmouth bass are predators with a varied diet and are known to prey on young salmonids, especially Chinook salmon, in circumstances where they co-occur (Fritts and Pearsons 2006; Carey et al. 2011). Smallmouth bass may also behaviorally harass or otherwise stress small Chinook salmon (Kuehne et al. 2012), and bass potentially exclude young-of-year salmonids from prime foraging locations in river littoral habitat and pools and glides in streams, especially where bass are brooding and rearing young (Ebersole, J.L. USEPA Corvallis Oregon, unpublished data).

Carey et al. (2011) mapped smallmouth bass as occurring in most of the Oregon coastal drainages. However the USGS Nonindigenous Aquatic Species database (https://nas.er.usgs.gov/viewer/omap.aspx?SpeciesID=396) only identifies localities in the Umpqua and Rogue River basins, among those in western Oregon supporting extant spring Chinook populations.

Common diseases that affect spring Chinook on the Oregon Coast include Furunculosis (*Aeromonas salmonicida*), Saprolegnia spp., Cold Water Disease (*Flavobacterium psychrophilum*), Trichodinids, and bacterial kidney disease (*Renibacterium salmoninarum*), among others. Through regular monitoring conducted by state and federal agencies, we know that disease is a constant problem when artificially rearing fish in high densities (Saunders 1991). Rearing facilities expose captive fish to increased risk of carrying pathogens because of the stresses associated with simplified and crowded environments. It is probable that spring Chinook and other salmonids transferred between facilities, adult fish carcasses being outplanted into the watershed, and other fish released from factories, have acted as a disease vectors to wild fish and other aquatic organisms. These diseases, amplified within the hatchery setting, contribute to the mortality of fish at all life stages and can travel rapidly to areas well beyond where effluent water is discharged. The outplanting of juvenile and adult fish can transfer disease upstream of the rearing site, and there is the potential for lateral infection

through the travel of avian, mammalian, and other terrestrial predators which overlap with the distribution of artificially propagated fish.

The release of artificially produced Oregon coast spring Chinook into the wild also poses a risk of introducing pathogens and parasites to wild populations that can result in temporary epidemics or permanent reductions in wild populations. These dynamics contribute to disease driven mortality at all life stages in wild fish populations.

Inadequacy of Existing Regulatory Mechanisms

Pacific Salmon Treaty

In the Oregon Coast ESU there are two streams that are monitored for purposes of the Pacific Salmon Treaty: the Salmon River, for which monitoring only occurs for coded-wire tagged, hatchery-origin fall Chinook; and the Siletz River, for which spawning surveys are conducted for wild fall Chinook. The Pacific Salmon treaty allocates the harvest of spring Chinook originating on the Oregon Coast in foreign and domestic fisheries without specific consideration of the condition of those individual populations.

Federal

National Environmental Policy Act

The National Environmental Policy Act (NEPA) (42 U.S.C.4321-4370a) requires federal agencies, including the U.S. Forest Service and U.S. Bureau of Land Management, to consider the effects of management actions on the environment. The NEPA process requires these agencies to describe a proposed action, consider alternatives, identify and disclose potential environmental impacts of each alternative, and involve the public in the decision-making process. However, a NEPA analysis does not prohibit these agencies from choosing project alternatives that may adversely affect Oregon coast spring Chinook salmon or their habitats. As a result, the NEPA process often results in the disclosure of impacts but affords little to no protections. The agencies must analyze the impacts of their actions on the species, but are not required to select alternatives that avoid harm to spring Chinook. Federal land management agencies regularly plan timber sales, maintain and utilize roads, and conduct other actions that harm Oregon coast spring Chinook. Oregon coast spring Chinook salmon are not formally listed as a sensitive species by either the Forest Service in Region 6 or the Bureau of Land Management (USWFS and USBLM 2018), impacts to these salmon from agency management actions get less scrutiny under NEPA. Southern Oregon Coast/Northern California Coast Chinook salmon are on the sensitive species list, but this does not cover the range of Oregon coast spring-run Chinook.

Endangered Species Act

Oregon coast spring-run Chinook salmon are not currently protected under the federal Endangered Species Act.

The Act offers potential protections through Habitat Conservation Plans (HCP) which cover non-listed species, but there are no Habitat Conservation Plans under the U.S. Endangered Species Act that cover Oregon coast spring-run Chinook salmon (USFWS 2018a).

NMFS and the Oregon Department of Forestry (ODF) developed a draft HCP in 1997 for logging and management of western Oregon state forests, the "Western Oregon State Forests Habitat Conservation Plan." NMFS detailed many substantive concerns with this draft HCP and questioned whether it would adequately protect coho salmon from logging and roads, especially from reduced stream shade and recruitment of large woody debris, slope instability, and sedimentation of coho-bearing streams. ODF did not want to enact stream protections that NMFS scientists determined were necessary to ensure coho survival, and abandoned the HCP planning. NMFS determined in a 2011 status review that the agency was "unable to conclude that the state forest management plans will provide for OC coho salmon habitat that is capable of supporting populations that are viable during both good and poor marine conditions." See the discussion under state forest management. ODF's refusal to address these concerns has stymied the development, completion, and implementation of a final HCP to this day. ODF is reportedly looking again at developing a HCP, but has made no firm commitment to do so.

Another potential Endangered Species Act protection could be through co-occurrence with other listed species such as Oregon Coast ESU coho salmon, marbled murrelet, and northern spotted owl, and their designated critical habitat.

The marbled murrelet (*Brachyramphus marmoratus*) was listed under the Endangered Species Act as a threatened species in 1992. Critical habitat was designated for the marbled murrelet in 1996, including within 1,338,200 acres of federal lands, 175,100 acres of state lands, and a very small amount of county and private lands (2,000 acres) in western Oregon. Critical habitat within these areas consists of mature forests that contain the primary constituent elements: individual trees with potential murrelet nesting platforms; and forested areas within 0.5 miles of individual trees with potential nesting platforms, and with a canopy height of at least one-half the site-potential tree height. Critical habitat was revised in 2011, which removed 46,184 acres in Oregon. Designated critical habitat for the marbled murrelet overlaps somewhat with habitat for Oregon coast spring-run Chinook salmon, particularly in the Siuslaw National Forest, and the Tillamook and Elliott State Forests (Figure 1).

Spring-run Chinook could benefit somewhat from protection of marbled murrelet nesting habitat consisting of stands of mature forest that can provide direct and indirect benefits to Chinook salmon streams, such as regulating stream temperature, providing streambank stability and preventing sedimentation. However, most older forest remnants in Oregon that could provide murrelet nesting habitat are highly fragmented (ODFW 2018b). Also, marbled murrelet nesting habitat loss has continued since the ESA listing of the murrelet and designation of critical habitat in the 1990s, mainly due to timber harvest on non-federal lands and wildfire on federal lands (ODFW 2018b). Overall, higher-suitability marbled murrelet habitat declined by 9.2% in Oregon from 1993 to 2012, from approximately 853,400 acres in 1993 to 774,800 acres in 2012, a net loss of 78,600 acres (ODFW 2018b). Existing state and federal programs and regulations have failed to prevent continued high rates of marbled murrelet forest habitat loss on non-federal lands in Oregon (ODFW 2018b). The overlap and potential benefits to Oregon coast spring-run Chinook from listing and critical habitat protections for marbled murrelets are limited.

The northern spotted owl (*Strix occidentalis caurina*) was listed under the Endangered Species Act as a threatened species in 1990. Critical habitat was designated for the northern spotted owl in 1992, then revised in 2008 and 2012. This included habitat within less than 860,000 acres on the Oregon coast. Critical habitat within these areas consists of early-, mid-, or late-seral conifer forests that contain the primary constituent elements for nesting, roosting and foraging habitat for owls: moderate to high canopy cover (60 to over 80 percent); multilayered, multispecies canopies with large overstory trees; high basal area; high diversity of different diameters of

trees; high incidence of large live trees with various deformities; and large snags and large accumulations of fallen trees and other woody debris on the ground. Designated critical habitat for the northern spotted owl overlaps somewhat with habitat for Oregon coast spring-run Chinook salmon, particularly in the Siuslaw National Forest, on BLM lands and the Tillamook and Elliott State Forests (Figure 1).

Figure 1. Oregon coast spring-run Chinook salmon overlap with designated critical habitat for marbled murrelet and northern spotted owl

Spring-run Chinook could benefit somewhat from protection of northern spotted owl nesting habitat consisting of stands of mature forest that can provide direct and indirect benefits to Chinook salmon streams, such as regulating stream temperature, providing streambank stability and preventing sedimentation. However, two decades of monitoring (Davis et al. 2016) documented significant annual declines in spotted owl populations, and a 1.5% decrease of spotted owl nesting/roosting habitat on federal lands. In the Oregon coast region, from 1993-2012 there was an estimated loss of 17.7% of suitable northern spotted owl nesting/roosting habitat on all lands (federal and non-federal) due to timber harvest, and a net loss of 11.7% of suitable owl nesting/roosting habitat (Davis et al. 2016). However, the Siuslaw National Forest is one of the areas where recruitment and net gain of suitable owl habitat appears to be occurring (Davis et al. 2016). Regardless, the overlap and potential benefits to Oregon coast spring-run Chinook from listing and critical habitat protections for northern spotted owls are limited.

On a regional basis and at a coarse scale, the Oregon Coast ESU of coho salmon (*Oncorhynchus kisutch*) can be seen to overlap substantially with that of wild spring Chinook salmon populations (Figure 2). However, in a few specific headwater situations, spring chinook pass over natural waterfalls and stream reaches that are dry or nearly dry in late summer and fall, hence many spawn in locations that fall-and winter-migrating coho salmon cannot reach. Oregon Coastal coho salmon were first proposed for listing in 1995; listed in 1998, listing set aside in 2001; in 2006 published a not warranted determination; finally ESA listed in 2008, with the listing reaffirmed in 2011 and 2014 (USFWS 2018b).

Although ESA listing of coho has resulted in some improved habitat protections on state, federal, and private forest lands, there is little evidence to date that habitat restoration and protection have been effective enough to lead to recovery of coho salmon populations in this ESU. Some actions intended to benefit listed coho salmon could also benefit spring-run chinook in same watersheds, but conservation actions to date in western Oregon appear insufficiently effective to produce consistent population increases or recovery of either species. It is also important to recognize that actions to reform hatchery and harvest threats of one species do not directly benefit the other, as the two species are regulated separately by state and federal management authorities.
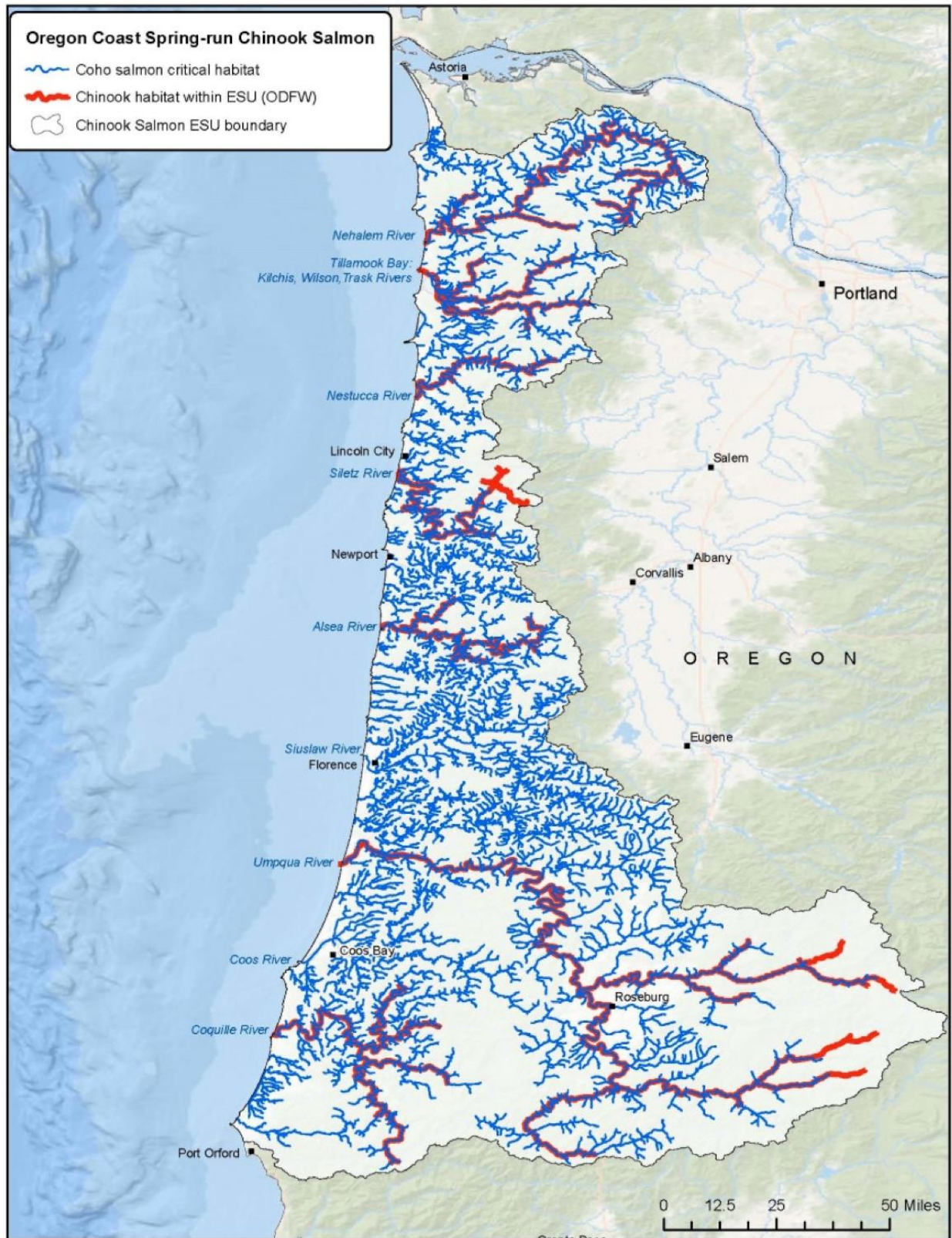
Figure 2. Oregon coast spring-run Chinook salmon overlap with designated critical habitat for Oregon coast coho salmon

National Forest Management Act

Under the National Forest Management Act, the Forest Service is required to "maintain viable populations of existing native and desired nonnative vertebrate species" (36 C.F.R. §219.19). As with NEPA, this requirement does not prohibit the Forest Service from carrying out management actions and projects that harm species or their habitat, but merely states that "where appropriate, measures to mitigate adverse effects shall be prescribed" (36 C.F.R. §219.19(a)(1)). This clause does little to limit long term impacts to salmonid habitat in Oregon coastal watersheds from agency management actions such as logging, road-building, mining and other activities.

Northwest Forest Plan

The 1994 Northwest Forest Plan (USDA and USDI 1994) was supposed to represent a coordinated ecosystem management strategy for federal lands administered by the Forest Service and Bureau of Land Management within the range of the Northern spotted owl, which overlaps significantly with the freshwater range of Chinook salmon. The Northwest Forest Plan established a system of federal reserves interspersed with matrix forestlands where timber harvest and other commodity production are given priority. Reserves were designed to provide large blocks of habitat for northern spotted owls and management on reserved lands generally attempted to protect species associated with older forests. Though the reserves may not have provided extensive protection to species such as Chinook salmon whose life history traits occur at a different scale than the spotted owl, the Aquatic Conservation Strategy (ACS) of the Northwest Forest Plan was explicitly supposed to protect native fish and their habitat. The Aquatic Conservation Strategy was supposed to provide safeguards for native fish by protecting their essential habitat needs through associated Standards and Guidelines that linked key watershed, riparian, hydrologic, physical, chemical and biological processes to types of land and water management actions and individual or groups of projects. The Aquatic Conservation Strategy included designation of riparian management zones, activity-specific management standards, watershed assessments, watershed restoration, and identification of key watersheds.

The habitat protections of the Northwest Forest Plan have been sabotaged by the Western Oregon Plan Revision (WOPR), which replaces the Northwest Forest Plan and has the express purpose of substantially increasing logging on federal lands in western Oregon. The WOPR was originally proposed in 2008 and abandoned by the BLM in 2012 after years of litigation. It was revived in 2015. The National Marine Fisheries Service commented on the draft Environmental Impact Statement for the WOPR (NMFS 2015), stating that the proposed riparian management in the preferred alternative would not adequately maintain and restore all of the riparian and aquatic habitat conditions and processes that are critical to the conservation of anadromous fish (in particular, wood delivery to streams, maintenance of stream shade and water temperature, and filtering of nutrients and sediment before delivery to streams). NMFS (2015) also noted that the WOPR alternatives do not incorporate a watershed-scale analysis or analytic protocol that ensures that the plan is consistent with and furthers the conservation of listed anadromous fish. Regardless, in 2016 the BLM issued a final Environmental Impact Statement implementing the WOPR (USBLM 2016).

The stated purpose and need of the WOPR is to shift the dominant use of BLM lands to timber production in order to increase timber harvest levels:

"The BLM is proposing to revise existing plans to replace the Northwest Forest Plan land use allocations and management direction because the BLM's plan evaluations found harvest levels

have not been achieving the timber harvest levels directed by existing plans" (p. 3). "The BLM has re-focused the goal for management of the BLM-administered lands to the statutory mandates specifically applicable to these lands. The statutory requirements of the O&C Act, which governs most BLM-administered lands in western Oregon, include, but are not limited to, managing the O&C lands for permanent forest production by selling, cutting, and removing timber in conformance with the principles of sustained yield; determining the annual productive capacity of the lands managed under the O&C Act; and offering that determined capacity annually under normal market conditions. The statute states that the purpose of sustained yield management of these lands is to provide a permanent source of timber, contribute to the economic stability of local communities and industries, as well as benefit watersheds, regulate stream flows, and provide recreational use" (USBLM 2016, p. 6).

The WOPR presents a substantial new threat to Oregon coast spring-run Chinook salmon by eliminating the Aquatic Conservation Strategy standards and guidelines, and allowing increased logging in reserves. The WOPR replaces the Northwest Forest Plan's late successional reserves (LSRs), with late-successional management areas (LSMAs). Whereas the LSR provision allowed no logging of stands older than 80 years, the LSMA allows logging "to promote the development of suitable habitat" (p. 110). This vague language permits timber harvest activities in former late successional reserves. The WOPR reduced the width of riparian reserves, eliminated protection of key watersheds intended to be core refugia for fish, replaced the Aquatic Conservation Strategy objectives with weaker and vague aspirational management guidance and optional "best management practices," and eliminated the aquatic restoration focus of the Northwest Forest Plan (NFS 2015). The Native Fish Society has noted that implementation of the WOPR will jeopardize native fish and water quality due to increased timber harvest, accelerated physical disturbance, renewed road construction, loss of restoration focus, reduced riparian reserve widths, and weakening of other protective standards (NFS 2015). Major fish and river conservation organizations note that the WOPR will gut aquatic ecosystem protections, resulting in increases in logging and road construction that will detrimentally impact aquatic health, resilience and size of riparian reserves, and anadromous fish (American Rivers et al. 2016).

National Forest Plans

Relevant National Forest Plans for Oregon coast spring-run Chinook salmon include a 1990 management plan for the Siuslaw National Forest (USFS 1990), which includes portions of the Alsea, Nestucca, Siletz, Siuslaw, and Umpqua rivers. The plan acknowledges impacts to anadromous fish habitat from timber harvest operations on stream temperatures, structure and sedimentation rates, and acknowledges that there will be a reduction of fish habitat and water quality below natural levels where timber production is favored over protection of stream systems. The plan contains some basic stream protections: stream buffers for timber harvest (50-100 feet near perennial streams and 50 feet for intermittent streams); a prohibition on timber harvest on slopes with high or moderate risk of landslide; and an unspecified limit on the percentage of land in a watershed that is made up of clearcuts and plantations less than 10 years old. The 1990 Siuslaw Forest Plan was amended by the Northwest Forest Plan in 1994.

National Forest lands make up a small portion of the Oregon coast watersheds relative to private lands. For Oregon coast coho salmon, the range of which overlaps significantly with Oregon coast spring-run Chinook, 65 percent of the habitat in the range of the Oregon coast coho salmon ESU is in non-federal ownership (NMFS 1998d). National Forest Plans do not have the authority to maintain fish habitat on private lands nor to regulate actions by private parties which are destructive to spring-run Chinook (such as mining, agriculture and timber

operations on private lands). Burnett et al. (2007) evaluated buffers around stream reaches with high intrinsic potential for steelhead trout and coho salmon in coastal Oregon, and found that nearly two-thirds of these stream buffer areas are in private ownership, and with less than 10% managed by the Forest Service. These are the same watersheds occupied by Oregon coast spring-run Chinook salmon.

Federal Clean Water Act

The Clean Water Act (CWA) establishes the basic structure for regulating the discharge of pollutants into U.S. waters, and for regulating quality standards of U.S. surface waters. Under the CWA, the U.S. Environmental Protection Agency (EPA) implements pollution control programs and sets wastewater standards for industry and water quality standards for all contaminants in surface waters. The CWA also provides federal funding to restore habitat, clean up toxic pollutants and reduce run-off from farms and cities.

Under Section 404 of the CWA, discharge of pollutants into waters of the U.S. is prohibited absent a permit from the U.S. Army Corps of Engineers. Theoretically the CWA should provide some protection for stream and estuarine habitats used by spring-run Chinook. However, implementation of the CWA, and the Section 404 program in particular, has fallen far short of Congress's intent to protect water quality (e.g., see Morriss et al. 2001). The EPA is also underfunded for addressing widespread pollution problems; and the Trump's administration's proposed EPA budget cuts the agency by 31 percent from $8.2 billion to $5.7 billion.

Despite the existence of the CWA, a significant percentage of Oregon coast stream reaches for coho salmon, which overlap considerably with Oregon coast spring-run Chinook salmon, do not meet current water quality standards. For instance, many of the coho salmon populations in the Oregon coast ESU have degraded water quality identified as a secondary limiting factor (ODFW 2007), and 40% of the stream miles inhabited by Oregon coast coho salmon are classified as temperature impaired (Stout et al. 2012). NMFS concluded that it is unlikely that CWA programs are sufficient to protect Oregon coast coho salmon habitat in a condition that would provide for sustainable populations during good and poor marine conditions (NMFS 2015b).

While the CWA may regulate pollutant discharge, it does not restrict all potential contaminants. Many pollution standards for industries are out of date, and new pollutant sources from pesticides and pharmaceuticals are constantly emerging. Also, much of the aging infrastructure for industries which attempted to address pollution during the early years of the CWA is in need of upgrades.

The CWA does not address the leading cause of pollution today, "nonpoint" source pollution. The CWA does not directly regulate nonpoint sources of pollution, such as logging and farming, leaving such efforts to states. See the discussion below on the failures of Oregon state agencies to adequately address nonpoint source pollution problems in coastal waters.

Coastal Zone Act

The U.S. Environmental Protection Agency and National Oceanic and Atmospheric Administration administer the Coastal Zone Act, which established a Coastal Nonpoint Pollution Control Program to address nonpoint source pollution problems in coastal waters. Section 6217 of the Coastal Zone Act requires states and territories with approved Coastal Zone Management Programs to develop Coastal Nonpoint Pollution Control Programs. In its program, a state or territory describes how it will implement nonpoint source pollution controls. Coastal Zone Act

Reauthorization Amendments (CZARA) requirements extend to logging, agriculture, and other sources of polluted run-off that are not regulated under Clean Water Act discharge permits. Oregon's coastal nonpoint program includes the coastal watersheds and the entirety of the Umpqua River basin.

The EPA and NOAA determined in 1998 that Oregon's Coastal Nonpoint Program failed to adequately protect coastal water quality due to coastal logging practices that were polluting water and degrading salmon habitat. The EPA and NOAA determined that Oregon's logging practices for private lands were inadequate to protect small and medium sized streams, to protect streams from landslides caused by logging, to ensure sufficient pollution controls on older logging roads, and to limit pesticide contamination. The agencies pointed to more protective logging practices used in Washington and California.

In 2004 the EPA and NOAA gave informal interim approval of Oregon's agricultural controls as sufficient to protect water quality. However, there has been considerable ongoing concern that the Oregon Department of Agriculture does not adequately control nonpoint source pollution coming from agricultural and animal operations. The federal agencies subsequently raised concerns about the adequacy of agricultural management measures and conditions, and revisited this issue in 2013 (NOAA and EPA 2013).

In 2010, in response to litigation, the Oregon Department of Environmental Quality (DEQ) proposed to develop a "new and novel approach" to protecting water quality, overriding the Oregon Department of Forestry's inadequate logging practices if necessary. DEQ was to demonstrate that new approach in Oregon's Mid-Coast Basin, but in 2013 DEQ formally repudiated its commitments in a letter to the federal agencies.

In 2013 the EPA and NOAA again rejected Oregon's coastal nonpoint pollution control program as inadequate (NOAA and USEPA 2013). The federal agencies found that Oregon has not satisfied additional management measures for forestry; nor fully satisfied several conditions related to new development and onsite sewage disposal systems, for which Oregon proposed reliance on inadequate voluntary measures. For forestry, the EPA and NOAA found that Oregon has not demonstrated that it has management measures, backed by enforceable authorities, in place to: protect riparian areas for medium and small fish bearing streams, and non-fish bearing streams; protect high-risk landslide areas; address the impacts of forest roads, particularly on so-called "legacy" roads; and ensure adequate stream buffers for the application of herbicides (NOAA and USEPA 2013).

FERC Relicensing

The Federal Energy Regulatory Commission (FERC) authorizes the construction, operation and maintenance of non-federal hydropower projects and reconsiders licenses under the Federal Power Act (FPA) every 30 to 50 years. There are 2 FERC-licensed projects, Winchester and North Umpqua, in the range of Oregon coast spring-run Chinook, both in the North Umpqua River basin. See the North Umpqua section of this petition for a brief review of those projects.

Section 10(j) of the FPA allows federal wildlife agencies (U.S. Fish and Wildlife Service and National Marine Fisheries Service) to conduct environmental reviews and to make recommendations during relicensing that have the potential to add conditions and mitigations that can benefit native fish such as spring-run Chinook. The major issues addressed in comments by NMFS during FERC relicensing that relate to salmonids include protecting fish from being entrained into dam turbines or impinged on trash racks, providing upstream and

downstream fish passage past dams, providing adequate base flows downstream from projects, reducing impoundment fluctuations, and providing flows in dewatered reaches.

Under the Fish and Wildlife Coordination Act (FWCA), FERC is supposed to give fish and wildlife resources "equal consideration" with hydropower and other purposes of water resource development, and incorporate the recommendations of federal and state fish and wildlife agencies. Measures suggested by NMFS to mitigate for project impacts to anadromous fish and to provide protection and enhancement - or an equivalent level of protection - must be accepted by FERC and incorporated into the license; unless FERC determines that the recommendations are inconsistent with the FPA or other applicable law. Section 18 of the FPA gives NMFS mandatory conditioning authority to prescribe upstream or downstream fish passage; these prescriptions must be incorporated into the license by FERC.

However, state and federal wildlife agency recommendations for fish passage and protection measures can be rejected by FERC if they make a determination that there is not substantial evidence of need – this has resulted in FERC refusing to require fish passage or deferring fish passage for projects which clearly block fish migration.

FERC is the federal arbiter of conflicts between federal and state fishery agencies and hydropower developers, who often resist mitigation and compensation measures because they can be expensive and result in reduced power generation. Historically, FERC has failed to adequately protect anadromous fish during licensing and relicensing; given inadequate consideration to fish and wildlife issues in its licensing decisions; been reluctant to impose license conditions for protection of fish and wildlife; and favored hydroelectric development over conservation of fish and wildlife (Bodi and Erdheim 1986). Bodi and Erdheim (1986) detailed FERC's poor track record in complying with statutory standards for protecting anadromous fish, issuing exemptions for small hydropower projects and preliminary permits, deferring consideration of the effects of projects on fish and need for fishways until after it has approved projects, avoiding comprehensive planning for river basins, and inadequately consulting with fish and wildlife agencies. More recent FERC relicensing proceedings may have implemented more enlightened conservation measures in some cases (the biological adequacy of those measures often remains a matter of professional and public controversy, however), because FERC licenses extend for 30 to 50 years, threats inherent in past licensing actions often remain.

FERC relicensing often involves negotiations between NMFS, dam owners, states, other federal agencies such as the Army Corps of Engineers, and stakeholders, that can take very long – sometimes decades – to complete. Negotiated settlements that balance the needs of fish with other competing uses, such as power generation and recreation, may result in minimal gains for anadromous fish. The fact that FERC licenses come up for review only every 30 to 50 years means that for most rivers with FERC hydroelectric projects that impact anadromous fish, there will be no opportunity to address dam impacts through the FERC process in the near future.

State

Oregon Sensitive Species List

Oregon coast spring-run Chinook salmon are not protected as threatened or endangered under the Oregon state Endangered Species Act. Coastal spring-run Chinook (the Coastal Species Management Unit/ESU) are listed as a state "sensitive species" (ODFW 2017). This designation does not provide any regulatory or substantive protection for the species.

Even if the state of Oregon were to list Oregon coast spring-run Chinook salmon under the Oregon state Endangered Species Act, it would not provide the same level of protection as listing under the federal ESA. A recent analysis by the Center for Biological Diversity (CBD 2019) shows that not a single state has laws in place that are as protective for imperiled wildlife and plants as the federal Endangered Species Act. The state of Oregon received a C- overall grade on protecting imperiled wildlife. Oregon received an A grade for funding for endangered species conservation since it provides a reasonably high level of funding, with state expenditure reports submitted to the USFWS of $5,127,000. However, through public records request, Oregon has no data available on the state Department of Fish and Wildlife overall budget, the Wildlife Division budget, game species budget, non-game species budget, state non-game percentage of Department budget, or imperiled species budget. Oregon received a B+ grade for citizen participation and petitions since it allows citizen petitions for listing new species. Oregon received a B grade for: classification of species since it protects both endangered and threatened species; and science-based criteria since it requires use of best science but may consider economic and political factors. Oregon received a C grade for: full spectrum of species since it protects only some species; designating critical habitat since it designates important habitat in general, but no explicit restrictions apply; consultations since other state agencies must communicate with the state wildlife agency; prohibitions and enforcement since it only prohibits intentional killing or poaching of state protected species; and requirements for state commissioners or director since it requires some general knowledge of wildlife for all commissions/director, or requires expertise for less than the majority of commissioners. Oregon received a D grade for protecting habitat from destruction since it has no prohibition on destruction of habitat for state protected species.

<u>Oregon State Forest Practices Act: Forest Management and Regulation on Private Lands</u>

Logging and management of riparian areas on state and private forest lands within the range of Oregon coast spring-run Chinook salmon is regulated by the Oregon Forest Practices Act ("OFPA") and Forest Practice Rules (ORS 527.610-527.785). The OFPA shares responsibility for managing the state's forestlands between ODF, the state forester, and the Oregon State Board of Forestry. ODF, the State Forester, and district foresters develop management plans with standards and guidelines to govern the state forester and district foresters' activities on state forests. The Board promulgates Forest Practice Regulations (FPRs), which direct the foresters to "actively manage" state forestlands and make available a "sustainable and predictable production of forest products" to realize the lands' "greatest permanent value" (see generally OAR 629-035-0020; 629-035-0020(2)).

In pursuit of the "greatest permanent value" on state forestlands, state and district foresters emphasize timber production over protection of salmon and other native wildlife. For example, the FPRs require the state forester to authorize logging on "any silviculturally capable lands" unless prohibited by "a legal or contractual obligation" or unless he determines that another use will be "more consistent" with the greatest permanent value (see OAR 629-035-0050(3)(A)). The FPRs allow the state forester to authorize timber sales, including clear-cutting, as well as road construction, on "erosion-prone" slopes (OAR 629-630-0150(1)-(3); 629-623-0400; 629-623-0800; 629-625-0100). The FPRs do not set additional standards to protect salmon and their freshwater habitats from sedimentation caused by landslides (OAR 629-623-0700). The FPRs allow road construction and reconstruction on "very steep slopes" (OAR 629-623-0050(2)), high landslide hazard locations (OAR 629-625-0100(3)), and/or "where there is an apparent risk of road-generating materials entering waters of the state" (OAR 629-625-0100(2)(a)). The FPRs permit logging activities without any effort by operators to leave large woody debris in fish-bearing streams to improve stream complexity for salmon (see OAR 629-640-0110,

acknowledging that many fish-bearing streams "currently need improvement" because "they lack adequate amounts of large woody debris in channels, or they lack other important habitat elements").

These FPRs do require the establishment of riparian management areas on certain streams that are within or adjacent to forestry operations. The riparian protection widths vary from 10 to 100 feet depending on the stream classification, with fish-bearing streams having wider riparian protections than streams that are not fish-bearing. Although the Oregon Forest Practices Act and the Forest Practice Rules generally have become more protective of riparian and aquatic habitats over time, the National Marine Fisheries Service states that significant concerns remain over their ability to adequately protect water quality and salmon habitat (NMFS 2011). The lack of adequate stream protections on these Oregon state forest lands was a primary basis for the National Marine Fisheries Service's decision to protect Oregon coast ESU coho salmon under the Endangered Species Act (NMFS 2011). In particular, the widths of riparian protections may not be sufficient to fully protect riparian functions and stream habitats; timber operations allowed within riparian management areas may degrade stream habitats; timber operations on high-risk landslide sites may result in excessive sedimentation of streams; and watershed-scale effects are not accounted for (NMFS 2011). On some Oregon coast streams, forestry operations conducted in compliance with the Act are likely to reduce stream shade, slow the recruitment of large woody debris, and add fine sediments (NMFS 2011). Another major failing of the Oregon Forest Practices Act is the failure to place limitations on cumulative watershed effects, so that the high road density on private forest lands in coastal Oregon is unlikely to decrease (NMFS 2011). NMFS (2011) concluded that the Oregon Forest Practices Act may not adequately protect Oregon coast coho salmon habitat. Thus it is also unlikely to adequately protect Oregon coast spring-run Chinook salmon habitat.

Talberth and Fernandez (2015) evaluated the failures of the Oregon Forest Practices Act in limiting the rate of harmful clearcutting. They found that the Act has inadequate forest diversity standards, inadequate water resource protection standards, and inadequate enforcement and public participation. The Oregon Forest Practices Act allows a rate of logging above the rate of forest regrowth; permits clearcuts for which the timing, size and placement allow forest fragmentation and reduce forest cover; and does not have adequate standards for retention of "biological legacies" such as residual trees, snags, and downed logs (Talberth and Fernandez 2015). As far as water resource protection, the Oregon Forest Practices Act does not provide no-cut buffers along all streams and stream courses adequate to protect water quality, temperature, and flow, nor to provide habitat and migration corridors for fish and wildlife species that depend on aquatic ecosystems; and clearcutting is allowed in watersheds that provide cold water fish habitat and on steep, unstable soils prone to landslides (Talberth and Fernandez 2015). Authority of the State Forester to approve or disapprove of major logging operations was rolled back in 2003 to help shield timber companies and the State Forester from lawsuits over endangered salmon and other imperiled species. The Oregon Department of Environmental Quality is not empowered to disapprove logging operations that adversely affect water resources.

State Forest Management

More than half a million acres of state owned forest land on the Oregon coast are managed by the Oregon Board of Forestry. The majority of these lands are managed under the Northwest Oregon Forest Management Plan and the Elliot Forest Management Plan. The Oregon state forests have long been managed by the Oregon Department of Forestry to emphasize logging over all other uses and at the expense of wildlife habitat and water quality protection.

The Oregon Department of Forestry attempted to initiate a federal Habitat Conservation Plan (HCP) for coho salmon for management of the coastal state forests (Elliott, Tillamook, and Clatsop) under section 10 of the Endangered Species Act. In 2009 the National Marine Fisheries Service notified ODF that their proposed management and conservation strategies would not meet the needs of trust resources nor provide for the survival and recovery of Oregon Coast coho salmon (NMFS 2011). NMFS (2011) identified concerns over logging practices which result in a lack of stream shade, inhibit woody debris recruitment, and other issues. NMFS (2011) stated that the agency is "unable to conclude that the Elliot State and the Northwest Oregon Forest Management Plans provide for OC Coho Salmon habitat that is capable of supporting populations that are viable during both good and poor marine conditions." ODF abandoned the HCP process and instead developed its own "take-avoidance plan."

Tillamook State Forest

The 364,000 acre Tillamook State Forest includes significant forested lands in the Tillamook River basin, specifically in the Wilson, Kilchis, and Trask watersheds; and to a lesser extent in the Miami River watershed and the Nestucca River basin. The Tillamook State Forest consists primarily of second-growth, 40- to 60-year-old Douglas fir, with a 35- to 55-year-old conifer and hardwood understory and hardwood-dominated riparian areas along perennial streams.

The Tillamook forests were subjected to several decades of intensive logging, a series of fires that burned hundreds of thousands of acres, and massive salvage logging operations, resulting in damage to sensitive soils, degradation of streams, and decimation of fish and wildlife populations. Timber companies subsequently abandoned the Tillamook to tax foreclosure by the counties, which then turned management of the land over to the state of Oregon, which formed the Tillamook State Forest. ODF undertook a massive reforestation and rehabilitation effort in the Tillamook Burn area from 1948 to 1973, when the Tillamook State Forest was established.

ODF logging and road-use practices in the Tillamook State Forest harm salmon habitat. ODF's Tillamook and Forest Grove districts plan and offer timber sales that include clear-cutting and road construction on the Tillamook State Forest. Poor forest practices by ODF causes landslides and debris flows, delivers harmful sediment pollution to salmon-bearing streams, and limits the supply of large woody debris; construction, maintenance, and use of roads for the hauling of cut logs cause landslides and results in chronic sediment inputs to streams (see CBD et al. 2018).

From 1991 to 2000, the average annual timber harvests in the Northwest Oregon State Forests Management Plan area (which includes the Tillamook, Clatsop, and Santiam State Forests) were approximately 116 million board feet, ranging from 72 million in 1991 to 214 million board feet in 2000 (ODF 2010).

The Oregon Department of Forestry's 2010 Northwest Oregon State Forests Management Plan barely mentions spring-run Chinook salmon, noting only that they exist on the Oregon coast and that the population is designated as a state species of special concern (ODF 2010). Otherwise the plan does not contain any specific management or protection measures for spring-run Chinook. The plan does contain minimal protections for coho salmon on the Oregon coast, but acknowledges that the routine authorization of clear-cutting and short logging rotations reduces snags and prevents large woody debris from entering streams that are essential coho breeding and rearing habitat. ODF admits that under the 2010 plan, the forest conditions necessary to

conserve coho salmon will not be achieved soon, and even under the best-case scenario, may not be achievable for decades (ODF 2010).

The 2010 plan does have stated goals for general protection of riparian and aquatic habitats: they will be managed to maintain or restore key functions and processes of aquatic systems. The plan commits ODF to conduct watershed assessments and analysis, implement management standards for aquatic and riparian management areas, initiate some aquatic habitat restoration, and pursue slope stability management and forest road management. However, two of the ODF's five primary management goals for the state forests - providing a sustainable supply of timber and a "reasonable" net economic value – conflict with adequate riparian, aquatic and forest protections. The Northwest Oregon State Forests Management Plan states that volumes of timber harvest are expected to increase in the future (ODF 2010). 200 year (twenty 10-year periods) harvest scenarios are offered for the North Coast state forests (Astoria, Tillamook and Forest Grove Districts), which would cut from 23-60 million board feet annually, clearcut from 274,000 to 1.1 million acres and thin from 636,000 to 1.4 million acres (ODF 2010).

In 2013 the Oregon Board of Forestry decided to examine alternative approaches to managing the Tillamook State Forest for improved conservation and financial viability; and committed to working with the conservation community and the timber industry to develop a new management plan that would potentially avoid harms to salmon and streams. After 6 years no such plan has materialized.

Since 2014, Oregon state foresters have authorized logging on more than 37,000 acres of the Tillamook and Clatsop State Forests—including the clear-cutting of 25,000 acres and partial cutting of 12,000 acres—through at least 186 timber sales, ranging from 100 to 1,000 acres across numerous watersheds. Many of these timber sales are on erosion-prone and/or "high landslide hazard locations" that are located above and/or adjacent to salmon-bearing streams. The road systems to access these timber sales are also prone to erosion and delivery of sediment and vehicle-generated chemical contamination to salmon streams and to many tributaries that serve as important water sources to salmon streams.

In 2018 fishing and conservation groups sued ODF for continued poor logging and road-use practices in the Tillamook State Forest that harm coho salmon and violate the Endangered Species Act (CBD et al. 2018). Similarly, forest-management-related threats to spring Chinook salmon and their habitat exist on Tillamook State forest lands in the Wilson, Kilchis, Trask, Miami, and Nestucca River basins.

Elliott State Forest

The Elliott State Forest encompasses 95,000 acres, mostly just north of Coos Bay, including significant forested lands in the Umpqua River basin, and to a lesser extent in the Coos River basin. Management of the Elliot State Forest affects water quality in tributaries to the mainstem Umpqua River, which serves as migratory and rearing habitat for South Umpqua and North Umpqua spring Chinook salmon.

The Elliott State Forest has historically been logged to provide funding for Oregon's Common School Fund. Tying logging revenue to school funding was envisioned at a time when old-growth forest and wildlife seemed limitless, but after a century of unsustainable logging practices only 41,000 acres of the Elliott's old-growth forest remains. Litigation over the logging impacts to threatened wildlife forced the Oregon Department of Forestry to halt logging in

mature and old-growth forests and focus instead on young plantations. But the state's expectation for revenue from the forest provides pressure to increase timber harvest.

The Oregon Department of Forestry's 2011 Elliot State Forest Management Plan does not mention spring-run Chinook salmon (ODF and ODSL 2011). The plan does have stated management strategies for general protection of riparian and aquatic habitats. The plan commits ODF to conduct watershed assessments and analysis, implement management standards for aquatic and riparian management areas, maintain or improve aquatic habitats, and pursue slope stability management and forest road management. Again, two of ODF's stated primary management strategies for the Elliot State Forest - maximizing revenue through timber harvest and providing predictable and dependable products and revenues - may conflict with a stated desire for sustainable forest ecosystem management and riparian, aquatic and forest protections (ODF and ODSL 2011). Nowhere does the plan quantify planned timber harvest volumes.

Proposals to sell off the Elliott State Forest to turn a profit were the subject of major public outcry. In 2017, the State Land Board voted to keep the Elliott Forest public, but management of this forest is still being debated. In December 2018 the State Land Board voted to transfer 80,000 acres of the Elliott State Forest to Oregon State University to create a "state research forest." The forest would be managed for mixed use including timber harvest, and other uses identified by the Land Board such as recreation, public access and conservation. It is unclear yet whether this plan will improve aquatic and riparian protections. This plan relies on securing $121 million to compensate the Common School Fund for the appraised value of the Elliott State Forest.

State Watershed and Salmon Management Plans

Salmon Monitoring

It is important to note that ODFW does not conduct regular systematic surveys for Oregon coast spring-run Chinook salmon. Monitoring spawning populations and establishing population trends is baseline information essential to adequately protecting and recovering salmon runs. For much of the state's monitoring and reporting, Oregon coast spring-run Chinook spawning numbers and population trends are lumped in with fall-run Chinook. Oregon coastal fall Chinook salmon are monitored by ODFW through a set of 56 standard spawning ground surveys, many conducted since the 1950s. There has not been a similar, consistent, coast-wide monitoring program for Oregon coastal spring Chinook salmon spawners. Abundance of spring-run populations has been loosely monitored through a variety of methods including freshwater harvest estimates, counts at dams and weirs, summer resting-hole counts, and occasional spawning ground surveys (Nott et al. 2013). ODFW's 2014 Coastal Multispecies Conservation and Management Plan was supposed to initiate regular resting pool counts of spring-run Chinook along the Oregon coast. After 2014, the only relevant ODFW documents we located (as cited in this petition) are various Hatchery and Genetic Management Plans, and draft material prepared for plans not yet completed.

1991 Coastal Chinook Salmon Plan

ODFW's 1991 Coastal Chinook Salmon Plan focused on state management actions for Chinook salmon in coastal watersheds from the Necanicum River south to the Oregon-California border (ODFW 1991). This plan was supposed to manage salmon hatcheries, harvest and habitat to protect coastal Chinook, but had some competing management objectives. Objectives included

maintaining healthy populations of wild chinook in coastal river basins, protecting Chinook habitat, and minimizing detrimental genetic impacts from hatchery production, harvest and habitat alteration. Maintaining healthy wild Chinook stocks was identified as the highest priority. The plan noted that in the 1980s 55% of Oregon coastal spring-run Chinook were wild. The plan offered "guidelines" to achieve management objectives. The plan acknowledged the limits of protecting wild Chinook based on state laws and regulations, given that Chinook salmon are not managed as a protected species, but as "food fish" and "game fish" to provide economic, commercial, recreational and aesthetic benefits.

The 1991 plan did not establish limits for Chinook harvest in ocean or in-river fisheries, but recommended harvest rates to guide fisheries managers and provide escapement goals. The plan noted that brood-year harvest of wild populations should not exceed 67%. The plan noted challenges given that ocean harvests are of a mixed stock fishery. The plan presumed that ocean harvests at the time were not excessive. Hatcheries were ostensibly to be managed to be compatible with wild populations, but also were to contribute to recreational and commercial harvest objectives. The plan characterized wild spring-run Chinook populations in the Siletz and Alsea rivers as "healthy" - even though the Siletz only had a few hundred spring-run fish, including hatchery strays, and the Alsea spring-run run size was an estimated 300 fish, with hatchery stray influence.

1997 Oregon Coastal Salmon Restoration Initiative

The Oregon Coastal Salmon Restoration Initiative, also known as the Oregon Plan for Salmon and Watersheds, was submitted by the state of Oregon to NMFS 1997, in an attempt to head off listings of salmon under the ESA. The Oregon Plan principles are no additional regulations or changes in existing law, increased enforcement of existing laws, and primary reliance on voluntary efforts from local landowners, organized through local watershed councils and industry trade or landowner associations. The Oregon Plan was intended to be "ground-up" with local watershed councils securing stakeholder buy in and proposing projects, and state agencies providing support rather than control. Timber and agricultural interests were able to deflect any state regulatory changes in land use practices, and the watershed councils, some of which are dominated by resource extraction industries, have no authority to curb local industrial land use practices which are contributing to salmon habitat destruction. Reliance on voluntary measures avoids addressing difficult, complex land use issues which are at the root of salmon habitat loss. Projects which typically gain approval though local watershed councils tend to be non-controversial rather than the most beneficial to salmon. Reliance on existing state laws is problematic since Oregon has relatively weak natural resource protection laws which have been ineffective in reigning in destructive land use practices which harm salmon habitat, such as timber harvest, agriculture and mining. Many elements of the Oregon Plan are further limited by political and funding constraints. The main benefits of the Oregon Plan seem to be coordination between state, federal, and tribal agencies, and ongoing monitoring of watershed health, water quality, and salmon recovery.

Watershed Fish Management Plans

There are two state watershed Fish Management Plans addressing Oregon coast spring-run Chinook salmon populations. These are the Alsea River Basin Fish Management Plan (ODFW 1997) and the Siletz River Basin Fish Management Plan (ODFW 1998). These are discussed in the appropriate basin status summaries.

2006 Oregon Conservation Strategy

The 2006 Oregon Conservation Strategy is an entirely voluntary state strategy for conserving fish and wildlife and prioritizing conservation needs. The strategy has lofty goals: to maintain healthy fish and wildlife populations by maintaining and restoring functioning habitats; prevent declines of at-risk species; and reverse declines in these resources where possible. However, the strategy provides no substantive protections for Chinook salmon or their habitat. It identifies conservation opportunity areas and provides a "conservation toolbox" for communities, planners, and other organizations. This merely consists of outreach and educational information, information on Oregon's existing planning and regulatory framework which has failed to protect salmon, and information on voluntary conservation programs. Coastal spring Chinook salmon are one of the "strategy species" targeted for conservation; flowing water and riparian habitats and estuaries are "strategy habitats." Recommended conservation actions for coastal spring Chinook are: maintain or restore aquatic and riparian habitat; continue ongoing restoration efforts involving landowners, tribes, and agency partners; and manage for sustainable harvest.

2014 Coastal Multispecies Conservation and Management Plan

Oregon's 2002 Native Fish Conservation Policy is intended to ensure the conservation and recovery of native fish. It is implemented through the development of conservation plans adopted by the Oregon Fish and Wildlife Commission and management actions of the Oregon Department of Fish and Wildlife. The goals of the Native Fish Conservation Policy are to prevent the serious depletion of native fish; maintain and restore naturally produced fish in order to provide substantial ecological, economic and cultural benefits; and foster and sustain opportunities for fisheries consistent with the conservation of naturally produced fish and responsible use of hatcheries. A 2005 status assessment of native fishes in Oregon (ODFW 2005) identified two coastal "Species Management Units" (Oregon Coastal Spring Chinook Salmon and Oregon Coastal Chum Salmon) as "at risk," leading to the need for a coastal species conservation plan. In 2013 the Oregon Department of Fish and Wildlife released a draft Coastal Multi-Species Salmonid Conservation and Management Plan (CMP), intended to conserve salmonids while managing fish hatchery and harvest programs, and covering Oregon coast spring-run Chinook salmon. It was adopted by the Oregon Fish and Wildlife Commission in 2014.

The CMP is a significant first-step toward compiling relevant data and reflecting on some of the conservation challenges facing Oregon's coastal salmonids. Unfortunately the CMP dismisses the value of wild early-run Chinook salmon stocks in several basins where historical data clearly show they were once of significant abundance, and mischaracterizes spring-run Chinook as a minor variant of fall-run chinook life history.

Fisheries experts conducted an independent review of the draft CMP (Huntington et al. 2013). They concluded that taken as a whole, the plan lacks fundamental elements that are expected by scientific convention from a comprehensive conservation plan for any species or populations, whether at risk or healthy (Huntington et al. 2013). Though the CMP makes some regional- and basin-scale proposals for the management of hatcheries and some fisheries, Huntington et al. (2013) cautioned that it should not be considered an adequate conservation plan for any species. Huntington et al. (2013) detailed the major failings of the plan:

• It does not address large conservation gaps for early-run Chinook salmon that ODFW (2005) identified as being "at risk." It claims there is no conservation crisis for Oregon's coastal

salmonids, but only after removing early-run Chinook and Chum Salmon from the discussion for reasons that are not well founded in science.

• It fails to discuss clearly the magnitude of unfavorable effects that ODFW hatchery programs are likely having on wild salmonid populations, and fails to evaluate and prescribe changes to these programs where needed in the face of human population growth and climate change. Instead, the CMP proposes to relax an interim management guideline for hatchery programs that no less than 90% of a naturally spawning population of salmonids should be wild fish.

• It assumes existing fish resources and programs can be maintained with only modest changes in management, and offers limited consideration of the full range and priority of actions necessary to protect and restore wild coastal salmonids. For example, it neither examines nor adjusts existing fish management (including hatchery) programs for consistency with the 2006 Oregon Conservation Strategy. It fails to link analyses of wild fish status, trends, and threats to salient conservation measures.

• It lacks a clear strategy for addressing critical watershed, habitat, and water quality issues relevant to the survival of spring-run Chinook.

Other Anthropogenic or Natural Factors

Artificial Propagation

All hatchery operations within the Oregon Coast Chinook ESU are for the intended purpose of augmenting commercial and/or recreational fisheries, and are not designed for conservation or reintroduction purposes. Four Oregon Department of Fish and Wildlife hatcheries contribute to juvenile releases of spring Chinook in 3 coastal populations, including the Trask River, Nestucca River, and North Umpqua River. Operating these hatcheries poses many risks, especially the potential hybridization between spring and fall-run Chinook. Kinzinger et al. (2008) documented the negative impacts of hybridization between spring and fall Chinook returning to the Trinity River, California.

The Trask River Hatchery rears spring Chinook salmon to augment fisheries harvest in recreational fisheries in Tillamook Bay and Trask River, as well as commercial and sport ocean harvest. The program annually provides 111,250 eggs to a Salmon Trout Enhancement Program, produces 63,000 fingerlings for transfer to the Tuffy Creek Facility to produce 60,000 smolts for release into the Trask River. In addition, the Trask Hatchery directly releases 95,000 smolts annually into the Trask River from its facility. The Trask River also provides 250,000 eggs annually for transfer to the Cedar Creek Hatchery.

The Whiskey Creek Hatchery is a Salmon Trout Enhancement Program hatchery that receives 110,000 eyed-egg spring Chinook salmon eggs annually from the Trask Hatchery. The production goal for Whiskey Creek, a tributary to Netarts Bay, is to release approximately 100,000 Stock 34 spring Chinook salmon smolts annually, with the purpose of augmenting recreational and commercial fisheries. Only 35,000 of these smolts are released from Whiskey Creek Hatchery into the Trask River. The remaining smolts are transferred to Trask Hatchery or Cedar Creek Hatchery for further rearing and eventual release into the Trask River.

The Cedar Creek Hatchery currently releases smolts into the Nestucca River watershed (Stock 47) with the primary goal of providing hatchery spring Chinook adults for recreational harvest in

the Nestucca Basin, as well as commercial and recreational in ocean fisheries. The hatchery spring Chinook salmon were first specifically identified in liberation records in 1962, and releases of spring Chinook have occurred annually since 1968. Stock 47 (Cedar Creek/Nestucca) spring Chinook salmon have been used since at least 1975 (ODFW Cedar Creek Hatchery Spring Chinook Sal HGMP 7-21-16).

The North Umpqua River hatchery raises 342,000 smolts (37,450 pounds) annually for release in the North Fork Umpqua River. The 55H stock originates from the Rock Creek Hatchery and is designed to provide fish for recreational harvest. Adults are collected at Winchester Ladder and two hatchery trap collection facilities from April to June. Adults are collected throughout the run, and spawned at a 1:1 male to female ratio, in a matrix system. Wild broodstock are integrated into that hatchery stock at a rate of 10-20% (ODFW Rock Creek Hatchery Program Management Plan 2017).

It is known that spring-run and fall-run Chinook salmon, whether inadvertently or intentionally, have been forcibly interbred in hatcheries (Kinziger et al. 2014, and see further discussion below). Traditional hatchery broodstock collection and spawning practices can easily, if not inherently, result in hybrids of these ecotypes in rivers where both types occur. Because the extent of this threat has not been thoroughly evaluated, and has only relatively recently been recognized, there is currently no reliable means to assess whether current hatchery practices sufficiently guard against this critical and direct threat to spring-run Chinook salmon.

Hybridization between spring-run and fall-run Chinook salmon is a major, imminent man-made threat to the spring run population--only recognized in recent scientific literature, but potentially widespread. The genotypic and phenotypic distinctiveness of the spring-run Chinook salmon can be modified when natural or man-made factors allow or force interbreeding between spring- and fall-run Chinook that were formerly separated by time or place of spawning.   Most commonly, such interbreeding is forced by dams, diversions, or other habitat changes that block historical migration paths (Thompson et al. 2018), but can also be forced by intentional or unintentional crossing of the two ecotypes in hatcheries (Kinziger et al. 2013). The result is intermediate phenotypes that typically migrate later than the indigenous spring-run fish, but earlier than the fall run. Such intermediate phenotypes are almost certainly maladapted to long-term survival in natural habitats, consistent with their absence from indigenous wild Chinook salmon populations (Thompson et al. 2018). Therefore such interbreeding likely harms both the early- and late-returning parent stocks both ecologically and genetically. The breach of evolutionary continuity particularly endangers spring-run Chinook, largely because most populations are already reduced to small population sizes with low or non-increasing productivity, hence are vulnerable to local extinction from endogenous as well as exogenous factors.

Ocean Conditions

Ocean conditions in the Pacific Northwest exhibit patterns of recurring, decadal-scale variability (including the Pacific Decadal Oscillation and the El Nino Southern Oscillation), and correlations exist between these oceanic changes and salmon abundance in the Pacific Northwest (Stout et al. 2011). It is also generally accepted that for at least 2 decades, beginning about 1977, marine productivity conditions were unfavorable for the majority of salmon and steelhead populations in the Pacific Northwest, but this pattern broke in 1998, after which marine productivity has been quite variable (Stout et al. 2011). NMFS (2011) was concerned about how prolonged periods of poor marine survival caused by unfavorable ocean conditions may affect the population viability parameters of abundance, productivity, spatial structure, and diversity for Oregon coast

salmonids. Although salmon have persisted through many favorable-unfavorable ocean/climate cycles in the past, much of their freshwater habitat was in good condition, buffering the effects of ocean/climate variability on population abundance and productivity. It is uncertain how these populations will fare in periods of poor ocean survival when their freshwater, estuary, and nearshore marine habitats are degraded (Stout et al. 2011).

Climate Change

Throughout the life cycle of Oregon coast salmonids, there are a numerous potential effects of climate change (Stout et al. 2011; Wainwright and Weitkamp, in review). The main predicted effects in terrestrial and freshwater habitats include warmer, drier summers, reduced snowpack, lower summer flows, higher summer stream temperatures, and increased winter floods, which would affect salmonids by reducing available summer rearing habitat, increasing potential scour and egg loss in spawning habitat, increasing thermal stress, and increasing predation risk (NMFS 2011). In estuarine habitats, the main physical effects are predicted to be rising sea level and increasing water temperatures, which would lead to a reduction in intertidal wetland habitats, increasing thermal stress, increasing predation risk, and unpredictable changes in biological community composition (NMFS 2011). In marine habitats, there are a number of physical changes that would likely affect salmonids, including higher water temperature, intensified upwelling, delayed spring transition, intensified stratification, and increasing acidity in coastal waters (NMFS 2011). Of these, only intensified upwelling would be expected to benefit coastal-rearing salmon; all the other effects would likely be negative (NMFS 2011).

Projected changes in regional climatic and weather patterns due to global climate change will have negative effects on Oregon coastal aquatic ecosystems and salmonids (ODFW 2014). Long-term warming trends and increasing weather variability in the Pacific Northwest will result in more frequent events (e.g., droughts, intense precipitation, and periods of unusually warm weather) that were considered extreme during the twentieth century, and the magnitude of these events may also exceed recent historical levels (Reiman and Isaaks 2010). Although the rain-dominated hydrology of coastal Oregon streams and rivers are not projected to experience the same magnitude of change in temperatures and flows as other portions of the Pacific Northwest (Beechie et al. 2012), coastal Oregon salmonid populations will likely be exposed to lower summer base flows, higher summer-fall water temperatures, and greater stochasticity in hydrology due to changes in precipitation and runoff patterns (ODFW 2014). Although it is not clear how global climate change will affect salmon in the ocean environment, some modeling efforts suggest that warmer air temperatures are likely to increase ocean stratification, which in the past has coincided with relatively poor ocean habitat for most Pacific Northwest salmon (CIG 2004).

Request for Critical Habitat Designation

The Petitioners request the designation of critical habitat for Oregon coast spring Chinook concurrent with listing. Critical habitat should encompass all known and potential freshwater spawning and rearing areas, migratory routes, estuarine habitats, riparian habitats and buffers, and essential near-shore ocean habitats.

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