Chinook Salmon, Chum Salmon, Coho Salmon, Pink Salmon, Sockeye Salmon

California, Oregon, Washington

Drift Gillnet, Purse Seine, Troll Pole

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About Seafood Watch®

Monterey Bay Aquarium’s Seafood Watch® program evaluates the ecological sustainability of wild-caught and farmed seafood commonly found in the United States marketplace. Seafood Watch® defines sustainable seafood as originating from sources, whether wild-caught or farmed, which can maintain or increase production in the long term without jeopardizing the structure or function of affected ecosystems. Seafood Watch® makes its science-based recommendations available to the public in the form of regional pocket guides that can be downloaded from www.seafoodwatch.org. The program’s goals are to raise awareness of important ocean conservation issues and empower seafood consumers and businesses to make choices for healthy oceans.

Each sustainability recommendation on the regional pocket guides is supported by a Seafood Report. Each report synthesizes and analyzes the most current ecological, fisheries and ecosystem science on a species, then evaluates this information against the program’s conservation ethic to arrive at a recommendation of “Best Choices,” “Good Alternatives” or “Avoid.” The detailed evaluation methodology is available upon request. In producing the Seafood Reports, Seafood Watch® seeks out research published in academic, peer-reviewed journals whenever possible. Other sources of information include government technical publications, fishery management plans and supporting documents, and other scientific reviews of ecological sustainability. Seafood Watch® Research Analysts also communicate regularly with ecologists, fisheries and aquaculture scientists, and members of industry and conservation organizations when evaluating fisheries and aquaculture practices. Capture fisheries and aquaculture practices are highly dynamic; as the scientific information on each species changes, Seafood Watch’s sustainability recommendations and the underlying Seafood Reports will be updated to reflect these changes.

Parties interested in capture fisheries, aquaculture practices and the sustainability of ocean ecosystems are welcome to use Seafood Reports in any way they find useful. For more information about Seafood Watch® and Seafood Reports, please contact the Seafood Watch® program at Monterey Bay Aquarium by calling 1-877-229-9990.
Guiding Principles

Seafood Watch defines sustainable seafood as originating from sources, whether fished\(^1\) or farmed, that can maintain or increase production in the long term without jeopardizing the structure or function of affected ecosystems.

Based on this principle, Seafood Watch had developed four sustainability criteria for evaluating wild-catch fisheries for consumers and businesses. These criteria are:

- How does fishing affect the species under assessment?
- How does the fishing affect other, target and non-target species?
- How effective is the fishery’s management?
- How does the fishing affect habitats and the stability of the ecosystem?

Each criterion includes:

- Factors to evaluate and score
- Guidelines for integrating these factors to produce a numerical score and rating

Once a rating has been assigned to each criterion, we develop an overall recommendation. Criteria ratings and the overall recommendation are color coded to correspond to the categories on the Seafood Watch pocket guide and the Safina Center’s online guide:

**Best Choice/Green**: Are well managed and caught in ways that cause little harm to habitats or other wildlife.

**Good Alternative/Yellow**: Buy, but be aware there are concerns with how they’re caught.

**Avoid/Red**: Take a pass on these for now. These items are overfished or caught in ways that harm other marine life or the environment.

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\(^1\) “Fish” is used throughout this document to refer to finfish, shellfish and other invertebrates.
Context of Salmonid Assessments

Salmon and steelhead are anadromous fish, meaning that they spawn in freshwater where juveniles hatch from eggs before spending some time in freshwater habitats (this time period varies between species, life history types and populations) before migrating to sea for a period of continued growth and maturation. When mature, salmon return to their natal freshwater habitats to spawn. Salmon are the most abundant anadromous species on the west coast of North America and are targeted by a number of socially, culturally and economically important fisheries; however, their complex life history also means that they are the subject of many other challenges and threats. Many salmonid populations are depressed, with some considered threatened or endangered under the U.S. Endangered Species Act (ESA) and by Committee on the Status of Endangered Wildlife in Canada (COSEWIC). The cause of these declines and continued threats to longevity are wide ranging and numerous, including the obstruction of natural migration routes by dams, deforestation, water extraction, pollution, urbanization, climate change, fisheries, salmon hatcheries and aquaculture operations. Seafood Watch has assessed salmon fisheries in the context of these wide ranging impacts, some of which are beyond the control of fishery management agencies to the extent possible. As a result, the listing of a stock as endangered, and the capture of such stocks does not automatically result in an Avoid recommendation; however, the existence of other threats does not result in ‘free ride’ for fisheries and fisheries managers. Seafood Watch believes that where there are interactions with depleted or listed stocks, managers and fishers should implement measures to reduce these interactions to the extent possible to allow rebuilding to occur, and that they should work with other stakeholders and agencies to find solutions to the other threats to salmonid populations along the west coast of North America.

Due to the unique nature of salmonid population dynamics and the wide variety of salmonid populations that are encountered by an individual fishery (an individual salmon fishery may interact with more than 20 individual salmon stocks), Seafood Watch has modified the approach to assessing salmonid fisheries. Rather than provide a recommendation for each stock caught by the fishery, as we would do for a cod or tuna fishery for example, we have provided a recommendation for each fishery, defined as a species caught by a particular gear in a specific region, for example, Chinook salmon caught by drift gillnet in Puget Sound.

For each fishery, the abundance of the stocks caught and the impact of the fishery are assessed collectively. Stocks that constitute 5% or more of the landings from a fishery are considered ‘major’ components of that fishery and are assessed in Criterion 1. Stocks accounting for less than 5% of a fishery’s landings are considered ‘minor’ components of that fishery and assessed
in Criterion 2. This distinction is made to account for minor stocks of the target species that the fishery may be trying to avoid due to low abundance, recognizing management efforts to minimize the impact of the fishery.

When assessing the abundance of salmon stocks, we consider the abundance of wild salmon. A wild salmon is defined as “a salmon which was spawned in the natural environment,” as opposed to a hatchery salmon that was spawned in an artificial environment. We consider the abundance of wild salmon to be unknown if there is no distinction between wild salmon and hatchery salmon in abundance estimates, unless it is unlikely that hatchery-origin fish are present. We recognize that some hatcheries exist in order to help conserve salmon populations, and as such the aim is for hatchery salmon to reach natural areas and spawn; however, we believe that in order to effectively manage these programs the contribution of hatchery salmon to natural spawning should be quantified and the hatcheries should be operating using guidelines described by the Hatchery Scientific Reform Group (HSRG)(http://www.hatcheryreform.us/).

**Understanding the recommendation**

Due to the complexity of salmonid fisheries, often the same gear type is used to target different species at different times of the year with different bycatch profiles, we have added a species component to the gear type. The result is a recommendation that looks slightly different to the typical Seafood Watch recommendation so here we include a short description to clarify the different terms used.

**Chinook Salmon**

**Horse Mt. to U.S./Mexico Border North Pacific–Trolling Lines–Chinook**

In the recommendation above “Chinook salmon” refers to the species for which the recommendation pertains. “Horse Mt. to U.S./Mexico Border” refers to the geographical region for the recommendation. “North Pacific” is the body of water, and “Trolling Lines – Chinook” identifies the gear type used and the species being targeted. It is important to realize that the species for which we are seeking a recommendation may not be the target species in all cases.
Summary

This report evaluates U.S. West Coast commercial salmon fisheries (all five Pacific salmon species) in and off the coasts of California, Oregon, and Washington. Most species and fisheries were recommended as a good alternative. However, Puget Sound Chinook salmon and Columbia River coho salmon should be avoided primarily because the wild stock in these fisheries is listed under the Endangered Species Act (ESA), and harvests likely include a high proportion of the ESA component.

Evaluation of the abundance factor in Criterion 1 was based on spawning escapements relative to goals and the presence of hatchery fish on the spawning grounds. Nearly all fisheries on the U.S. West Coast are supported by hatchery (sea ranching) production. Production hatcheries are often located on large watersheds that support wild salmon; therefore, many hatchery fish stray to the streams and spawn with the wild salmon. Hatchery fish contribution to naturally spawning populations is generally not estimated. Thus the abundance factor for Chinook, coho and chum salmon was typically a moderate concern, because hatchery production is significant and may confound the status of the natural-origin stock. In contrast, pink and sockeye abundance was typically a low concern because these species have relatively little hatchery production. Puget Sound Chinook and Columbia coho were scored as a Very High concern because the primary stocks caught by the fishery are both ESA listed.

Significant progress in fisheries management has occurred in all fisheries, largely in response to numerous listings of salmon under the Endangered Species Act. Essentially one or more ESA-listed salmon species is incidentally harvested in each of the fisheries. Fishing mortality on the targeted (recommended) species is therefore often constrained by these “weak” stocks, and fishing mortality on the targeted species was typically rated as a low or moderate concern because it was within the range of sustainability for the targeted species. However, Puget Sound Chinook (gillnet and troll) received a high concern because these fisheries, in addition to outside fisheries, likely harvested a number of ESA-listed fish while attempting to capture hatchery fish not listed by the ESA. Many hatchery Chinook in Puget Sound are ESA listed.

Evaluation of Criterion 2 (impacts on other species) usually involved one or more ESA-listed salmon species, therefore this Criterion typically received the lowest score of all four Criteria. Abundance of these species typically received a ‘Very High’ conservation concern, whereas fishing mortality sometimes received a ‘Low Concern’ because managers effectively reduced incidental impacts on these species. Fisheries receiving a ‘Moderate Concern’ included all west coast troll fisheries (Chinook, and sometimes coho) and Puget Sound sockeye (gillnet, seine).

Management effectiveness (Criterion 3) typically was scored as ‘Moderately Effective.’
Management of these fisheries is complicated by the presence of ESA-listed species, a broad mixture of natural populations and hatchery stocks, gauntlet fisheries, multiple user groups (sport, treaty, non-treaty), and numerous hatchery fish entering the spawning grounds. Nevertheless, most of the fisheries are carefully managed with a reasonable strategy, recovery objectives, research, enforcement, and track record. Inclusion of stakeholders in a transparent process and incorporation of scientific advice were considered ‘Highly Effective.’ Bycatch was typically scored as ‘Highly Effective’ when actions were taken to avoid ESA-listed species. Research has led to catch and release survival estimates that are incorporated into management.

Impacts on Habitat and Ecosystem (Criterion 4) typically received a ‘Very Low Concern’ with regard to impacts of the fishery on the substrate because salmon fishing gear usually has little contact with the bottom. However, ecosystem-based fisheries management was typically scored as a ‘High Concern’ because many hatchery fish are allowed to spawn in the rivers, leading to potential genetic and ecological impacts to the wild population.

**Table of Conservation Concerns and Overall Recommendations**

<table>
<thead>
<tr>
<th>Stock / Fishery</th>
<th>Impacts on the Stock</th>
<th>Impacts on other Spp.</th>
<th>Management</th>
<th>Habitat and Ecosystem</th>
<th>Overall Recommendation</th>
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<tr>
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<td>Yellow (2.64)</td>
<td>Red (1.00)</td>
<td>Yellow (3.00)</td>
<td>Yellow (3.16)</td>
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<td>Puget Sound–Purse seine–</td>
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<td>Gillnet, Drift–Coho</td>
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Scores range from zero to five where zero indicates very poor performance and five indicates the fishing operations have no significant impact.

Final Score = geometric mean of the four Scores (Criterion 1, Criterion 2, Criterion 3, Criterion 4).

- **Best Choice/Green** = Final Score >3.2, and no Red Criteria, and no Critical scores
- **Good Alternative/Yellow** = Final score >2.2-3.2, and neither Harvest Strategy (Factor 3.1) nor Bycatch Management Strategy (Factor 3.2) are Very High Concern\(^2\), and no more than one Red Criterion, and no Critical scores
- **Avoid/Red** = Final Score <=2.2, or either Harvest Strategy (Factor 3.1) or Bycatch Management Strategy (Factor 3.2) is Very High Concern or two or more Red Criteria, or one or more Critical scores.

\(^2\) Because effective management is an essential component of sustainable fisheries, Seafood Watch issues an Avoid recommendation for any fishery scored as a Very High Concern for either factor under Management (Criterion 3).
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Introduction
Scope of the Analysis and Ensuing Recommendation

The overall objective of this analysis is to assess wild salmon fisheries in the Northeast Pacific, particularly those that have not been certified as sustainable to the Marine Stewardship Council (MSC) standard. This report includes U.S. West Coast commercial salmon fisheries in and off the coasts of California, Oregon, and Washington. Columbia River commercial fisheries, both treaty and non-treaty, are included as well. Recommendations are made for five Pacific salmon species: Chinook salmon (*Oncorhynchus tshawytscha*), coho salmon (*O. kisutch*), chum salmon (*O. keta*), sockeye salmon (*O. nerka*), and pink salmon (*O. gorbuscha*).

Overview of the Species and Management Bodies

Chinook Salmon
Chinook salmon are the largest of the Pacific salmon species (*Oncorhynchus* spp.) and mature at the oldest ages. As with all Pacific salmon they are anadromous, spawning in freshwater but spending the majority of their lives in the ocean (Healey 1991). Like all salmon, maturing individuals ‘home’ back to their natal areas to spawn. In North America, Chinook salmon spawn in freshwater rivers draining into the Pacific Ocean from San Francisco Bay to western Alaska. They also spawn in Russian rivers from Chukotka to Kamchatka, but are less abundant there than in North America (Augerot 2005). Chinook salmon are often classified into two juvenile life history types: “stream-type” Chinook reside in freshwater for a year or more before migrating to the ocean; "ocean-type" Chinook migrate to the ocean within a year of emergence.

Coho Salmon
Coho salmon are an anadromous species of Pacific salmon that occurs at relatively low abundances in small populations (Sandercock 1991). In North America they spawn in rivers from central California to Alaska, with higher concentrations of fish occurring from central Oregon to western Alaska. In Asia, they occur mostly in Russia from the Anadyr River basin to Sakhalin (Augerot 2005). Juvenile coho typically rear in freshwater 1-2 years and utilize a wide range of freshwater habitats (Sandercock 1991). Nearly all coho return to spawn after 12-18 months at sea.

Chum Salmon
Chum salmon are the most widely distributed of the Pacific salmon species (Augerot 2005). They spawn as far north as the McKenzie River on the arctic coast of Canada and historically as far south as Monterey, California, but they currently occur only as far south as Tillamook Bay on the northern Oregon coast. In Asia, they are found in Korea, Japan, and the far north of Russia. Chum salmon do not rear in freshwater for extended periods, typically migrating to estuarine or
marine waters shortly after they hatch and emerge from gravel. They are one of the larger Pacific salmon species.

Sockeye Salmon
Sockeye salmon are a smaller species of Pacific salmon that typically rears in lakes for one to two years during the juvenile life stage. Sockeye show a high diversity of life history strategies, with fish spawning in streams, rivers, and on lake shores (Burgner 1991). Most sockeye are anadromous, but there is a non-anadromous form known as kokanee that spend their whole lives in freshwater. In North America, anadromous sockeye spawn from the Columbia River to Point Hope in northwestern Alaska. In Russia, they occur from the Anadyr River area of Siberia to the Kuril Islands (Augerot 2005). Sockeye typically spend two or three winters at sea.

Pink Salmon
Pink salmon are an anadromous species of Pacific salmon that are notable for their abundance and fixed age at maturity. Pink salmon are broadly distributed across the North Pacific, as their current spawning grounds range from Sakhalin and Kamchatka in Russia to the Columbia River in the United States (Augerot 2005). They are the most abundant of the Pacific salmon, especially at higher latitudes. Pink salmon have a fixed two-year lifespan, which results in minimal interbreeding between populations that spawn in odd and even years (Heard 1991). As a result, odd and even year pink salmon are often treated as separate stocks. Juveniles spend minimal time in freshwater before migrating to the ocean. Pink salmon have relatively high rates of straying, where individuals do not return to their natal sites to spawn (Quinn 2011).

Management Bodies
A variety of federal, state, and tribal authorities manage Pacific salmon fisheries on the U.S. West Coast. These include the Pacific Fishery Management Council (PFMC), the National Marine Fisheries Service (NMFS), the North Pacific Anadromous Fish Commission, the U.S.–Canadian Pacific Salmon Commission, state fisheries departments, and Native American tribes.

History of the Fisheries
Pacific salmon have long been an important food and cultural resource for Native American tribes and First Nations along the U.S. West Coast, with pre-industrial harvests in some regions (e.g., California) considerably greater than they are today. Despite the apparent plentitude of salmon runs, the U.S. was well aware of the factors that can endanger salmon populations at an early stage. In 1875, America’s first national Fish Commissioner, Spencer Baird, issued a report identifying habitat alteration, dam construction, and over-exploitation as factors with the potential to threaten salmon populations (Lichatowich et al. 1999). However, Baird believed each of these problems could be resolved through artificial propagation of fish. This untested belief paved the way to rampant loss of habitat, overfishing and the widespread construction of hatcheries. Harvests in rivers throughout the contiguous U.S. generally peaked between 1880
and 1920 and have gradually declined despite management efforts. It took nearly 100 years of declining salmon runs before managers began to take a critical look at hatcheries, but by then many salmon runs were already extinct. By the early 1990s, native salmon species had been extirpated from an estimated 40% of their native spawning territory in the region, and numerous populations had been listed as Threatened or Endangered under the U.S. Endangered Species Act (ESA). Negative impacts to wild salmon due to hatchery programs include the introduction of diseases, competition with naturally spawned fish, and alteration of genetic diversity through interbreeding, which may affect the fitness of subsequent generations (Naish et al. 2007). Today, Pacific salmon are one of the most intensively monitored and managed groups of fish in the world. Given their commercial importance as well as the ESA status of many stocks, considerable attention is devoted to assessing and maintaining stock abundance.

**Production Statistics**

According to North Pacific Anadromous Fish Commission statistical yearbooks, global production of Pacific salmon is on the order of 926,000 metric tonnes per year. Major producers include the United States (with the large majority of fish caught in Alaska), Canada, Russia, and Japan. Within the global context, lower U.S. West Coast salmon fisheries (Washington, Oregon, and California) are relatively small producers, having landed an annual average of 12,986 metric tonnes from 1998 to 2012 (NMFS 2014d). The productivities of the fisheries assessed in this report relative to U.S. and North American catches are shown in Table 1. Chinook salmon caught in the lower U.S. make up a significant portion (52%) of the total North American catch. The other Pacific salmon species comprise much smaller portions of the total North American catch (10% or less).
Table 1: Commercial catches (in numbers of fish) and proportions of total catches (lower U.S., total U.S., and North America), by species, for the fisheries assessed in this report. The lower U.S. catch includes only catches from Washington, Oregon, and California, while the total U.S. catch also includes Alaska catches. The North America catch combines U.S. and Canada catches. Annual data were obtained from the North Pacific Anadromous Fish Commission and were averaged over the past fifteen years (1999-2013).

<table>
<thead>
<tr>
<th>Area</th>
<th>Species</th>
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<th>% US + AK catch</th>
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Within Washington, Oregon, and California, commercial catches of Pacific salmon have been variable. The following figures show the majority of total commercial catches for these states but do not include recreational, tribal, and freshwater fisheries (Irvine et al. 2012). Chinook catches have increased following an especially low catch in 2008, while coho catches have been fairly stable (Fig. 1). Sockeye catches have been low in recent years, chum catches have increased slightly, and pink catches have been quite high since 2009 (Fig. 2).
Importance to the US/North American Market
The U.S. imported 280,680 tonnes of salmon products in 2013, with farmed Atlantic salmon making up over 99% of imports (NMFS 2013). Imports have come mostly from Chile, followed by Canada, China, and Norway. China is primarily a processor rather than a producer, so much
of the product imported from China was produced by other countries, including the U.S. In 2013 the U.S. exported 186,023 tons of salmon valued at 620 million dollars (NMFS 2013). Salmon caught in the U.S. are exported to Japan, the European Union, and to China. The fish exported to China are mostly reprocessed and then sold to markets in the U.S. and European Union.

U.S. imports of Pacific salmon have fluctuated over time but were at a record high in 2013, with particularly large imports of sockeye and pink salmon (Fig. 3).

![Figure 3: U.S. imports of Pacific salmon over time, by species. Data are in metric tons and are from the National Marine Fisheries Service Commercial Fisheries Statistics Division (http://www.st.nmfs.noaa.gov/commercial-fisheries/).](image)

**Common and Market Names**

Chinook salmon: king salmon, spring salmon
Coho salmon: silver salmon, medium red salmon
Chum salmon: keta salmon, dog salmon
Sockeye salmon: blueback salmon, red salmon
Pink salmon: humpback salmon
Primary Product Forms

Chinook salmon: fillets, steaks, and whole fish (fresh and frozen), canned, smoked, dried, salted, roe
Coho salmon: fillets and whole fish (fresh and frozen), canned, smoked, dried, salted, roe
Chum salmon: mostly canned but also sold as fillets (fresh and frozen), dried-salted, smoked, roe
Sockeye salmon: fillets, steaks, and whole fish (fresh and frozen), canned, smoked, dried, salted, roe
Pink salmon: mostly canned but also sold as fillets (fresh and frozen), dried-salted, smoked, roe
Assessment
This section assesses the sustainability of the fishery(s) relative to the Seafood Watch Criteria for Fisheries, available at http://www.seafoodwatch.org.

Criterion 1: Stock for which you want a recommendation
This criterion evaluates the impact of fishing mortality on the species, given its current abundance. The inherent vulnerability to fishing rating influences how abundance is scored, when abundance is unknown. The final Criterion 1 score is determined by taking the geometric mean of the abundance and fishing mortality scores. The Criterion 1 rating is determined as follows:

- Score >3.2=Green or Low Concern
- Score >2.2 and <=3.2=Yellow or Moderate Concern
- Score <=2.2=Red or High Concern
  Rating is Critical if Factor 1.3 (Fishing Mortality) is Critical.

Criterion 1 Summary

<table>
<thead>
<tr>
<th>CHINOOK SALMON</th>
<th>Region / Method</th>
<th>Inherent Vulnerability</th>
<th>Abundance</th>
<th>Fishing Mortality</th>
<th>Subscore</th>
</tr>
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<td>Puget Sound</td>
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<tr>
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<tr>
<td>Region / Method</td>
<td>Inherent Vulnerability</td>
<td>Abundance</td>
<td>Fishing Mortality</td>
<td>Subscore</td>
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**COHO SALMON**

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<th>Subscore</th>
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**PINK SALMON**

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**SOCKEYE SALMON**

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</table>
Columbia River Gillnet, Drift–sockeye  
3.00:Low Concern  3.00:Moderate Concern  3.67:Low Concern  Green (3.318)

Puget Sound Gillnet, Drift–sockeye  
3.00:Low Concern  4.00:Low Concern  3.67:Low Concern  Green (3.831)

Puget Sound Purse seine–sockeye  
3.00:Low Concern  4.00:Low Concern  3.67:Low Concern  Green (3.831)

Washington North Pacific Gillnet, Drift–sockeye  
3.00:Low Concern  4.00:Low Concern  3.67:Low Concern  Green (3.831)

Criterion 1 Assessment

CHINOOK SALMON

Factor 1.1–Inherent Vulnerability

Scoring Guidelines

- **Low**—The FishBase vulnerability score for species is 0-35, OR species exhibits life history characteristics that make it resilient to fishing, (e.g., early maturing).
- **Medium**—The FishBase vulnerability score for species is 36-55, OR species exhibits life history characteristics that make it neither particularly vulnerable nor resilient to fishing, (e.g., moderate age at sexual maturity (5-15 years), moderate maximum age (10-25 years), moderate maximum size, and middle of food chain).
- **High**—The FishBase vulnerability score for species is 56-100, OR species exhibits life history characteristics that make is particularly vulnerable to fishing, (e.g., long-lived (>25 years), late maturing (>15 years), low reproduction rate, large body size, and top-predator).

Note: The FishBase vulnerability scores is an index of the inherent vulnerability of marine fishes to fishing based on life history parameters: maximum length, age at first maturity, longevity, growth rate, natural mortality rate, fecundity, spatial behaviors (e.g., schooling, aggregating for breeding, or consistently returning to the same sites for feeding or reproduction) and geographic range.

Columbia River, Gillnet, Drift–Chinook
Klamath River, Gillnet, Drift–Chinook
Puget Sound, Gillnet, Drift–Chinook
Puget Sound, Purse Seine–Chinook
Puget Sound, Trolling Lines–Chinook
Cape Falcon to Humbug Mt. North Pacific, Trolling Lines–Chinook
The FishBase vulnerability score for Chinook salmon is 68, which corresponds to high inherent vulnerability. However, productivity susceptibility analysis (PSA) suggests moderate vulnerability based on attributes including age at maturity, maximum size, reproductive strategy, and trophic level (see Table 2 for estimates used). We rated inherent vulnerability as 'Medium.'

Rationale
The FishBase score is based on life history traits and ecological characteristics including maximum length, age at first maturity, and geographic range (Cheung et al. 2005). Data used for the productivity susceptibility analysis were obtained from Fishbase.org and are shown in Table 2.

<table>
<thead>
<tr>
<th>Factor 1.2–Abundance</th>
</tr>
</thead>
</table>

Scoring Guidelines

- 5 (Very Low Concern)—All major stocks encountered in the fishery are healthy and exceed management targets over 75% of the time.
- 4 (Low Concern)—Majority of major stocks (>75%) encountered are healthy and exceed management targets over 50% of the time, and no major stocks are listed as threatened or endangered.
- 3 (Moderate Concern) —Abundance of majority of major stocks (>50%) encountered is unknown relative to management goals, or most of major stocks (>50%) encountered are healthy and exceed management targets over 50% of the time.
• 2 (High Concern)—Most of the major stocks (>50%) encountered are failing to meet management targets 50-74% of the time, but are not listed as endangered or threatened.

• 1 (Very High Concern)—One or more major stock is listed as threatened or endangered by a national or international body, or the majority (>75%) of major stocks encountered are failing to meet management targets 75% of the time.

**Horse Mt. to U.S./Mexico Border North Pacific, Trolling Lines—Chinook**

**Moderate Concern**

California Central Valley Chinook stocks, particularly Central Valley Fall (CVF) Chinook, are important contributors to fisheries throughout this area, and Southern Oregon/Northern California (SONCC) Chinook stocks contribute to fisheries in the northern part of this area (PFMC 2011). The indicator stock for the Central Valley Fall (CVF) Chinook has met escapement goals in 67% of the past fifteen years (1999 to 2013) (PFMC 2014a), and the SONCC indicator stock has met natural spawning escapement goals in 60% of the past fifteen years (PFMC 2014a). However, because escapement monitoring and goals do not distinguish between wild and hatchery-origin fish, abundance for this fishery is of 'Moderate Concern.'

**Rationale**

Sacramento River Fall (SRF) Chinook is the indicator stock for Central Valley Fall Chinook, while Klamath River Fall (KRF) Chinook is the indicator stock for Southern Oregon/Northern California Chinook. SRF Chinook is primarily a hatchery stock, and escapement monitoring does not distinguish between hatchery and wild fish (PFMC 2011). Management targets for Sacramento and Klamath River fall Chinook have varied over the past fifteen years, but when evaluating abundances, we compared escapement counts against the lower escapement goals (122,000 fish for Sacramento and 40,700 fish for Klamath), which are based on spawning abundance at maximum sustainable yield (SMSY). The lower escapement goal for SRF Chinook was met in 67% of the past fifteen years (1999-2013), with low escapements from 2007 to 2011 followed by two years of high escapements (Fig. 5) (PFMC 2014a). The lower escapement goal for KRF Chinook was met in 60% of the past fifteen years, with a period of low escapements from 2004 to 2006 (Fig. 6). The escapement goal was exceeded in both 2012 and 2013 (PFMC 2014a). Escapement goals for both stocks are for naturally spawning fish, which include hatchery-origin fish. There are significant hatchery programs for both of these stocks. One study estimated that 90% of the Chinook salmon caught off the California Coast were of hatchery-origin (Barnett-Johnson et al. 2007). Proportions of hatchery-origin salmon in escapements to natural spawning areas in California have been estimated, and they vary from 0 to 90% (Palmer-Zwahlen and Kormos 2013) (Austing and Null 2013).
Figure 5: Sacramento River fall Chinook escapements to natural areas (blue line) relative to the lower escapement target ($S_{\text{MSY}}$) of 122,000 fish (black line). The escapement counts and target include both hatchery and natural-origin fish. Data from the Pacific Fishery Management Council.

Figure 6: Klamath River Fall Chinook escapements (blue line) relative to the escapement target ($S_{\text{MSY}}$) of 40,700 fish (black line). The escapement counts and target are for salmon spawning in natural areas in both the Klamath and Trinity rivers, but may include both hatchery and natural-origin fish. Data from the Pacific Fishery Management Council.
Puget Sound, Gillnet, Drift—Chinook

Very High Concern

The Puget Sound Chinook salmon fishery targets primarily hatchery Chinook while attempting to minimize bycatch of natural-origin ESA-listed (threatened) stocks. Many of the hatchery stocks are also protected by ESA because they are deemed necessary for rebuilding. The abundance factor receives a ‘Very High conservation concern’ because more than 5% of the harvested Chinook likely includes Chinook listed as threatened, and many of the monitored stock components were not consistently meeting the Lower Abundance Threshold, especially those stocks having goals based on natural-origin returns. (Puget Sound Indian Tribes and the Washington Department of Fish and Wildlife 2010, WDFW & PSTIT 2013, PSC 2012, Ford et al. 2011).

Rationale

The Puget Sound Chinook evolutionarily significant unit (ESU) includes 22 extant populations originating in 12 river basins, plus 26 artificial production programs. Abundance and productivity of Puget Sound Chinook populations is currently between 10% and 25% of historical levels (Puget Sound Indian Tribes and the Washington Department of Fish and Wildlife. 2010.). Puget Sound Chinook were listed as a threatened species in 1999, and that status was reaffirmed in 2005. Spawning escapement of Chinook is monitored annually in most watersheds using a variety of methods, expansions, and assumptions. Estimates of hatchery fish on the spawning grounds have often been documented in recent years. Upper management thresholds (approximate maximum sustainable yield (MSY) escapement) and lower abundance thresholds (set well above the level that might cause population instability) have been established in most watersheds, although only three watersheds have goals specifically for natural-origin (NOR) spawners (excluding hatchery fish). Watersheds with NOR spawner goals typically have not met the lower threshold during the most recent 15 years for which data are available (Puget Sound Indian Tribes and the Washington Department of Fish and Wildlife 2010.). Some watersheds and hatcheries have an integrated production strategy whereby hatchery fish are intended to spawn in the wild. The ability to meet the total spawner goals (natural and hatchery spawners combined) was mixed: five of the eleven watersheds exceeded the lower threshold only 20% of the years. The upper management goal was met in a few of the watersheds, i.e., those where counts include both natural and hatchery-origin fish. Regarding spawning escapement trends, the managers state: “Of the 22 Chinook populations comprising the Puget Sound ESU, 14 exhibit positive escapement trends over the past fifteen years (1994 – 2008), all but one trend is biologically significant. Five populations exhibit negative trends, but none are significant. Trends for three populations were not assessed because they lack a 15-year time series of escapement estimates.” These trends apparently included both natural and hatchery-origin spawners, therefore it is difficult to evaluate the status of the natural component. Comparison of the spawning thresholds with spawning observations was not straightforward. The evaluation required comparison of multiple tables throughout the management document.

NOAA Fisheries concluded during its recent review: “All Puget Sound Chinook populations are well below
the TRT planning range for recovery escapement levels. Most populations are also consistently below the spawner recruit levels identified by the TRT as consistent with recovery. Across the ESU, most populations have declined in abundance somewhat since the last status review in 2005, and trends since 1995 are mostly flat. Several of the risk factors identified in the 2005 assessment are also still present, including high fractions of hatchery fish in many populations and widespread loss and degradation of habitat.” (Ford et al. 2011). During 2008-2012, approximately 27% of the natural Skagit River stock was harvested in Puget Sound commercial fisheries (PFMC 2014a).

In summary, the Puget Sound Chinook salmon fishery targets primarily hatchery Chinook while attempting to minimize bycatch of ESA-threatened stocks which also include the hatchery stocks that are deemed necessary for rebuilding. The abundance factor is scored as a ‘Very High’ conservation concern because more than 5% of the harvested fish likely include Chinook listed as threatened (Ford et al. 2011). Escapements of natural-origin Puget Sound Chinook have been low but somewhat stable (Fig. 4).

Figure 4: Total natural-origin returns of Chinook to Puget Sound in return years representing total return (before any harvest and brood stock take), terminal return (before terminal harvest and broodstock take), and natural-origin spawners to the spawning grounds (Esc).

Humbug Mt. to Horse Mt. North Pacific, Trolling Lines–Chinook

Moderate Concern

This area is referred to as the Klamath Management Zone (KMZ). The KMZ was created to focus
management on Klamath River Fall (KRF) Chinook because ocean fishery impacts on this stock occur primarily in this area. Other major contributing stocks include Sacramento River fall (SRF) Chinook and Southern Oregon/Northern California Coast (SONCC) Chinook. The SRF Chinook stock has met escapement goals in 67% of the past fifteen years (1999-2013), and the KRF Chinook stock (which serves as the indicator stock for both KRF and SONCC Chinook) has met escapement goals in 60% of the past fifteen years (PFMC 2014a). However, there is substantial hatchery production in both the Sacramento and Klamath River systems, and both natural and hatchery-origin fish on the spawning grounds are counted in 'natural' escapements. Abundance for this fishery is of 'Moderate Concern' because although escapement goals for indicator stocks are being met more than 50% of the time, escapement monitoring does not differentiate between wild and hatchery-origin fish.

Rationale
Management targets for KRF and SRF Chinook have varied over the past fifteen years, but when evaluating abundances, we compared escapement counts against the lower escapement goals, which are based on SMSY. For Sacramento River fall Chinook, the lower escapement goal of 122,000 fish was met in 67% of the past fifteen years (1999-2013), with low escapements from 2007 to 2011 followed by two years of high escapements (Fig. 5)(PFMC 2014a). Klamath River fall Chinook is the indicator stock for both KRF and SONCC Chinook. The escapement goal of 40,700 fish on the natural spawning grounds was met in 60% of the past fifteen years, with a period of low escapements from 2004 to 2006 (Fig. 6). The escapement goal was exceeded in both 2012 and 2013 (PFMC 2014a). There are significant hatchery programs for both of these stocks. One study estimated that 90% of the Chinook salmon caught off the California Coast were of hatchery-origin (Barnett-Johnson et al. 2007). Proportions of hatchery-origin Chinook salmon in escapements to natural spawning areas in California have been estimated, and they vary from 0% to 90% (Palmer-Zwahlen and Kormos 2013)(Austing and Null 2013).
target \(S_{\text{MSY}}\) of 122,000 fish (black line). The escapement counts and target include both hatchery and natural-origin fish. Data from the Pacific Fishery Management Council.

![Klamath River escapements](image)

**Figure 6:** Klamath River Fall Chinook escapements (blue line) relative to the escapement target \(S_{\text{MSY}}\) of 40,700 fish (black line). The escapement counts and target are for salmon spawning in natural areas in both the Klamath and Trinity rivers, but may include both hatchery and natural-origin fish. Data from the Pacific Fishery Management Council.

**North of Cape Falcon North Pacific, Trolling Lines–Chinook**

**Moderate Concern**

Fisheries in this management area are heavily dependent on the production of tule fall Chinook from Columbia River hatcheries, which can comprise over half of the catch in a typical year. Other stocks that contribute significant proportions to catches include Upper Columbia River summer and “bright” fall Chinook, and in some years, Sacramento River fall Chinook (PFMC 2011). Hatchery-produced Columbia River tule fall Chinook will not be evaluated for this factor because they are a hatchery stock. Upper Columbia River summer and bright fall Chinook met their respective escapement goals in all of the past fifteen years (1999-2013), and the Columbia Lower River Wild (LRW) indicator stock met its escapement goal for 87% of the past fifteen years (1999 to 2013). The Sacramento River fall Chinook stock met its escapement goal in 67% of the past fifteen years (PFMC 2014a). However, escapement counts for all of these stocks include hatchery-origin fish spawning in natural spawning areas. Thus even though the majority of natural stocks exceeded management goals more than 50% of the time, conservation concern was deemed ‘Moderate.’

**Rationale**
These stocks are managed as composite stocks, with escapement counts and goals including both hatchery-origin and wild salmon. The Columbia Lower River natural escapement goal is 5,700 spawners in the North Lewis River. The interim escapement goal for Upper Columbia River summer Chinook is 20,000 fish upstream of Priest Rapids Dam. This escapement goal is currently under review, in part because the Chief Joseph Hatchery became operational in 2013 (Joint Columbia River Management Staff 2014b). The escapement goal for Upper Columbia River summer Chinook was 40,000 to 45,000 fish above McNary Dam, plus enough fish to meet treaty obligations until 2011, when a goal of 60,000 fish was set. Management targets for Sacramento River fall Chinook have varied over the past fifteen years, but when evaluating abundances, we compared escapement counts against the lower escapement goal, which is based on $S_{MSY}$. For Sacramento River fall Chinook, the lower escapement goal of 122,000 fish was met in 67% of the past fifteen years (1999-2013), with low escapements from 2007 to 2011 followed by two years of high escapements (PFMC 2014a).

### Cape Falcon to Humbug Mt. North Pacific, Trolling Lines—Chinook

#### High Concern

Southern Oregon Coast Chinook (south migrating/local stocks and the Upmqua River spring stock), Central Valley River Chinook, and Klamath River fall Chinook stocks contribute substantially to fisheries in this area (PFMC 2011). Southern Oregon Coast Chinook escapement goals were met in 20% of the past fifteen years (1999 to 2013) for fall stocks and 0% of the years from 1998 to 2012 for the two spring stocks (PFMC 2014a). The indicator stock for Central Valley River Chinook (Sacramento River fall Chinook) met its escapement goal in 67% of the past fifteen years (1999-2013), and Klamath River fall Chinook met its escapement goal in 60% of those years (PFMC 2014a). The escapement goal for Klamath River fall Chinook is for 'natural' fish, but escapement counts include hatchery-origin fish spawning in natural habitat. Southern Oregon Coast Chinook escapements were reportedly for naturally produced fish, though supporting data were not found. Abundance for this fishery is of 'High Concern' because more than 50% of stocks have not been meeting escapement goals, and escapement monitoring does not always differentiate between wild and hatchery fish.

#### Rationale

Escapement goals for south migrating Oregon coastal fall and spring Chinook are expressed in terms of the geometric mean of individual index counts (number of adults per mile), and the goal of 60 to 90 adults per mile is the same for each stock or stock index. The south migrating Oregon coastal fall Chinook index (Deep Creek, Big Emily Creek, and Bear Creek combined) exceeded this goal in only three of past fifteen years (1999-2013), and spring Chinook stocks (Rogue River and Upmqua River) never met this goal based on the fifteen most recent years of data (PFMC 2014a). Management targets for Sacramento and Klamath River fall Chinook have varied over the past fifteen years, but when evaluating abundances, we compared escapement counts against the lower escapement goals, which are equivalent to $S_{MSY}$. Sacramento River fall Chinook is primarily a hatchery stock. The lower escapement goal of 122,000 fish was met in 67% of the past fifteen years (1999-2013), with low escapements from
2007 to 2011 followed by two years of high escapements (Fig. 5) (PFMC 2014a). For Klamath River fall Chinook, the escapement goal of 40,700 fish was met in 60% of the past fifteen years, with a period of low escapements from 2004 to 2006 (Fig. 6). The escapement goal was exceeded in both 2012 and 2013 (PFMC 2014a). Proportions of hatchery-origin salmon in escapements to natural spawning areas have been estimated, and they vary from 0 to 90% (Palmer-Zwahlen and Kormos 2013) (Austing and Null 2013).
Figure 6: Klamath River Fall Chinook escapements (blue line) relative to the escapement target ($S_{\text{MSY}}$) of 40,700 fish (black line). The escapement counts and target are for salmon spawning in natural areas in both the Klamath and Trinity rivers, but may include both hatchery and natural-origin fish. Data from the Pacific Fishery Management Council.

**Washington North Pacific, Gillnet, Drift–Chinook**

**Moderate Concern**

There are eight Washington coastal Chinook stocks caught in this fishery: 1. Willapa Bay, 2. Grays Harbor, 3. Queets River spring, 4. Queets River fall, 5. Hoh River spring/summer, 6. Hoh River fall, 7. Quillayute River spring/summer, and 8. Quillayute River fall. All of these stocks have escapement goals for naturally spawning fish and four of the eight stocks met their escapement goals for more than 50% of the past 15 years (PFMC 2014a). The stocks that have not been meeting their escapement goals in the majority of years have escapements fluctuating near the goal. Additionally, the Willapa Bay fall, Grays Harbor fall, Grays Harbor spring, Queets River fall, Hoh River fall, Hoh River spring/summer, Quillayute River fall, and Quillayute River spring/summer Chinook stocks have not exceeded 'overfished' limit reference points (minimum stock size threshold) based on escapement data from 2011 to 2013 (PFMC 2014a). However, ‘natural’ escapement counts for some stocks, such as Grays Harbor Chinook, explicitly include or may include hatchery-origin fish spawning in natural areas. Thus conservation concern was deemed ‘Moderate.’

**Rationale**

Washington coastal Chinook stocks include all fall, summer, and spring stocks from coastal streams north of the Columbia River through the western Strait of Juan de Fuca. Escapement targets were generally set by the Washington Department of Fish and Wildlife and treaty Indian tribes and recognized in the PFMC Salmon Fishery Management Plan. Of the eight Washington coastal stocks, only the Willapa Bay fall Chinook stock has estimated natural escapements that were assumed to be derived from natural-origin parents (PFMC 2014a), but it is unclear how natural-origin fish are counted. Escapements to other streams likely include an unknown fraction of hatchery-origin Chinook.

The minimum stock size threshold (MSST) is a biomass level set below the level corresponding to maximum sustainable yield (MSY) to allow for fluctuations in abundance while maintaining the capability to produce MSY on a continuing basis. A stock is considered overfished if the 3-year geometric mean spawning escapement is less than MSST (PFMC 2014a).

**Klamath River, Gillnet, Drift–Chinook**

**Moderate Concern**

The Klamath River commercial salmon fishery targets spring- and fall-run Chinook salmon returning to the Klamath basin (including the Trinity River). Klamath River Fall (KRF) Chinook salmon is the indicator
stock and has met the maximum sustained yield spawning ($S_{MSY}$) target for natural spawning fish (including hatchery-origin fish spawning in natural areas) in 60% of the past fifteen years (PFMC 2014a). Abundance for this fishery is of 'Moderate Concern' because the $S_{MSY}$ target and monitoring does not differentiate between wild and hatchery-origin fish.

**Rationale**

Klamath River Chinook include spring- and fall-run fish of natural- and hatchery-origin (Williams et al. 2013). Klamath River Chinook stocks are not classified as “Endangered” or “Threatened.” KRF Chinook is the indicator stock for natural and hatchery stocks south of the Elk River, Oregon to (and including) the Klamath River, plus Umpqua River spring Chinook. The KRF $S_{MSY}$ target of 40,700 naturally spawning fish (including hatchery-origin fish) was met in 60% of the past fifteen years, with a period of low escapements from 2004 to 2006. The $S_{MSY}$ target was exceeded in both 2012 and 2013 (PFMC 2014a). However, management objectives and limits are set annually using a control rule that depends on the preseason abundance forecast (PFMC 2014e). As a result, the escapement objective can be set greater or less than $S_{MSY}$ depending on the abundance forecast. Historically, the spring-run was much larger and likely the dominant run, but habitat loss due to dams and other anthropogenic activities has reduced the spring-run to a few tributaries and hatcheries. Spring-run escapement is monitored only at a few index sites in the basin. These indices suggest that spring-run escapements are highly variable but have likely not declined since the early 1980s (Williams et al. 2013). The effect of Klamath hatchery programs on the natural Chinook population is not well understood but is thought to be significant. According to the Regional Mark Processing Center (RMPC), about 8.3 million fall-run and 1.2 million spring-run hatchery Chinook are released in the Klamath/Trinity basin each year. On average, hatchery-origin fish were estimated to represent 23% of the naturally spawning fall Chinook in the Klamath River (from Iron Gate Hatchery down to the Shasta River) (CHSRG 2012c) and 46% of those in the Trinity River (upstream of the Junction City weir) (CHSRG 2012d). The uncertainty of estimates of the hatchery-origin fish in the Klamath River was considered large because, until recently, the Iron Gate Hatchery did not mark their releases, or had marked them at very low rates (Williams et al. 2013).

**Puget Sound, Purse Seine–Chinook**

**Very High Concern**

The Puget Sound Chinook salmon seine fishery primarily targets other salmon species while minimizing bycatch of natural-origin ESA-threatened stocks. Many of the Chinook hatchery stocks are protected by ESA because they are deemed necessary for rebuilding. The purse seine fishery is often required to live-release all Chinook salmon prior to October 20, except in Area 7B near the Nooksack River (WDFW 2013). According to the Pacific Fishery Management Council, approximately 40% of the Chinook salmon harvested in the Nooksack/Samish area (purse seine and gillnet) are natural-origin fish; therefore, they are considered a major component of the catch. The Nooksack stock is not meeting its lower abundance threshold of 1,000 Chinook (WDFW & PSTIT 2013)(PSIT/WDFW 2013). Therefore, the abundance factor for the purse seine fishery is scored as a ‘Very High Concern.’
Rationale

The Puget Sound Chinook ESU includes 22 extant populations originating in 12 river basins, plus 26 artificial production programs. Abundance and productivity of Puget Sound Chinook populations is currently between 10% and 25% of historical levels (Puget Sound Indian Tribes and the Washington Department of Fish and Wildlife 2010). Puget Sound Chinook were listed as a threatened species in 1999, and that status was reaffirmed in 2005. Spawning escapement of Chinook is monitored annually in most watersheds using a variety of methods, expansions, and assumptions. Estimates of hatchery fish on the spawning grounds have often been documented in recent years. Upper management thresholds (approximate MSY escapement) and lower abundance thresholds (set well above the level that might cause population instability) have been established in most watersheds, although only three watersheds have goals that specify natural-origin (NOR) spawners (excluding hatchery fish). Watersheds with NOR spawner goals typically have not met the lower threshold during the recent 15 years or when data were available (Puget Sound Indian Tribes and the Washington Department of Fish and Wildlife 2010). Some watersheds and hatcheries have an integrated production strategy whereby hatchery fish are intended to spawn in the wild. The ability to meet the total spawner goals (natural and hatchery spawners combined) was mixed: five of the eleven watersheds only met the lower threshold in 20% of years. The upper management goal was met in a few of the watersheds, i.e., those where counts include both natural and hatchery-origin fish. Regarding spawning escapement trends, the managers state: “Of the 22 Chinook populations comprising the Puget Sound ESU, 14 exhibit positive escapement trends over the past fifteen years (1994 – 2008), all but one trend is biologically significant. Five populations exhibit negative trends, but none are significant. Trends for three populations were not assessed because they lack a 15-year time series of escapement estimates.” These trends apparently included both natural and hatchery-origin spawners, therefore it is difficult to evaluate the status of the natural component. Comparison of the spawning thresholds with spawning observations was not straightforward. The evaluation required comparison of multiple tables throughout the management document.

NOAA Fisheries concluded during its recent review: “All Puget Sound Chinook populations are well below the TRT planning range for recovery escapement levels. Most populations are also consistently below the spawner recruit levels identified by the TRT as consistent with recovery. Across the ESU, most populations have declined in abundance somewhat since the last status review in 2005, and trends since 1995 are mostly flat. Several of the risk factors identified in the 2005 assessment are also still present, including high fractions of hatchery fish in many populations and widespread loss and degradation of habitat.” (Ford et al. 2010a).

In summary, the Puget Sound Chinook salmon fishery primarily targets hatchery Chinook while attempting to minimize bycatch of ESA-threatened stocks which also include the hatchery stocks that are deemed necessary for rebuilding. The abundance factor is scored as a ‘Very High’ conservation concern because some of the harvested stock is listed as threatened and many of the monitored stock components were not consistently meeting the lower abundance threshold, especially those stocks
having goals based on natural-origin returns (Ford et al. 2010a).

Puget Sound, Trolling Lines–Chinook

**Very High Concern**

The Puget Sound troll fishery occurs in the Strait of Juan de Fuca and is relatively small. Chinook salmon captured in this fishery originate from a variety of rivers. Stock composition of this catch was not readily available for recent years, but genetic data collected in previous years indicate that most Chinook are destined for the Columbia River and Puget Sound (CDFO/NMFS/WDFW 1988). The contribution of Puget Sound Chinook increases to the east, but most troll catch is taken in the western portion of the Strait of Juan de Fuca. All natural and some hatchery Chinook in Puget Sound are ESA listed. Many Chinook returning to the Columbia are ESA listed although a large fraction of the fall run is natural and robust (Upriver bright). This fishery does not attempt to live-release unmarked Chinook. We assume that 5% or more of the catch involves ESA listed Chinook, therefore the concern is judged to be ‘Very High.’

Columbia River, Gillnet, Drift–Chinook

**Moderate Concern**

The Columbia River fisheries considered here include non-treaty and treaty (tribal) commercial fisheries as well as fisheries below and above Bonneville Dam. Columbia River fisheries harvest fish from about fourteen Chinook salmon stocks, many of which include hatchery-produced fish. The Mid-Columbia River spring, Upper Columbia River summer (UCS) and Upper Columbia River fall (Upriver Bright, URB) ESUs are the only non-ESA-listed Chinook stocks in the Columbia Basin. Escapement goals have been established for the UCS and URB stocks (20,000 fish above Priest Rapids Dam for UCS Chinook and 60,000 fish above McNary Dam for URB Chinook). The UCS goal has been met 100%, and the URB goal over 75%, of the fifteen years from 1999 to 2013 (PFMC 2014a), but the goals are for natural and hatchery-origin fish combined (Joint Columbia River Management Staff 2014a)(Joint Columbia River Management Staff 2014b). Thus we rated conservation concern as ‘Moderate.’

Rationale

Fall Chinook stocks include Lower River Hatchery tule, Lower River Wild fall, Bonneville Pool Hatchery, Upriver Bright, Mid-Columbia Bright, and Select Area Bright Chinook (Joint Columbia River Management Staff 2014a). Spring Chinook stocks include Willamette River Spring, Clackamas River Spring, Sandy River Spring, Washington Lower River Spring, Select Area Spring, and Upriver Spring Chinook. The one summer stock is Upper Columbia River summer Chinook (the Snake River summer run is included in the Upriver Spring Chinook evolutionarily significant unit) (Joint Columbia River Management Staff 2014b). Some of these stocks, such as Lower River Wild fall and spring Chinook, are assessed under Criterion 2
due to their status as ESA-listed stocks. Most of the catch consists of robust natural-origin fall Chinook (e.g., Hanford Reach stock) and hatchery-produced Chinook, and no ESA-listed stocks (ESUs) constitute more than 5% of landings (Joint Columbia River Management Staff 2015b). Based on a study using data from coded wire tags, the proportion of hatchery fish in Upriver Bright fall Chinook escapements may be around 30% in some areas (Evenson et al. 2002). The current Upriver Bright escapement target is 60,000 fish, but prior to 2008 the target was 40,000 fish plus sufficient fish for meeting treaty Indian obligations.

Factor 1.3–Fishing Mortality

Scoring Guidelines

5 (Very Low Concern)—Highly likely that fishing mortality is below a sustainable level (e.g., below fishing mortality at maximum sustainable yield, FMSY), OR fishery does not target species and its contribution to the mortality of species is negligible (≤ 5% of a sustainable level of fishing mortality).

3.67 (Low Concern)—Probable (>50%) chance that fishing mortality is at or below a sustainable level, but some uncertainty exists, OR the majority (>75%) of major stocks encountered in the fishery exhibit population trends that are increasing or stable in the short and long term due to management AND all stocks which exhibit decline do not exceed a 5% annual decrease in abundance.

2.33 (Moderate Concern)—Fishing mortality is fluctuating around sustainable levels, OR fishing mortality is unknown but for any depleted population effective management is in place OR most (>50%) of the major stocks encountered exhibit population trends that are increasing or stable in the short and long term AND all stocks which exhibit decline do not exceed a 5% annual decrease in abundance.

1 (High Concern)—Overfishing is occurring, but management is in place to curtail overfishing, OR fishing mortality is unknown, species is depleted, and no effective management is in place OR most (>50%) major stocks encountered in the fishery are exhibiting declines in abundance.

0 (Critical)—Overfishing is known to be occurring and no reasonable management is in place to curtail overfishing.

Horse Mt. to U.S./Mexico Border North Pacific, Trolling Lines–Chinook

Moderate Concern

Major stocks in this fishery include Central Valley fall (CVF) Chinook and Southern Oregon/Northern California Coast (SONCC) Chinook. Both of these stocks include large hatchery programs which can sustain relatively high harvest rates compared to wild stocks. The indicator stock for Central Valley River fall Chinook is Sacramento River fall Chinook, while the indicator stock for SONCC Chinook is Klamath
River fall Chinook. Total exploitation rates on the Sacramento and Klamath River fall Chinook stocks were estimated from 2011 to 2015, and they did not exceed the maximum fishing mortality threshold (78% for Sacramento, 71% for Klamath) (PFMC 2015a). Thus overfishing did not occur, and escapements for these stocks do not appear to be declining (Figs. 5, 6, 9). However, the exploitation rates on the natural-origin stock components are unknown and may be too high to maintain the populations without hatchery supplementation. Additionally, ocean harvests of Chinook are substantial in this region, with over 150,000 fish landed each year since 2012 (PFMC 2014a). Conservation concern regarding fishing mortality was rated ‘Moderate.’

**Rationale**

According to the PFMC, a stock experiences overfishing if the total annual exploitation rate exceeds the maximum fishing mortality threshold, which is based on the maximum sustainable yield exploitation rate ($F_{MSY}$) (PFMC 2015a).

The proportion of hatchery-origin Chinook salmon caught off the California Coast was estimated to be 90% (Barnett-Johnson et al. 2007). The primary stock harvested in this area is Sacramento River fall Chinook (SRFC). Proportions of hatchery-origin Chinook salmon in escapements to natural spawning areas in California have been estimated, and they vary from 0% to 90% (Palmer-Zwahlen and Kormos 2013)(Austing and Null 2013). Hatchery stocks can withstand higher harvest rates than wild stocks due to enhanced fertilization and survival of eggs. SRFC harvest rates ranged from 44% to 87% until the stock collapsed in 2007 and California fisheries were closed (Fig. 10)(PFMC 2014d).

![Figure 10](image)

*Figure 10: Estimated total harvest rate on Sacramento River fall Chinook salmon, 1983-2013. Data taken from Table II-1 PFMC 2014d.*
Puget Sound, Gillnet, Drift–Chinook

High Concern

Fisheries management has improved during the past 10-20 years, in response to the ESA-listing of Puget Sound Chinook salmon. Monitoring of fishery impacts has improved, and relative proportions of hatchery and natural-origin fish are often estimated on the spawning grounds. Co-managers indicate that the escapement trends (hatchery plus natural) have been increasing over time, whereas NOAA Fisheries reported that the escapement of natural-origin returns (NOR) declined from 32,794 Chinook during 2000-2004 to 25,848 Chinook during 2005-2009 (the most recent period available in the report). The estimated recent overall harvest rate of 42% on an ESA-listed population is high (Ford et al. 2011), especially for the natural-origin component. Although the NMFS Biological Opinion on the Pacific Salmon Treaty fisheries concludes that the fisheries would not cause jeopardy to the Puget Sound Chinook ESU, the fisheries are still having an adverse impact (NMFS 2008). The Fishing Mortality factor is judged to be a ‘High Concern’ based on this information. The score does not warrant a critical concern because co-managers are actively managing the fishery, significant improvements have been made over time, some data suggest very low exploitation rates on some natural stocks (<5%)(PSC 2012), and managers have implemented programs to monitor progress against goals.

Rationale

The Chinook Harvest Management Plan (Plan) establishes management guidelines for annual harvest regimes (WDFW 2010). In each catch area, harvest is focused on the target species or stock according to its migration timing through that area. Chinook-directed commercial fisheries are of limited scope and most are directed at abundant hatchery production in terminal areas. Total exploitation rates for each of the 22 Chinook populations, including fish taken in Alaska and British Columbia, were estimated by Ford et al. (2011). Median exploitation rates have declined from over 50% during the 1980s to 38% during the early 1990s, to 42% during brood years 2002-2006 (see Table 3). Exploitation rates in the Puget Sound fishery have been relatively low, ranging from 10%–15% during the 1980s to 4%–9% during the 1990s, to 16% during brood years 2002-2006. (Puget Sound Indian Tribes and the Washington Department of Fish and Wildlife 2010)(Washington Department of Fish and Wildlife and Puget Sound Indian Tribes 2013)(Washington Department of Fish and Wildlife and Puget Sound Indian Tribes 2014)

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Table 3: Median exploitation rates on 22 Puget Sound Chinook salmon populations (ESA listed) in fisheries outside Puget Sound, inside Puget Sound, and all fisheries combined.
### North of Cape Falcon North Pacific, Trolling Lines–Chinook

#### Low Concern

Major stocks in this area include tule fall Chinook from Columbia River hatcheries and Columbia River summer and Bright fall Chinook. In some years, Sacramento River fall Chinook comprise a moderate portion of the catch. Upper Columbia River bright Chinook did not experience overfishing from 2011 to 2012, and neither did Sacramento River fall Chinook from 2011 to 2015 (PFMC 2015a). Upper Columbia River summer Chinook did not experience overfishing in 2011, but in 2012 the total exploitation rate on the stock was 76%, just exceeding the maximum fishing mortality threshold of 75% (PFMC 2015a). Overall, it appears that overfishing occurs only occasionally, and escapement data suggest that at least 75% of major monitored stocks in this fishery are not in decline (PFMC 2014a). Conservation concern regarding fishing mortality was rated as ‘Low Concern.’

#### Rationale

According to the PFMC, a stock experiences overfishing if the total annual exploitation rate exceeds the maximum fishing mortality threshold (MFMT), which is based on the maximum sustainable yield exploitation rate \( F_{\text{MSY}} \) (PFMC 2015a). MFMTs for stocks in this area are as follows: 75% for Upper Columbia River summer Chinook, 85% for Upper Columbia River bright Chinook, and 78% for Sacramento River fall Chinook (PFMC 2015a). Escapement data suggest that the predominantly wild stocks are not declining (Figs. 7, 12) (IMG-3334: Columbia Lower River wild escapements). However, escapement counts for most of these stocks do not differentiate between natural- and hatchery-origin fish spawning in the wild. Failing to exclude hatchery-origin fish from the escapement counts inflates escapement numbers and can mask the impact of a high harvest rate on natural-origin fish. Hatchery stocks can withstand higher harvest rates than wild stocks due to enhanced fertilization and survival of eggs.
Figure 7: Columbia Upriver Bright fall Chinook escapements past McNary Dam (blue line) relative to the escapement target of 40,000 to 60,000 fish (black line). The escapement counts and target are for fish spawning in natural areas but may include both hatchery and natural-origin fish.

Figure 12: Columbia River Lower River wild fall Chinook escapements (blue line) relative to the escapement target of 5,700 fish (black line). The escapement counts and target are for fish spawning in natural areas but may include both hatchery and natural-origin fish.
Cape Falcon to Humbug Mt. North Pacific, Trolling Lines–Chinook

**Low Concern**

Major stocks in this area include Southern Oregon Coast Chinook (south migrating/local stocks and the Umpqua River spring stock), Central Valley River fall Chinook, and Klamath River fall Chinook (PFMC 2011). The indicator stock for Central Valley River fall Chinook is Sacramento River fall Chinook. Total exploitation rates on the Sacramento and Klamath River fall Chinook stocks were estimated from 2011 to 2015, and they did not exceed the maximum fishing mortality threshold (78% for Sacramento, 71% for Klamath) (PFMC 2015a). Thus, overfishing did not occur. Escapement monitoring for Oregon Coast Chinook (Fig. 9), Sacramento River fall Chinook (Fig. 5), and Klamath River fall Chinook (Fig. 6) suggests that stocks are not declining. Impact of the fishery on these stocks is of 'Low Concern' because overfishing is not occurring, and more than 75% of stocks appear stable. Additionally, ocean harvests of Chinook in this region are relatively small, no more than 20,000 fish per year since 2005 (PFMC 2014a). However, these stocks are supplemented by large hatchery programs, and escapement counts do not clearly distinguish between natural- and hatchery-origin fish. Thus, harvest impacts on natural-origin fish are somewhat unclear.

**Rationale**

According to the PFMC, a stock experiences overfishing if the total annual exploitation rate exceeds the maximum fishing mortality threshold, which is based on the maximum sustainable yield exploitation rate ($F_{MSY}$) (PFMC 2015a).

Escapements to natural spawning areas suggest that stocks are not declining. However, escapement counts for most of these stocks do not differentiate between natural- and hatchery-origin fish spawning in the wild. Failing to exclude hatchery-origin fish from the escapement counts inflates escapement numbers and can mask the impact of a high harvest rate on natural-origin fish. Hatchery stocks can withstand higher harvest rates than can wild stocks due to enhanced fertilization and survival of eggs.
Figure 9: Southern Oregon Coast Chinook escapement index counts (for Deep, Big Emily, and Bear creeks combined; blue line) relative to the escapement index target of 60 fish per mile (black line). The escapement counts and target are for fish spawning in natural areas but may include both hatchery- and natural-origin fish. Data from Table B-8 in the 2014 Pacific Fishery Management Council Salmon Assessment and Fishery Evaluation Document.

Washington North Pacific, Gillnet, Drift–Chinook

Low Concern

Major stocks in this area include Willapa Bay, Grays Harbor, Queets River spring, Queets River fall, Hoh River spring/summer, Hoh River fall, Quillayute River spring/summer, and Quillayute River fall Chinook. Total exploitation rates do not appear to have been estimated in recent years (PFMC 2015a), but escapement data suggest that none of the major stocks is declining (PFMC 2014a). The policy document for Grays Harbor Basin salmon management includes objectives for focusing harvest on hatchery fish and reducing fishing mortality on natural stocks by implementing mark-selective fisheries that release unmarked (natural-origin) fish (WDFW 2014c). Additionally, exploitation rates on fall Chinook are limited to 5% when escapements to natural spawning areas are relatively low. Thus fishing mortality concern was rated ‘Low Concern.’

Rationale

According to the PFMC, a stock experiences overfishing if the total annual exploitation rate exceeds the maximum fishing mortality threshold (MFMT), which is based on the maximum sustainable yield exploitation rate ($F_{MSY}$) (PFMC 2015a). All of the major stocks in this fishery have an MFMT (ranging from 78% to 90%), but exploitation rates do not appear to have been estimated since 2012, and even then they were estimated for the Queets fall stock only (PFMC 2015a). Counts of escapements to natural...
spawning areas suggest that none of the major stocks is declining (e.g., Figs. 13, 14). (IMG-3337: Figure 14: Willapa Bay Chinook escapements) However, escapement counts for most of these stocks do not differentiate between natural and hatchery-origin fish spawning in the wild. Failing to exclude hatchery-origin fish from the escapement counts inflates escapement numbers and can mask the impact of a high harvest rate on natural-origin fish. Hatchery stocks can withstand higher harvest rates than wild stocks due to enhanced fertilization and survival of eggs.

Figure 13: Grays Harbor fall Chinook escapements (blue line) relative to the escapement target of 14,600 fish (black line). The escapement counts and target are for fish spawning in natural areas but may include both hatchery- and natural-origin fish. Data from the Pacific Fishery Management Council.
Klamath River, Gillnet, Drift–Chinook

Low Concern

Escapements of Klamath River Fall (KRF) Chinook have been fluctuating around $S_{MSY}$ (met 60% of time over past 15 years) indicating that abundance has been relatively stable over the long- and short term. The Klamath River commercial fishing mortalities (expressed as exploitation rates) have been relatively stable or slightly increasing over the past thirty years (Williams et al. 2013). Since 2012, annual management objectives for KRF have been determined by a control rule that specifies maximum allowable exploitation rates as a function of preseason forecasted abundance (PFMC 2014e). Exploitation rates vary from year to year based on the control rule and abundance forecast. Because abundance has been relatively stable, the fishing mortality conservation concern was rated ‘Low Concern.’

Rationale

Harvest of KRF Chinook is co-managed by federal, state, and tribal agencies with tribal government having responsibility for managing the Klamath River commercial fishery (Pierce 1998). The total allowable catch of KRF Chinook is set preseason through the PFMC process. Management of KRF Chinook harvest is designed to meet a number of goals (PFMC 2014d) including: 1) achieve a minimum escapement of 40,700 natural spawners ($S_{MSY}$) (including hatchery strays); 2) achieve a 50/50 allocation between tribal (in-river) and non-tribal fisheries; and 3) NMFS ESA consultation standard restricts the KRF Chinook harvest rate to no more than 16% to limit fishery impacts on ESA listed California Coastal Chinook (which are not directly monitored). Since 2012, annual management objectives for KRF Chinook have been determined by a control rule that specifies maximum allowable exploitation rates as a function of forecast abundance (PFMC 2014e). Use of the control rule to set annual management objectives means that escapement objectives can vary from year to year, and that KRF Chinook are no longer strictly managed to meet $S_{MSY}$ each year. As a result, the sustainable exploitation rate changes from year to year based on the preseason forecast. For example, the acceptable fishery exploitation rate can be much higher during years of strong forecasted abundance, but much lower in years of poor forecasts. In-river tribal fishing mortalities (expressed as in-river exploitation rates) have been relatively stable or slightly increasing over the past thirty years (Williams et al. 2013) and have typically been less than 30% (Fig. 8). KRF Chinook salmon has met $S_{MSY}$ for natural spawning fish (including hatchery-origin fish spawning in natural areas) in 60% of the past fifteen years (PFMC 2014a). While abundance has varied widely over time, the overall trend has been stable over the long and short term.
Major stocks in this fishery include Sacramento River fall (SRF) Chinook and Southern Oregon/Northern California Coast (SONCC) Chinook, both of which include large hatchery programs. Management in this area is primarily focused on Klamath River Fall (KRF) Chinook which is the indicator stock for SONCC Chinook. Management limits exploitation rates on Klamath River stocks through an intensive preseason regulatory process and inseason monitoring. Ocean harvest rates of KRF Chinook have been greatly reduced since the 1980s, averaging 13% between 1999 and 2013 (PFMC 2014a). However, the KRF Chinook stock includes a large hatchery component, and harvest rates on the natural-origin component are unknown. Escapement monitoring for SRF and SONCC Chinook do not suggest that stocks are declining, although index escapement counts for Southern Oregon Coast Chinook are low and near the threshold of being considered overfished (Fig. 9). Because ocean harvest rates are relatively low, the conservation concern regarding fishing mortality was rated ‘Low Concern.’

**Rationale**

This area is known as the Klamath Management Zone (KMZ), which was established in the mid-1980s to manage ocean harvests (commercial and sport) of KRF Chinook. KRF Chinook are the indicator stock for SONCC and Upper Klamath/Trinity Chinook ESUs. Management of KRF Chinook harvest is designed to meet a number of objectives (PFMC 2014d) including: 1) achieve a minimum escapement of 40,700 natural spawners (including hatchery strays); 2) achieve a 50/50 allocation between tribal (in-river) and non-tribal fisheries; and 3) NMFS ESA consultation standard restricts the KRF Chinook harvest rate to no
more than 16% to limit fishery impacts on ESA listed California Coastal Chinook (which are not directly monitored). This latter objective has greatly reduced KRF Chinook ocean harvest rates since it was implemented in 1992. Between 1999 and 2013 ocean harvest rates on age-4 KRF Chinook ranged from 0%–34%, averaging 13% (Fig. 11) (PFMC 2014d).

Figure 11: Estimated ocean harvest rates on age-4 Klamath River Fall Chinook salmon, 1986-2013. Data taken from Table II-5 PFMC 2014d.

Puget Sound, Purse Seine–Chinook

Moderate Concern

Fisheries management has improved during the past 10-20 years in response to the ESA-listing of Puget Sound Chinook salmon. Monitoring of fishery impacts has improved, and relative proportions of hatchery and natural-origin fish are often estimated on the spawning grounds. Co-managers indicate that the escapement trends (hatchery plus natural) have been increasing over time, whereas NOAA Fisheries reported that the escapement of natural-origin returns (NOR) declined from 32,794 Chinook during 2000-2004 to 25,848 Chinook during 2005-2009 (the most recent period available in the report). The estimated recent overall harvest rate of 42% on an ESA-listed population is high (Ford et al. 2011), especially for the natural-origin component. The purse seine fishery does not typically target Chinook salmon in Puget Sound and seiners are required to live-release Chinook in most areas until October 20. Managers assume an incidental mortality rate of 45% for immature Chinook and 33% for mature Chinook that are live-released (Puget Sound Indian Tribes and the Washington Department of Fish and Wildlife 2010). The primary directed Chinook fishery using purse seine is in area 7B near the Nooksack River. The terminal area exploitation rate goal for the Nooksack stock is 7%; average
exploitation has averaged ~4% (2003-2010) and has been within the goal during that period (PSIT/WDFW 2013). Exploitation of this stock in all US and Canada fisheries is 20%-30% per year. The Fishing Mortality factor is judged to be a ‘Moderate Concern’ based on this information. The score does not warrant a ‘High Concern’ because the co-managers are actively managing the fishery, significant improvements have been made over time, and Chinook are often live-released from purse seines.

Puget Sound, Trolling Lines–Chinook

High Concern

The Puget Sound troll fishery is limited to the Strait of Juan de Fuca, and harvests are moderate to small. For example, in 2010, only 2,910 Chinook were harvested (WDFW & PSTIT 2013). In recent years, annual harvests ranged from 400 to over 20,600 in the winter fishery, and from 100 to 4,500 in the spring/summer fishery. Limited genetic data indicate Columbia River and Puget Sound Chinook salmon are the primary stocks taken in this fishery, which occurs over multiple seasons. Given that many Chinook returning to Puget Sound (including some hatchery stocks) and the Columbia River are ESA listed, we assume a portion of the troll catch is on ESA Chinook, though we are not aware of specific estimates. Cumulative harvest rates on these ESA salmon in the fisheries is high (e.g., 56% for brood years 2002 to 2006 (Table 3)) (Ford et al. 2011) (PSIT/WDFW 2013). Trends in catch versus predicted catch have been relatively constant (flat) over the past 6 years, indicating catch is meeting preseason expectations. Long-term annual catch statistics for this fishery were not readily available in reports. However, there is no attempt to reduce mortality on natural fish by live-releasing unmarked salmon even though many Puget Sound populations are not meeting escapement goals for natural-origin fish. Although the NMFS biological opinion on the Pacific Salmon Treaty fisheries concludes that the fisheries are achieving recovery exploitation rates and that fisheries would not cause jeopardy to the Puget Sound Chinook ESU, the fisheries are still having a negative impact (NMFS 2008). Therefore, given high harvest rates on an ESA-listed stock and no attempt to live-release ESA salmon, fishing mortality is judged to have a high concern.

Rationale

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Table 3: Median exploitation rates on 22 Puget Sound Chinook salmon populations (ESA listed) in fisheries outside Puget Sound, inside Puget Sound, and all fisheries combined.
Columbia River, Gillnet, Drift–Chinook

Low Concern

Under the U.S. versus Oregon 2008-2017 Management Agreement, fishery exploitation rates on specific stocks are managed using harvest rate schedules, where harvest limits are determined each year based on inseason monitoring of fish abundance. There are harvest rate schedules for Lower Columbia River wild tule Chinook, Upper Columbia River Summer Chinook, and Chinook in the fall and spring management periods (Joint Columbia River Management Staff 2014a)(Joint Columbia River Management Staff 2014b). As an example, the fall harvest rate schedule limits harvest on Snake River fall Chinook from 21.5% to 45% for all fisheries (non-treaty commercial, non-treaty recreational, treaty commercial, treaty ceremonial and subsistence). These harvest rate limits were met in 2013 (Joint Columbia River Management Staff 2014a)(Joint Columbia River Management Staff 2014b), and the limits appear appropriate because escapements of major stocks, including Upper Columbia River summer and Upriver Bright Chinook, have been stable. Conservation concern was therefore rated 'Low Concern.'

Rationale

Columbia River salmon fisheries are complex, spanning essentially all seasons (fall, summer, winter, spring), including multiple components (e.g. commercial and recreational, treaty and non-treaty), and catching both hatchery and non-hatchery stocks, many of which are listed under the Endangered Species Act. The largest Chinook salmon fishery occurs in fall and largely harvests Hanford Reach Chinook, a productive, mostly natural-origin stock. A portion of hatchery-produced Chinook are marked. Columbia treaty gillnet fisheries do not selectively harvest marked hatchery Chinook, but there is a non-treaty commercial spring Chinook fishery that is mark selective. Select Area commercial fisheries target hatchery-produced fish in off-channel areas. Upriver Bright (URB) fall Chinook are one of the major stocks caught in this fishery. Escapement data suggest that population abundances are steady or possibly increasing (Fig. 7), although the status of the natural-origin stock is somewhat uncertain because hatchery-produced fish are included in escapement counts.
Figure 7: Columbia Upriver Bright fall Chinook escapements past McNary Dam (blue line) relative to the escapement target of 40,000 to 60,000 fish (black line). The escapement counts and target are for fish spawning in natural areas but may include both hatchery and natural-origin fish.

CHUM SALMON

Factor 1.1–Inherent Vulnerability

Scoring Guidelines

- **Low**—The FishBase vulnerability score for species is 0-35, OR species exhibits life history characteristics that make it resilient to fishing, (e.g., early maturing).
- **Medium**—The FishBase vulnerability score for species is 36-55, OR species exhibits life history characteristics that make it neither particularly vulnerable nor resilient to fishing, (e.g., moderate age at sexual maturity (5-15 years), moderate maximum age (10-25 years), moderate maximum size, and middle of food chain).
- **High**—The FishBase vulnerability score for species is 56-100, OR species exhibits life history characteristics that make is particularly vulnerable to fishing, (e.g., long-lived (>25 years), late maturing (>15 years), low reproduction rate, large body size, and top-predator).

Note: The FishBase vulnerability scores is an index of the inherent vulnerability of marine fishes to fishing based on life history parameters: maximum length, age at first maturity, longevity, growth rate, natural mortality rate, fecundity, spatial behaviors (e.g., schooling,
aggregating for breeding, or consistently returning to the same sites for feeding or reproduction) and geographic range.

| Puget Sound, Gillnet, Drift–Chum |
| Puget Sound, Purse seine–Chum |
| Washington North Pacific, Gillnet, Drift–Chum |

**Medium**

The FishBase vulnerability score for chum salmon is 49, making inherent vulnerability ‘Medium.’ The FishBase score is based on life history traits and ecological characteristics including maximum length, age at first maturity, and geographic range (Cheung et al. 2005). Chum salmon have medium vulnerability because, although they are a relatively large salmon, they have the widest natural geographic distribution of all Pacific salmon species.

**Factor 1.2–Abundance**

**Scoring Guidelines**

- **5 (Very Low Concern)**—All major stocks encountered in the fishery are healthy and exceed management targets over 75% of the time.
- **4 (Low Concern)**—Majority of major stocks (>75%) encountered are healthy and exceed management targets over 50% of the time, and no major stocks are listed as threatened or endangered.
- **3 (Moderate Concern)**—Abundance of majority of major stocks (>50%) encountered is unknown relative to management goals, or most of major stocks (>50%) encountered are healthy and exceed management targets over 50% of the time.
- **2 (High Concern)**—Most of the major stocks (>50%) encountered are failing to meet management targets 50%–74% of the time, but are not listed as endangered or threatened.
- **1 (Very High Concern)**—One or more major stock is listed as threatened or endangered by a national or international body, or the majority (>75%) of major stocks encountered are failing to meet management targets 75% of the time.

| Puget Sound, Gillnet, Drift–Chum |

**Moderate Concern**

The fall and winter chum runs in Puget Sound are considered "healthy," and approximately 70% of the return are natural-origin spawners (Fig. 15). Escapement goals have been established throughout the sound for the timing groups. The escapement goals are typically met for both the winter and fall chum stocks. Approximately 30% of the chum run to Puget Sound is hatchery-origin. Hatchery chum are
typically not distinguished from natural-origin chum on the spawning grounds, therefore the status and trends of the natural population is less certain. Hood Canal summer chum is listed as threatened under ESA, but this stock is not considered here because the fisheries avoid most summer chum (WDFW 2014b)(WDFW and Point No Point Treaty Tribes 2000). The abundance factor is ranked as a ‘Moderate Concern’ because hatchery chum is counted along with natural chum on the spawning grounds.

**Rationale:**

![Abundance of chum spawning in rivers, total abundance of natural-origin chum, and total abundance of hatchery and natural chum salmon in Puget Sound.](image)

Figure 15: Abundance of chum spawning in rivers, total abundance of natural-origin chum, and total abundance of hatchery and natural chum salmon in Puget Sound.

**Puget Sound, Purse Seine—Chum**

**Moderate Concern**

The fall and winter chum runs in Puget Sound are considered "healthy," and approximately 70% of the return are natural-origin spawners. Escapement goals have been established throughout the sound for the timing groups. The escapement goals are typically met for both the winter and fall chum stocks. Approximately 30% of the chum run to Puget Sound is hatchery origin. Hatchery chum are typically not distinguished from natural-origin chum on the spawning grounds, therefore the status and trends of the natural population is less certain. Hood Canal summer chum is listed as threatened under ESA, but this stock is not considered here because the fisheries avoid most summer chum (WDFW...
The abundance factor is ranked as a ‘Moderate Concern’ because hatchery chum are counted along with natural chum on the spawning grounds.

### Washington North Pacific, Gillnet, Drift—Chum

#### Low Concern

Grays Harbor and Willapa Bay chum are the two major Washington coastal chum stocks. Grays Harbor chum met the escapement goal of 21,000 fish in 40% of the years from 1997 to 2011, whereas Willapa Bay chum met the escapement goal of 35,400 fish in 67% of those years (data from http://wdfw.wa.gov/fishing/salmon/chum/coastal/data.html). Both Grays Harbor and Willapa Bay escapements were relatively low from 2005 to 2009 but have since increased. Escapement goals and monitoring are for fish spawning in natural areas and may include some fish produced in small hatchery projects, but the proportion of hatchery-origin chum is low (generally 5% or less). Because escapement levels are fluctuating about their respective escapement goals, and population sizes have increased in the short term, conservation concern was rated 'Low Concern.'

#### Rationale

There is a third group of Washington coastal chum (North Coast), but North Coast populations are not closely monitored. Natural spawning chum escapement estimates in the Coastal region are typically based on analysis of live chum counts collected within each watershed.

From 1997 to 2011, the proportion of hatchery-origin fish in the total chum run averaged 3% for Grays Harbor and 2% for Willapa Bay (see data sheets on http://wdfw.wa.gov/fishing/salmon/chum/coastal/data.html).

### Factor 1.3—Fishing Mortality

#### Scoring Guidelines

- **5 (Very Low Concern)**—Highly likely that fishing mortality is below a sustainable level (e.g., below fishing mortality at maximum sustainable yield, FMSY), OR fishery does not target species and its contribution to the mortality of species is negligible (≤ 5% of a sustainable level of fishing mortality).
- **3.67 (Low Concern)**—Probable (>50%) chance that fishing mortality is at or below a sustainable level, but some uncertainty exists, OR the majority (>75%) of major stocks encountered in the fishery exhibit population trends that are increasing or stable in the short and long term due to management AND all stocks which exhibit decline do not exceed a 5% annual decrease in abundance.
2.33 (Moderate Concern)—Fishing mortality is fluctuating around sustainable levels, OR fishing mortality is unknown but for any depleted population effective management is in place OR most (>50%) of the major stocks encountered exhibit population trends that are increasing or stable in the short and long term AND all stocks which exhibit decline do not exceed a 5% annual decrease in abundance.

1 (High Concern)—Overfishing is occurring, but management is in place to curtail overfishing, OR fishing mortality is unknown, species is depleted, and no effective management is in place OR most (>50%) major stocks encountered in the fishery are exhibiting declines in abundance.

0 (Critical)—Overfishing is known to be occurring and no reasonable management is in place to curtail overfishing.

Puget Sound, Gillnet, Drift—Chum

Low Concern

The fall and winter chum runs in Puget Sound are considered "healthy." Escapement goals have been established throughout the sound for the timing groups. The escapement goals are typically met for both the winter and fall chum stocks, and trends over time are variable but not declining. Approximately 30% of the chum run to Puget Sound is hatchery-origin. Hatchery chum are typically not distinguished from natural-origin chum on the spawning grounds, therefore the status and trends of the natural population is less certain (WDFW 2014b)(WDFW and Point No Point Treaty Tribes 2000). Harvest rates on "wild" fall chum averaged 56% during 2000-2009, whereas it was 34% for winter chum. The fishing mortality factor is ranked as a ‘Low Concern’ because the spawning escapement has been relatively stable over time.

Puget Sound, Purse Seine—Chum

Low Concern

The fall and winter chum runs in Puget Sound are considered "healthy." Escapement goals have been established throughout the sound for the timing groups. The escapement goals are typically met for both the winter and fall chum stocks, and trends over time are variable but not declining. Approximately 30% of the chum run to Puget Sound is hatchery-origin. Hatchery chum are typically not distinguished from natural-origin chum on the spawning grounds, therefore the status and trends of the natural population is less certain (WDFW 2014b)(WDFW and Point No Point Treaty Tribes 2000). Harvest rates on "wild" fall chum averaged 56% during 2000-2009, whereas it was 34% for winter chum. The fishing mortality factor is ranked as a ‘Low Concern’ because the spawning escapement has been relatively stable over time.
Washington North Pacific, Gillnet, Drift–Chum

**Low Concern**

The two major stocks caught in this fishery are Grays Harbor and Willapa Bay chum. Directed fisheries for chum salmon occur in both the Grays Harbor and Willapa Bay systems when returns are large enough to meet escapement needs, and escapement data suggest that Washington coastal chum salmon stocks are stable and increasing in the short term. In addition, the policy document for Grays Harbor Basin salmon management states that exploitation rates on chum will be limited to 5% when escapements to natural spawning areas are relatively low (WDFW 2014c). Conservation concern was therefore rated 'Low Concern.'

**Rationale**

The Willapa Bay commercial fishery generally involves non-Indian fishers, whereas the Grays Harbor commercial fishery is managed jointly by the Washington Department of Fish and Wildlife (WDFW) and the Quinault Indian Nation. When returns are low, chum salmon are caught mostly incidentally in fisheries targeting coho. In Grays Harbor, coho and chum timing overlap, such chum fishing seasons may not be set if harvest rates on coho may be too high. Both Grays Harbor and Willapa Bay escapements were relatively low from 2005 to 2009 but have since increased (Figs. 16, 17). (IMG-3337, Figure 14, Willapa Bay Chinook escapements).

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Figure 13: Grays Harbor fall Chinook escapements (blue line) relative to the escapement target of 14,600 fish (black line). The escapement counts and target are for fish spawning in natural areas but may include both hatchery and natural-origin fish. Data from the Pacific Fishery Management Council.
Figure 14: Willapa Bay fall Chinook escapements (blue line) relative to the escapement target of 3,393 fish (black line). The escapement counts and target are for naturally produced fish, though supporting documentation is needed to show that hatchery-origin fish are not included in counts.

COHO SALMON

Factor 1.1–Inherent Vulnerability

Scoring Guidelines

- **Low**—The FishBase vulnerability score for species is 0-35, OR species exhibits life history characteristics that make it resilient to fishing, (e.g., early maturing).
- **Medium**—The FishBase vulnerability score for species is 36-55, OR species exhibits life history characteristics that make it neither particularly vulnerable nor resilient to fishing, (e.g., moderate age at sexual maturity (5-15 years), moderate maximum age (10-25 years), moderate maximum size, and middle of food chain).
- **High**—The FishBase vulnerability score for species is 56-100, OR species exhibits life history characteristics that make it particularly vulnerable to fishing, (e.g., long-lived (>25 years), late maturing (>15 years), low reproduction rate, large body size, and top-predator).

Note: The FishBase vulnerability scores is an index of the inherent vulnerability of marine fishes to fishing based on life history parameters: maximum length, age at first maturity, longevity, growth rate, natural mortality rate, fecundity, spatial behaviors (e.g., schooling, aggregating for breeding, or consistently returning to the same sites for feeding or reproduction) and geographic range.
The FishBase vulnerability score for coho salmon is 53, making inherent vulnerability ‘Medium.’ The FishBase score is based on life history traits and ecological characteristics including maximum length, age at first maturity, and geographic range (Cheung et al. 2005). Coho salmon have medium vulnerability because they widely distributed but occur in somewhat small and isolated populations.

**Factor 1.2—Abundance**

*Scoring Guidelines*

- **5 (Very Low Concern)** — All major stocks encountered in the fishery are healthy and exceed management targets over 75% of the time.
- **4 (Low Concern)** — Majority of major stocks (>75%) encountered are healthy and exceed management targets over 50% of the time, and no major stocks are listed as threatened or endangered.
- **3 (Moderate Concern)** — Abundance of majority of major stocks (>50%) encountered is unknown relative to management goals, or most of major stocks (>50%) encountered are healthy and exceed management targets over 50% of the time.
- **2 (High Concern)** — Most of the major stocks (>50%) encountered are failing to meet management targets 50%–74% of the time, but are not listed as endangered or threatened.
- **1 (Very High Concern)** — One or more major stock is listed as threatened or endangered by a national or international body, or the majority (>75%) of major stocks encountered are failing to meet management targets 75% of the time.

**North of Cape Falcon North Pacific, Trolling Lines—Coho**

**Moderate Concern**

Major coho salmon stocks in this area include the Columbia River and Washington coastal stocks, with Columbia River early and late hatchery coho dominating ocean catches (PFMC 2014a). Naturally
produced Columbia River coho salmon are listed under the Endangered Species Act and are evaluated under Criterion 2. Five Washington coastal stocks (Willapa Bay, Grays Harbor, Queets River, Hoh River, Quillayute River) have escapement goals and monitoring for naturally spawning fish, and 60% of these stocks have exceeded the goal for at least 50% of the past fifteen years in which data were collected (1998 to 2012 or 1999 to 2013) (PFMC 2014a). Escapement counts include hatchery-origin fish spawning in natural areas. Conservation concern is therefore rated ‘Moderate.’

Rationale
Willapa Bay and Grays Harbor coho escapements have exceeded escapement targets more than 70% of the past fifteen years, with relatively low escapements from 1998 to 2000 and 2006 to 2008. Escapement goals are expressed as ranges for the Queets, Hoh, and Quillayute rivers to reflect uncertainty. The lower bound is the escapement estimated to result in maximum sustainable yield (MSY) assuming a high estimate of recruits per spawner and a low estimate of smolt carrying capacity, whereas the upper bound is the estimated MSY escapement assuming a low estimate of recruits per spawner and a high estimate of smolt carrying capacity. Here we assumed that escapements exceeding the midpoint of the escapement goal range had met the target (PFMC 2014a). Hoh River coho escapement counts exceeded the escapement target in 73% of the past fifteen years, whereas Queets and Quillayute river coho escapements exceeded the target in 20% and 0% of the past fifteen years, respectively. Escapements were particularly low from 2006 to 2008 and 2012 to 2013.

Washington North Pacific, Gillnet, Drift–Coho

Moderate Concern
The major coho salmon stocks in this fishery are Washington coastal stocks. Five of these stocks (Willapa Bay, Grays Harbor, Queets River, Hoh River, Quillayute River) have escapement goals and monitoring for naturally spawning fish, and all five have exceeded the goal for at least 50% of the past fifteen years in which data were collected (1998 to 2012 or 1999 to 2013) (PFMC 2014a). However, there is substantial hatchery production, and most escapement counts include hatchery-origin fish spawning in natural areas, so conservation concern is rated ‘Moderate Concern.’

Rationale
Willapa Bay and Grays Harbor coho escapements have exceeded escapement goals more than 70% of the past fifteen years, with relatively low escapements from 1998 to 2000 and 2006 to 2008. Escapement goals are expressed as ranges for the Queets, Hoh, and Quillayute rivers. The lower bound is the escapement estimated to result in maximum sustainable yield (MSY) assuming a high estimate of recruits per spawner and a low estimate of carrying capacity, whereas the upper bound is the estimated MSY escapement assuming a low estimate of recruits per spawner and a high estimate of carrying capacity. Here we assumed that escapements exceeding the lower bound had met the goal (PFMC 2014a). Queets, Hoh, and Quillayute river escapement counts exceeded the goal in 60%–90% of the past fifteen years, with relatively low escapements from 2006 to 2008 and 2012 to 2013.
The 2014 preseason forecast of wild and hatchery coho returns indicated that Washington coastal coho stocks may be comprised of about 40% hatchery-produced fish in aggregate (http://wdfw.wa.gov/fishing/northfalcon/2014/coho.pdf).

**Puget Sound, Gillnet, Drift–Coho**

**Moderate Concern**

Escapement of coho salmon to rivers and hatcheries in Puget Sound is monitored each year (PFMC 2014a). Escapement goals have been established for coho spawning in most large watersheds, and spawning levels have typically exceeded the goals during the past 15 years. However, the spawner counts and goals do not distinguish between hatchery-origin and natural-origin spawners in the stream, and it is likely that numerous hatchery fish contribute to the spawner counts in watersheds where hatcheries are located. The abundance factor for coho is therefore scored as a ‘Moderate Concern.’

**Rationale**

Coho abundances in Puget Sound appear variable but stable (Fig. 18).

![Figure 18: Abundances of Puget Sound coho salmon, 1986-2009.](image)

**Puget Sound, Purse Seine–Coho**

**Moderate Concern**

Escapement of coho salmon to rivers and hatcheries in Puget Sound is monitored each year (PFMC
Escapement goals have been established for coho spawning in most large watersheds, and spawning levels have typically exceeded the goals during the past 15 years. However, the spawner counts and goals do not distinguish between hatchery-origin and natural-origin spawners in the stream, and it is likely that numerous hatchery fish contribute to the spawner counts in watersheds where hatcheries are located. The abundance factor for coho is therefore scored as a ‘Moderate Concern.’

Puget Sound, Trolling Lines–Coho

**Moderate Concern**

The Puget Sound troll fishery occurs in the Strait of Juan de Fuca. Relatively few Puget Sound coho are harvested here; exploitation rates on each Puget Sound coho management unit is typically less than 2% (PSC 2013c). We therefore assume that the coho stock composition is similar to that in the north of Falcon troll fishery, which extends into the outer portion of the Strait. Major coho salmon stocks in the north of Falcon fishery include the Columbia River and Washington coastal stocks, with Columbia River early and late hatchery coho dominating ocean catches (PFMC 2014a). Escapements to natural spawning areas in the Columbia River are tracked, but there is no explicit escapement goal (Joint Columbia River Management Staff 2014a), and escapement counts include hatchery-origin fish. Five Washington coastal stocks (Willapa Bay, Grays Harbor, Queets River, Hoh River, Quillayute River) have escapement targets and monitoring for naturally spawning fish, and all five have exceeded the target for at least 50% of the past fifteen years in which data were collected (1998 to 2012 or 1999 to 2013) (PFMC 2014a). Again however, escapement counts include hatchery-origin fish spawning in natural areas. Conservation concern is therefore rated ‘Moderate Concern.’

Columbia River, Gillnet, Drift–Coho

**Very High Concern**

Wild coho populations were largely extirpated from Columbia River tributaries by the 1930s (Joint Columbia River Management Staff 2014a). The only remaining natural stock is Lower Columbia River coho, which is listed under the Endangered Species Act as threatened (NOAA 2014a). The Lower Columbia River coho evolutionarily significant unit includes both naturally spawned and hatchery-produced fish, with the large majority being hatchery produced. Because the major stock is listed as threatened, conservation concern was deemed ‘Very High Concern.’

**Rationale**

Coho salmon averaged 30% of the total Columbia River fall commercial harvest from 1999 to 2013 (Joint Columbia River Management Staff 2014a), and much of this catch was hatchery-produced Lower Columbia River coho. Thus we evaluated Lower Columbia River coho as a major stock. The Lower Columbia River coho evolutionarily significant unit includes naturally spawned coho salmon originating
from the Columbia River and its tributaries downstream from the Big White Salmon and Hood Rivers (inclusive), and from the Willamette River and its tributaries below Willamette Falls. Coho produced in 21 artificial propagation programs are included as well. Unmarked, naturally produced coho have also been returning to the Columbia River system in increasing numbers since 2000, but their origin is unknown (Joint Columbia River Management Staff 2014a). However, the Washington and Oregon Departments of Fish and Wildlife have improved monitoring of the wild-origin stock by estimating coho escapements and proportions of wild and hatchery fish in some Columbia River tributaries. Some of these data are posted on the Salmon Conservation and Reporting Engine (SCoRE; https://fortress.wa.gov/dfw/score/score/). Another positive management development is that the Yakama Nation has re-introduced coho to the Yakima, Wenatchee, and Methow River basins (Bonneville Power Administration et al. 2012). These fish are not marked because they are attempting to rebuild the stocks, and some fisheries target marked fish.

**Factor 1.3—Fishing Mortality**

*Scoring Guidelines*

- **5 (Very Low Concern)**—Highly likely that fishing mortality is below a sustainable level (e.g., below fishing mortality at maximum sustainable yield, FMSY), OR fishery does not target species and its contribution to the mortality of species is negligible (≤ 5% of a sustainable level of fishing mortality).
- **3.67 (Low Concern)**—Probable (>50%) chance that fishing mortality is at or below a sustainable level, but some uncertainty exists, OR the majority (>75%) of major stocks encountered in the fishery exhibit population trends that are increasing or stable in the short and long term due to management AND all stocks which exhibit decline do not exceed a 5% annual decrease in abundance.
- **2.33 (Moderate Concern)**—Fishing mortality is fluctuating around sustainable levels, OR fishing mortality is unknown but for any depleted population effective management is in place OR most (>50%) of the major stocks encountered exhibit population trends that are increasing or stable in the short and long term AND all stocks which exhibit decline do not exceed a 5% annual decrease in abundance.
- **1 (High Concern)**—Overfishing is occurring, but management is in place to curtail overfishing, OR fishing mortality is unknown, species is depleted, and no effective management is in place OR most (>50%) major stocks encountered in the fishery are exhibiting declines in abundance.
- **0 (Critical)**—Overfishing is known to be occurring and no reasonable management is in place to curtail overfishing.
**Moderate Concern**

The major coho salmon stocks in this fishery include Columbia River and Washington coastal stocks. Escapement counts in natural spawning areas do not indicate declining population trends (Joint Columbia River Management Staff 2014a)(PFMC 2014a). Lower Columbia River natural coho salmon are listed under the Endangered Species Act as threatened, but exploitation rate limits (20% or lower) are in place to constrain harvest impacts on the stock. Estimated exploitation rates on Lower Columbia River natural (LCN) coho did not exceed limits in 78% of the years from 2005 to 2013 (PFMC 2014a). However, hatchery- and natural-origin fish are essentially managed together as a single stock so there is some uncertainty regarding fishing mortality levels on the wild stock component. Because the depleted natural stock is subject to some fishing mortality, but there is management aimed at maintaining abundances, conservation concern was rated 'Moderate Concern.'

**Rationale**

Escapement data suggest that stocks are not declining.

![Grays Harbor escapements](image)

Figure 20: Grays Harbor coho escapements (blue line) relative to the escapement target of 35,400 fish (black line). The escapement counts and target are for fish spawning in natural areas but may include both hatchery and natural-origin fish. Data from the Pacific Fishery Management Council.
However, escapement counts for most of these stocks do not differentiate between natural- and hatchery-origin fish spawning in the wild. Failing to exclude hatchery-origin fish from the escapement counts inflates escapement numbers and can mask the impact of a high harvest rate on natural-origin fish. Hatchery stocks can withstand higher harvest rates than wild stocks due to enhanced fertilization and survival of eggs.

A stock is considered overfished if the 3-year geometric mean spawning escapement is less than the minimum stock size threshold (MSST). This is a biomass level set below the level corresponding to maximum sustainable yield (MSY) to allow for fluctuations in abundance while maintaining the capability to produce MSY on a continuing basis. The Grays Harbor, Queets River, Hoh River, and Quillayute River coho stocks exceeded their respective MSSTs based on their geometric mean escapement from 2011 to 2013 (PFMC 2014a). The MSST for Willapa Bay coho has not yet been defined.

**Washington North Pacific, Gillnet, Drift–Coho**

**Low Concern**

The major coho salmon stocks in this fishery are Washington coastal stocks. Escapement data suggest that these stocks have generally stable abundances (PFMC 2014a). The policy document for Grays Harbor Basin salmon management includes objectives for focusing harvest on hatchery fish and
reducing fishing mortality on natural stocks by implementing mark-selective fisheries that release unmarked (natural-origin) fish (WDFW 2014c). In addition, exploitation rates on coho are limited to 5% when escapements to natural spawning areas are relatively low. Based on abundance data and management measures taken to reduce fishing mortality on natural stocks, concern regarding fishing mortality was deemed 'Low Concern.'

**Rationale**

Escapement data suggest that stocks are not declining.

Figure 21: Queets River coho escapements (blue line) relative to the escapement target of 5,800 fish (black line). The escapement counts and target are for fish spawning in natural areas but may include both hatchery and natural-origin fish. Data from the Pacific Fishery Management Council.
However, failing to exclude hatchery-origin fish from the escapement counts inflates escapement numbers and can mask the impact of a high harvest rate. Hatchery stocks can withstand higher harvest...
rates than can wild stocks due to enhanced fertilization and survival of eggs.

A stock is considered overfished if the 3-year geometric mean spawning escapement is less than the minimum stock size threshold (MSST), which is a biomass level set below the level corresponding to maximum sustainable yield (MSY) to allow for fluctuations in abundance while maintaining the capability to produce MSY on a continuing basis. The Grays Harbor, Queets River, Hoh River, and Quillayute River coho stocks exceeded their respective MSSTs based on their geometric mean escapement from 2011 to 2013 (PFMC 2014a). The MSST for Willapa Bay coho has not yet been defined.

Puget Sound, Gillnet, Drift—Coho

Low Concern

Coho fisheries are managed to allow adequate spawning escapement to Puget Sound rivers. Spawning levels have typically exceeded the goals during the past 15 years (PFMC 2014a). Population trends appear to be stable over time, but hatchery coho contribute to counts on the spawning grounds, leading to some uncertainty about the accuracy of harvest rates on the natural-origin coho. Total exploitation rates (US and Canada) have been relatively stable since 1998 and moderate for most management units (e.g., 20% for Stilliguamish, Snohomish; 30% for Skagit, 15% for Strait of Juan de Fuca), but exploitation has increased for Hood Canal coho (60% during 2005-2009) (PSC 2013c). The fishing mortality factor for coho is therefore scored as a ‘Low Concern.’

Puget Sound, Purse Seine—Coho

Low Concern

Coho salmon are typically taken incidentally to seine fisheries directed on other salmon species in Puget Sound. Coho are managed to allow adequate spawning escapement to Puget Sound rivers. Spawning levels have typically exceeded the goals during the past 15 years (PFMC 2014a). Population trends appear to be stable over time, but hatchery coho contribute to counts on the spawning grounds, leading to some uncertainty about the adequacy of harvest rates on the natural-origin coho. Total exploitation rates (US and Canada) have been relatively stable since 1998 and moderate for most management units (e.g., 20% for Stilliguamish, Snohomish; 30% for Skagit, 15% for Strait of Juan de Fuca), but exploitation has increased for Hood Canal coho (60% during 2005-2009) (PSC 2013c). The fishing mortality factor for coho is therefore scored as a ‘Low Concern.’

Puget Sound, Trolling Lines—Coho

Low Concern
Relatively few Puget Sound coho are harvested here; exploitation rates on each Puget Sound management unit is typically less than 2% (PSC 2013c). We therefore assume that the coho stock composition is similar to that in the north of Falcon troll fishery, which extends into the outer portion of the Strait. Major coho salmon stocks in the north of Falcon fishery include Columbia River and Washington inside coastal stocks. Escapement counts in natural spawning areas do not indicate declining population trends (Joint Columbia River Management Staff 2014a)(PFMC 2014a), and none of these stocks are currently considered overharvested, although the Queets River coho stock was considered ‘overfished’ before its status was updated by NOAA Fisheries in 2011 to ‘rebuilt.’ Total harvest rates (including Canada) on Quillayute, Hoh, Queets and Grays Harbor coho were typically 30%–40% (PSC 2013c). Escapement counts do not clearly differentiate between natural and hatchery-origin fish. Concern regarding fishing mortality was deemed ‘Low Concern.’

Columbia River, Gillnet, Drift–Coho

Moderate Concern

The only major Columbia River coho stock is Lower Columbia River natural (LCN) coho, which is listed under the Endangered Species Act but harvested in fall Columbia gillnet fisheries. Lower Columbia River coho escapements do not appear to be declining, and estimated wild abundance was especially high in 2014 (see Fig. 19 in Detailed Rationale). Under the U.S. versus Oregon 2008-2017 Management Agreement, fishery exploitation rates on specific stocks (including LCN coho) are managed using harvest rate schedules, where harvest limits are determined each year based on in-season monitoring of salmon abundances. For LCN coho these limits have ranged from 8% to 20%, and estimated exploitation rates on LCN coho did not exceed limits in 78% of the years from 2005 to 2013 (PFMC 2014a). Starting in 2015, a new harvest matrix that considers parameters of ocean survival and parental escapement has been used. The new matrix is designed to concentrate fishing in the 18%–23% range while allowing for exploitation rates up to 30% when marine survival is very high; at the same time, exploitation rates are supposed to be lowered in years when levels of artificial juvenile seeding is low (< 30% of full seeding) (PFMC 2014f). This change may make harvest limits more responsive to stock status information, but the target exploitation rates do not appear more conservative than they have been since the ESA listing of LCN coho. Additionally, fishing mortality is estimated on hatchery- and natural-origin fish combined, so there is some uncertainty regarding fishing mortality levels on the wild stock component. Conservation concern was rated ‘Moderate Concern.’

Rationale

Columbia River salmon fisheries are complex, spanning essentially all seasons (fall, summer, winter, spring), including multiple components (e.g., commercial and recreational, treaty and non-treaty), and catching both hatchery and non-hatchery stocks, many of which are listed under the Endangered Species Act. Hatcheries in the lower Columbia River mark the coho they produce. Columbia River treaty gillnet fisheries do not selectively harvest marked hatchery salmon, but select area commercial fisheries target hatchery-produced fish in off-channel areas, sometimes using tangle net gear and recovery boxes
in more recent years (Joint Columbia River Management Staff 2015b). The allowable exploitation rate on LCN coho is for ocean and non-tribal Columbia River fisheries (downstream of Bonneville Dam) combined. The allocation of non-Indian catch and ESA impacts between ocean and in-river fisheries is determined annually by the states and occurs during the Pacific Fishery Management Council and North of Falcon meetings (Joint Columbia River Management Staff 2015b).

According to run reconstructions conducted by the Oregon Production Index Technical Team, wild LCN coho abundances have been stable and showed a large increase in 2014 (Fig. 19)(ODFW 2015a). Exploitation rates on this stock are estimated using the Coho Fishery Regulation Assessment Model (FRAM), which uses data from fish that have been marked using coded wire tags.

**Figure 19:** Estimated numbers of wild coho spawners (blue line) for the Oregon portion of the Lower Columbia River coho ESU. Data from Oregon Production Index Technical Team run reconstructions.

## PINK SALMON

### Factor 1.1—Inherent Vulnerability

**Scoring Guidelines**

- **Low**—The FishBase vulnerability score for species is 0-35, OR species exhibits life history characteristics that make it resilient to fishing, (e.g., early maturing).
• **Medium**—The FishBase vulnerability score for species is 36-55, OR species exhibits life history characteristics that make it neither particularly vulnerable nor resilient to fishing, (e.g., moderate age at sexual maturity (5-15 years), moderate maximum age (10-25 years), moderate maximum size, and middle of food chain).

• **High**—The FishBase vulnerability score for species is 56-100, OR species exhibits life history characteristics that make it particularly vulnerable to fishing, (e.g., long-lived (>25 years), late maturing (>15 years), low reproduction rate, large body size, and top-predator).

Note: The FishBase vulnerability scores is an index of the inherent vulnerability of marine fishes to fishing based on life history parameters: maximum length, age at first maturity, longevity, growth rate, natural mortality rate, fecundity, spatial behaviors (e.g., schooling, aggregating for breeding, or consistently returning to the same sites for feeding or reproduction) and geographic range.

<table>
<thead>
<tr>
<th>Puget Sound, Gillnet, Drift—Pink</th>
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<tbody>
<tr>
<td>Puget Sound, Purse seine—Pink</td>
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<tr>
<td>Puget Sound, Trolling Lines—Pink</td>
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**Medium**

The FishBase vulnerability score for pink salmon is 37, making inherent vulnerability medium. The FishBase score is based on life history traits and ecological characteristics including maximum length, age at first maturity, and geographic range (Cheung et al. 2005). Pink salmon have medium to low vulnerability because this species matures quickly and has a relatively small body size. They have homogenous life history characteristics and are widely distributed.

**Factor 1.2—Abundance**

**Scoring Guidelines**

• **5 (Very Low Concern)**—All major stocks encountered in the fishery are healthy and exceed management targets over 75% of the time.

• **4 (Low Concern)**—Majority of major stocks (>75%) encountered are healthy and exceed management targets over 50% of the time, and no major stocks are listed as threatened or endangered.

• **3 (Moderate Concern)**—Abundance of majority of major stocks (>50%) encountered is unknown relative to management goals, or most of major stocks (>50%) encountered are healthy and exceed management targets over 50% of the time.

• **2 (High Concern)**—Most of the major stocks (>50%) encountered are failing to meet management targets 50-74% of the time, but are not listed as endangered or threatened.
• **1 (Very High Concern)**—One or more major stock is listed as threatened or endangered by a national or international body, or the majority (>75%) of major stocks encountered are failing to meet management targets 75% of the time.

| Puget Sound, Gillnet, Drift—Pink |
| Puget Sound, Purse Seine—Pink |
| Puget Sound, Trolling Lines—Pink |

**Very Low Concern**

Pink salmon return to Puget Sound primarily in odd-numbered years owing to their two-year life cycle. They are the most abundant salmon species in Puget Sound, with annual abundances up to 10 million salmon in recent years (PFMC 2014a). Hatchery pink salmon production is very small, typically less than 1% of the total. Spawning escapement goals have been established for most but not all the areas. The goals have been met or exceeded 75% of the past fifteen years. Given the high abundance (Fig. 23) and lack of hatchery fish on the spawning grounds, the abundance of Puget Sound pink salmon is judged to have a very low conservation concern.

**Rationale**
Figure 23: Abundance of pink salmon returning to Puget Sound, 1981-2013. Only odd years are shown because very few return in even years.

**Factor 1.3—Fishing Mortality**

**Scoring Guidelines**

- **5 (Very Low Concern)**—Highly likely that fishing mortality is below a sustainable level (e.g., below fishing mortality at maximum sustainable yield, FMSY), OR fishery does not target species and its contribution to the mortality of species is negligible (≤ 5% of a sustainable level of fishing mortality).
- **3.67 (Low Concern)**—Probable (>50%) chance that fishing mortality is at or below a sustainable level, but some uncertainty exists, OR the majority (>75%) of major stocks encountered in the fishery exhibit population trends that are increasing or stable in the short and long term due to management AND all stocks which exhibit decline do not exceed a 5% annual decrease in abundance.
• 2.33 (Moderate Concern)—Fishing mortality is fluctuating around sustainable levels, OR fishing mortality is unknown but for any depleted population effective management is in place OR most (>50%) of the major stocks encountered exhibit population trends that are increasing or stable in the short and long term AND all stocks which exhibit decline do not exceed a 5% annual decrease in abundance.

• 1 (High Concern)—Overfishing is occurring, but management is in place to curtail overfishing, OR fishing mortality is unknown, species is depleted, and no effective management is in place OR most (>50%) major stocks encountered in the fishery are exhibiting declines in abundance.

• 0 (Critical)—Overfishing is known to be occurring and no reasonable management is in place to curtail overfishing.

Puget Sound, Gillnet, Drift—Pink
Puget Sound, Purse Seine—Pink
Puget Sound, Trolling Lines—Pink

Very Low Concern

Pink salmon are the most abundant salmon species in Puget Sound with annual abundances up to 10 million salmon in recent years (PFMC 2014a). Hatchery pink salmon production is very small, typically less than 1% of the total. Abundance has been increasing during the past 10 or more years. Given the high abundance and lack of hatchery fish on the spawning grounds, fishing mortality of Puget Sound pink salmon is judged to have a very low conservation concern.

**SOCKEYE SALMON**

**Factor 1.1—Inherent Vulnerability**

**Scoring Guidelines**

- **Low**—The FishBase vulnerability score for species is 0-35, OR species exhibits life history characteristics that make it resilient to fishing, (e.g., early maturing).

- **Medium**—The FishBase vulnerability score for species is 36-55, OR species exhibits life history characteristics that make it neither particularly vulnerable nor resilient to fishing, (e.g., moderate age at sexual maturity (5-15 years), moderate maximum age (10-25 years), moderate maximum size, and middle of food chain).

- **High**—The FishBase vulnerability score for species is 56-100, OR species exhibits life history characteristics that make it particularly vulnerable to fishing, (e.g., long-lived (>25 years), late maturing (>15 years), low reproduction rate, large body size, and top-predator).
Note: The FishBase vulnerability scores is an index of the inherent vulnerability of marine fishes to fishing based on life history parameters: maximum length, age at first maturity, longevity, growth rate, natural mortality rate, fecundity, spatial behaviors (e.g., schooling, aggregating for breeding, or consistently returning to the same sites for feeding or reproduction) and geographic range.

Columbia River, Gillnet, Drift–Sockeye
Puget Sound, Gillnet, Drift–Sockeye
Puget Sound, Purse Seine–Sockeye

Washington North Pacific, Gillnet, Drift–Sockeye

Low

The FishBase vulnerability score for sockeye salmon is 32, making inherent vulnerability ‘Low.’ The FishBase score is based on life history traits and ecological characteristics including maximum length, age at first maturity, and geographic range (Cheung et al. 2005). Sockeye salmon have low vulnerability because they have high diversity in life history traits.

Factor 1.2–Abundance

Scoring Guidelines

• 5 (Very Low Concern)—All major stocks encountered in the fishery are healthy and exceed management targets over 75% of the time.
• 4 (Low Concern)—Majority of major stocks (>75%) encountered are healthy and exceed management targets over 50% of the time, and no major stocks are listed as threatened or endangered.
• 3 (Moderate Concern) —Abundance of majority of major stocks (>50%) encountered is unknown relative to management goals, or most of major stocks (>50%) encountered are healthy and exceed management targets over 50% of the time.
• 2 (High Concern)—Most of the major stocks (>50%) encountered are failing to meet management targets 50-74% of the time, but are not listed as endangered or threatened.
• 1 (Very High Concern)—One or more major stock is listed as threatened or endangered by a national or international body, or the majority (>75%) of major stocks encountered are failing to meet management targets 75% of the time.

Puget Sound, Gillnet, Drift–Sockeye
**Low Concern**

The Puget Sound sockeye salmon fishery targets primarily Fraser River sockeye salmon originating from British Columbia. Relatively small sockeye runs occur in Lake Washington and Baker Lake, but these runs often are not sufficient to allow a directed commercial harvest. The Fraser sockeye salmon stock consists of many populations but is managed according to four migration timing groups; spawning escapements are monitored on about 18 populations. Fraser sockeye abundance is cyclic, and productivity has been highly variable in recent years. In 2009, a peak cycle year, the sockeye run was much lower than anticipated, leading to multiple inquiries (Peterman et al. 2010). However, in 2010, the run was one of the largest in the past 50 or more years. The 2014 return is expected to be near 20 million sockeye salmon. Spawning escapements of the timing groups have fluctuated about the escapement targets, which vary year to year (Fraser River Panel 2012). Some populations include artificial spawning channel sockeye, which are enumerated separately. Fraser sockeye abundance is judged to have a ‘Low Concern’ regarding overall abundance because the majority of major stocks typically meet or exceed management targets. Weak sockeye stocks are evaluated under Criterion 2.

**Rationale**

Although the major stocks have been relatively abundant, some smaller stocks have been depressed (CSAS 2013). For example, the Cultus population was determined to be endangered by COSEWIC (Committee on the Status of Endangered Wildlife in Canada), leading to actions to reduce harvest rates to some extent (see Criterion 2). Fraser sockeye abundance is judged to have a ‘Low Concern’ regarding overall abundance because the majority of major stocks typically exceed management targets.

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**Puget Sound, Purse Seine–Sockeye**

**Low Concern**

The Puget Sound sockeye salmon fishery targets primarily Fraser River sockeye salmon originating from British Columbia. Relatively small sockeye runs occur in Lake Washington and Baker Lake, but these runs often are not sufficient to allow a directed commercial harvest. The Fraser sockeye salmon stock consists of many populations but is managed according to 4 migration timing groups; spawning escapements are monitored on about 18 populations. Fraser sockeye abundance is cyclic, and productivity has been highly variable in recent years. In 2009, a peak cycle year, the sockeye run was much lower than anticipated, leading to multiple inquiries (Peterman et al. 2010). However, in 2010, the run was one of the largest in the past 50 or more years. The 2014 return is expected to be near 20 million sockeye salmon. Spawning escapements of the timing groups have fluctuated about the escapement targets, which vary year to year (Fraser River Panel 2012). Some populations include artificial spawning channel sockeye, which are enumerated separately. Fraser sockeye abundance is judged to have a ‘Low Concern’ regarding overall abundance because the majority of major stocks typically exceed management targets. Weak sockeye stocks are evaluated under Criterion 2.
Rationale
Although the major stocks have been relatively abundant, some smaller stocks have been depressed (CSAS 2013). For example, the Cultus population was determined to be endangered by COSEWIC (Committee on the Status of Endangered Wildlife in Canada), leading to actions to reduce harvest rates to some extent (see Criterion 2). Fraser sockeye abundance is judged to have a ‘Low Concern’ regarding overall abundance because the majority of major stocks typically exceed management targets.

Columbia River, Gillnet, Drift–Sockeye

Moderate Concern
Sockeye salmon stocks in the Columbia Basin have declined substantially from historic levels. Currently, most ocean-migrating (anadromous), naturally produced sockeye originate from the Okanogan and Wenatchee basins. Escapement goals for Bonneville Dam (relating to all stocks) have been met in 93% of the past fifteen years (1999-2013), and the goal for Wenatchee sockeye has been met in 53% of the past fifteen years (Joint Columbia River Management Staff 2014b). However, Wenatchee sockeye are a mixed natural and hatchery stock, and the escapement goal and escapement counts do not differentiate between natural and hatchery-origin fish. Conservation concern was therefore rated ‘Moderate Concern.’

Rationale
The escapement goal of 65,000 sockeye salmon at Priest Rapids Dam requires that 75,000 sockeye migrate past Bonneville Dam. The Wenatchee River has a current escapement goal of 23,000 adult sockeye. Escapements to the Wenatchee River have been cyclical and have frequently not met the management goal. Nonetheless, escapements have been relatively high since 2008 (Joint Columbia River Management Staff 2014b). Wenatchee sockeye are a mixed natural and hatchery stock that includes native fish. Snake River sockeye is another anadromous sockeye stock occurring in the Columbia River basin, but it is listed as Endangered under the Endangered Species Act and is evaluated under Criterion 2. In addition, sockeye have been recently re-introduced in the Yakima River, and passage has been re-established at Round Butte Dam on the Deschutes River. However, these stocks are not currently considered major contributors to the fishery.

Washington North Pacific, Gillnet, Drift–Sockeye

Low Concern
Washington coastal sockeye salmon stocks include Lake Pleasant and Quinault sockeye. The Lake Pleasant spawning population is small but stable (mean of 1039 fish from 1999-2013) and probably caught only incidentally. Quinault sockeye are a naturally produced stock with an annual escapement goal of 15,000 fish, which has been met for 73% of the past fifteen years from 1999 to 2013 (Rawson et
There is currently no significant hatchery production for Washington coastal sockeye stocks. Because the major stock is generally meeting escapement goals, conservation concern was deemed ‘Low Concern.’

**Rationale**

Lake Ozette is another Washington coastal sockeye stock, but the stock is listed under the Endangered Species Act as threatened and will not be evaluated here. Quinault sockeye escapements appear cyclical, with peak abundances from 2001 to 2004 and 2009 to 2012.

![Quinault sockeye escapements](image)

Figure 24: Quinault sockeye escapements (blue line) relative to the escapement target of 15,000 fish (black line).

**Factor 1.3—Fishing Mortality**

**Scoring Guidelines**

- **5 (Very Low Concern)**—Highly likely that fishing mortality is below a sustainable level (e.g., below fishing mortality at maximum sustainable yield, FMSY), OR fishery does not target species and its contribution to the mortality of species is negligible (≤ 5% of a sustainable level of fishing mortality).

- **3.67 (Low Concern)**—Probable (>50%) chance that fishing mortality is at or below a sustainable level, but some uncertainty exists, OR the majority (>75%) of major stocks encountered in the fishery exhibit population trends that are increasing or stable in the short and long term due to management AND all stocks which exhibit decline do not exceed a 5% annual decrease in abundance.
• **2.33 (Moderate Concern)**—Fishing mortality is fluctuating around sustainable levels, OR fishing mortality is unknown but for any depleted population effective management is in place OR most (>50%) of the major stocks encountered exhibit population trends that are increasing or stable in the short and long term AND all stocks which exhibit decline do not exceed a 5% annual decrease in abundance.

• **1 (High Concern)**—Overfishing is occurring, but management is in place to curtail overfishing, OR fishing mortality is unknown, species is depleted, and no effective management is in place OR most (>50%) major stocks encountered in the fishery are exhibiting declines in abundance.

• **0 (Critical)**—Overfishing is known to be occurring and no reasonable management is in place to curtail overfishing.

### Puget Sound, Gillnet, Drift–Sockeye

**Low Concern**

The Puget Sound sockeye salmon fishery targets primarily Fraser River sockeye salmon in British Columbia. Relatively small sockeye runs occur in Lake Washington and Baker Lake, but these runs often are not sufficient to allow a directed commercial harvest. Fraser sockeye salmon consists of many populations but it is managed according to 4 migration timing groups; spawning escapements are monitored on about 18 populations. Fraser sockeye abundance is cyclic and productivity has been highly variable in recent years (Peterman et al. 2010). Harvest rates are adjusted inseason to reflect inseason estimates of abundance of each run timing group (Fraser River Panel 2012)(DFO 2013a). Spawning escapements of the timing groups have fluctuated about the escapement targets, which vary year to year (Fraser River Panel 2012). Over the past 20 years, total spawning escapement of sockeye salmon to the Fraser River has increased, whereas stock productivity has often declined (Connors et al. 2010). Some populations include artificial spawning channel sockeye, which are enumerated separately. Overall, Fraser sockeye is judged to have a low concern regarding fishing mortality because the run timing groups are typically (>50% of time) managed at sustainable harvest levels. See Criterion 2 for weak sockeye stocks.

### Puget Sound, Purse Seine–Sockeye

**Low Concern**

The Puget Sound sockeye salmon fishery targets primarily Fraser River sockeye salmon in British Columbia. Relatively small sockeye runs occur in Lake Washington and Baker Lake, but these runs often are not sufficient to allow a directed commercial harvest. Fraser sockeye salmon consists of many populations but it is managed according to 4 migration timing groups; spawning escapements are monitored on about 18 populations. Fraser sockeye abundance is cyclic and productivity has been highly variable in recent years (Peterman et al. 2010). Harvest rates are adjusted inseason to reflect inseason estimates of abundance of each run timing group (Fraser River Panel 2012)(DFO 2013a). Spawning escapements of the timing groups have fluctuated about the escapement targets, which vary year to year (Fraser River Panel 2012). Over the past 20 years, total spawning escapement of sockeye salmon to the Fraser River has increased, whereas stock productivity has often declined (Connors et al. 2010). Some populations include artificial spawning channel sockeye, which are enumerated separately. Overall, Fraser sockeye is judged to have a low concern regarding fishing mortality because the run timing groups are typically (>50% of time) managed at sustainable harvest levels. See Criterion 2 for weak sockeye stocks.
2013a). Spawning escapements of the timing groups have fluctuated about the escapement targets, which vary year to year (Fraser River Panel 2012). Over the past 20 years, total spawning escapement of sockeye salmon to the Fraser River has increased, whereas stock productivity has often declined (Connors et al. 2010). Some populations include artificial spawning channel sockeye, which are enumerated separately. Overall, Fraser sockeye is judged to have a ‘Low Concern’ regarding fishing mortality because the run timing groups are typically (>50% of time) managed at sustainable harvest levels. See Criterion 2 for weak sockeye stocks.

### Columbia River, Gillnet, Drift–Sockeye

**Low Concern**

Major stocks caught in this fishery include Okanogan and Wenatchee sockeye. Under the U.S. versus Oregon 2008-2017 Management Agreement, fishery exploitation rates on specific stocks are managed using harvest rate schedules. To help protect Snake River sockeye, tribal commercial fisheries are limited to harvesting 5%–7% of the run, with the allowable harvest rate depending on sockeye run size, and non-tribal commercial fisheries are limited to harvesting 1% of the run (Joint Columbia River Management Staff 2014b). The 1% harvest allowance for non-tribal commercial fisheries is essentially incidental catch; there is no targeted non-tribal commercial fishery on Snake River sockeye. Escapement estimates do not indicate that stocks are declining. For example, Wenatchee River escapements have been cyclical and appear to be slightly increasing or at least stable since 2008 (Fig. 25). Thus, concern regarding fishing mortality is judged to be a ‘Low Concern’ at this time.

**Rationale**

Under U.S. versus Oregon, non-Indian and treaty Indian commercial fisheries for sockeye only occur when the escapement goal of 75,000 fish at Bonneville Dam has been achieved (Joint Columbia River Management Staff 2014b).

Escapements to the Wenatchee River have been cyclical and have met the management goal in only 53% of the past fifteen years (1999 to 2013). Nevertheless, escapements have been relatively high since 2008 (Fig. 25)(Joint Columbia River Management Staff 2014b). The Wenatchee stock has relatively little hatchery production, although there have been increasing releases of sockeye fry produced in Canada. While the proportion of hatchery fish is low, estimated exploitation rates should reflect fishing mortality on the natural-origin stock. This assumption will need to be checked if hatchery releases increase, particularly if natural- and hatchery-produced fish differ at all in run timing, body size at return, or other biological characteristics.
Figure 25: Wenatchee sockeye escapements (blue line) relative to the escapement target of 23,000 fish (black line).

**Washington North Pacific, Gillnet, Drift–Sockeye**

**Low Concern**

Quinault sockeye are the major stock caught in this fishery. Escapement data indicate that this stock is not currently in decline (Fig. 24), and the National Oceanic and Atmospheric Administration does not consider the stock overfished. Harvest is managed to not exceed a 40% exploitation rate (L. Gilbertson pers. comm.), and exploitation rates have not exceeded this limit in any of the past 15 years (1999 to 2013), although there was a 40% exploitation rate in 2003 (Rawson et al. 2009). Conservation concern was rated ‘Low Concern.’

**Rationale**

There is currently no significant hatchery production, so the estimated exploitation rates are assumed to be on the naturally produced stock. Quinault sockeye escapements appear cyclical, with peak abundances from 2001 to 2004 and 2009 to 2012 (Fig. 24).
Figure 24: Quinault sockeye escapements (blue line) relative to the escapement target of 15,000 fish (black line).
Criterion 2: Impacts on Other Species

All main retained and bycatch species in the fishery are evaluated in the same way as the species under assessment were evaluated in Criterion 1. Seafood Watch® defines bycatch as all fisheries-related mortality or injury to species other than the retained catch. Examples include discards, endangered or threatened species catch, and ghostfishing. To determine the final Criterion 2 score, the score for the lowest scoring retained/bycatch species is multiplied by the discard rate score (ranges from 0-1), which evaluates the amount of non-retained catch (discards) and bait use relative to the retained catch. The Criterion 2 rating is determined as follows:

- Score >3.2=Green or Low Concern
- Score >2.2 and <=3.2=Yellow or Moderate Concern
- Score <=2.2=Red or High Concern

Ratings are Critical if Factor 2.3 (Fishing Mortality) is Critical.

Criterion 2 Summary

Only the lowest scoring main species is/are listed in the table and text in this Criterion 2 section; a full list and assessment of the main species can be found in Appendix A.

<table>
<thead>
<tr>
<th>Species</th>
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<th>Fishing Mortality</th>
<th>Subscore</th>
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### Chinook Salmon: Klamath River, Gillnet, Drift–Chinook

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### Chinook Salmon: Puget Sound, Gillnet, Drift–Chinook

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### Chinook Salmon: Puget Sound, Purse S seine–Chinook

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### Chinook Salmon: Cape Falcon to Humbug Mt. North Pacific, Trolling Lines–Chinook

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### Chinook Salmon: Horse Mt. to U.S./Mexico Border North Pacific, Trolling Lines–Chinook

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### Chinook Salmon: Humbug Mt. to Horse Mt. North Pacific, Trolling Lines–Chinook

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### Chinook Salmon: North of Cape Falcon North Pacific, Trolling Lines–Chinook

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### Chum Salmon: Puget Sound, Gillnet, Drift–Chum

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### Coho Salmon: Columbia River, Gillnet, Drift–Coho

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<td>Abundance</td>
<td>Fishing Mortality</td>
<td>Subscore</td>
</tr>
<tr>
<td>--------------------------</td>
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<td>--------------------------</td>
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</tr>
<tr>
<td>CHINOOK SALMON: Minor Stocks</td>
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<td>1.00: Very High Concern</td>
<td>1.00: High Concern</td>
<td>1.000</td>
</tr>
<tr>
<td>COHO SALMON: Minor Stocks</td>
<td>Medium</td>
<td>1.00: Very High Concern</td>
<td>2.33: Moderate Concern</td>
<td>1.526</td>
</tr>
<tr>
<td>STEELHEAD</td>
<td>Medium</td>
<td>1.00: Very High Concern</td>
<td>5.00: Very Low Concern</td>
<td>2.236</td>
</tr>
<tr>
<td>COHO SALMON: Major Stocks</td>
<td>Medium</td>
<td>3.00: Moderate Concern</td>
<td>3.67: Low Concern</td>
<td>3.318</td>
</tr>
</tbody>
</table>

**Coho Salmon: Puget Sound, Trolling Lines–Coho**

<table>
<thead>
<tr>
<th>Species</th>
<th>Inherent Vulnerability</th>
<th>Abundance</th>
<th>Fishing Mortality</th>
<th>Subscore</th>
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<tr>
<td>COHO SALMON: Minor Stocks</td>
<td>Medium</td>
<td>1.00: Very High Concern</td>
<td>2.33: Moderate Concern</td>
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<tr>
<td>STEELHEAD</td>
<td>Medium</td>
<td>1.00: Very High Concern</td>
<td>5.00: Very Low Concern</td>
<td>2.236</td>
</tr>
<tr>
<td>COHO SALMON: Major Stocks</td>
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<td>3.00: Moderate Concern</td>
<td>3.67: Low Concern</td>
<td>3.318</td>
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**Coho Salmon: North of Cape Falcon North Pacific, Trolling Lines–Coho**

<table>
<thead>
<tr>
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<th>Inherent Vulnerability</th>
<th>Abundance</th>
<th>Fishing Mortality</th>
<th>Subscore</th>
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</thead>
<tbody>
<tr>
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<td>1.00: High Concern</td>
<td>1.000</td>
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<tr>
<td>COHO SALMON: Minor Stocks</td>
<td>Medium</td>
<td>1.00: Very High Concern</td>
<td>2.33: Moderate Concern</td>
<td>1.526</td>
</tr>
<tr>
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### Coho Salmon: Washington North Pacific, Gillnet, Drift–Coho

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<th>Abundance</th>
<th>Fishing Mortality</th>
<th>Subscore</th>
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<tbody>
<tr>
<td>CHINOOK SALMON: Minor Stocks</td>
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<tr>
<td>COHO SALMON: Major Stocks</td>
<td>Medium</td>
<td>3.00: Moderate Concern</td>
<td>3.67: Low Concern</td>
<td>3.318</td>
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</tbody>
</table>

### Pink Salmon: Puget Sound, Gillnet, Drift–Pink

<table>
<thead>
<tr>
<th>Species</th>
<th>Inherent Vulnerability</th>
<th>Abundance</th>
<th>Fishing Mortality</th>
<th>Subscore</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHINOOK SALMON: Minor Stocks</td>
<td>Medium</td>
<td>1.00: Very High Concern</td>
<td>2.33: Moderate Concern</td>
<td>1.526</td>
</tr>
<tr>
<td>SOCKEYE SALMON: Minor Stocks</td>
<td>Low</td>
<td>1.00: Very High Concern</td>
<td>2.33: Moderate Concern</td>
<td>1.526</td>
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<tr>
<td>PINK SALMON</td>
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<td>5.00: Very Low Concern</td>
<td>5.00: Very Low Concern</td>
<td>5.000</td>
</tr>
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</table>

### Pink Salmon: Puget Sound, Purse Seine–Pink

<table>
<thead>
<tr>
<th>Species</th>
<th>Inherent Vulnerability</th>
<th>Abundance</th>
<th>Fishing Mortality</th>
<th>Subscore</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHINOOK SALMON: Minor Stocks</td>
<td>Medium</td>
<td>1.00: Very High Concern</td>
<td>2.33: Moderate Concern</td>
<td>1.526</td>
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<tr>
<td>SOCKEYE SALMON: Minor Stocks</td>
<td>Low</td>
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<td>2.33: Moderate Concern</td>
<td>1.526</td>
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<tr>
<td>PINK SALMON</td>
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### Pink Salmon: Puget Sound, Trolling Lines–Pink

<table>
<thead>
<tr>
<th>Species</th>
<th>Inherent Vulnerability</th>
<th>Abundance</th>
<th>Fishing Mortality</th>
<th>Subscore</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHINOOK SALMON: Minor Stocks</td>
<td>Medium</td>
<td>1.00: Very High Concern</td>
<td>2.33: Moderate Concern</td>
<td>1.526</td>
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<tr>
<td>SOCKEYE SALMON: Minor Stocks</td>
<td>Low</td>
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<td>2.33: Moderate Concern</td>
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<tr>
<td>PINK SALMON</td>
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### Chinook Salmon: Minor Stocks

<table>
<thead>
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<th>Subscore</th>
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<th>C2 Rate</th>
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<tbody>
<tr>
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<td>1.00: High Concern</td>
<td>1.000</td>
</tr>
<tr>
<td>PINK SALMON</td>
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<td>5.00: Very Low Concern</td>
<td>5.00: Very Low Concern</td>
<td>5.000</td>
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### Sockeye Salmon: Columbia River, Gillnet, Drift–Sockeye

<table>
<thead>
<tr>
<th>Subscore</th>
<th>Discard Rate</th>
<th>C2 Rate</th>
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<tr>
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### Sockeye Salmon: Puget Sound, Gillnet, Drift–Sockeye

<table>
<thead>
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<th>Subscore</th>
<th>Discard Rate</th>
<th>C2 Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.526</td>
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### Sockeye Salmon: Puget Sound, Purse Seine–Sockeye

<table>
<thead>
<tr>
<th>Subscore</th>
<th>Discard Rate</th>
<th>C2 Rate</th>
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<tr>
<td>Species</td>
<td>Inherent Vulnerability</td>
<td>Abundance</td>
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<td>-------------------------------</td>
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<tr>
<td>CHINOOK SALMON: Minor Stocks</td>
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<tr>
<td>SOCKEYE SALMON: Major Stocks</td>
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</table>

**Summary**

The stocks assessed under Criterion 2 were selected based on their depleted status (listed under ESA or determined to be threatened or endangered under COSEWIC) and their potential susceptibility to harvest within the main fisheries being assessed, based on gear type and/or run timing. For example, Columbia River coho fisheries operate during the fall, so only ESA-listed stocks that migrate into the river at that time (fall Chinook, summer steelhead, chum) may be incidentally caught. Non-ESA listed salmon and non-salmon species were typically not assessed because they were not the most vulnerable species caught. In fisheries where multiple ESA-listed stocks were potentially captured, Criterion 2 was largely evaluated using the species that was judged to be most susceptible; this often was a conspecific ESA-listed stock.

**Columbia River**

Commercial gillnet fisheries in the mainstream Columbia River operate within a complex system that includes many salmon stocks, many of which are federally listed. Fisheries targeting Chinook salmon operate over much of the year and may encounter most salmon species, though ESA-listed Chinook and coho stocks are most susceptible to incidental harvest. Fisheries targeting coho salmon operate during the fall and may incidentally catch ESA-listed Chinook, coho, chum, and steelhead. Fisheries targeting sockeye salmon operate during the summer and may incidentally catch ESA-listed Chinook and sockeye. Other ESA-listed species found in Columbia River fishery management areas include the southern distinct population segments (DPSs) of green sturgeon and eulachon (Joint Columbia River Management Staff 2014a), but incidental harvests of these species should be minimal. Lower Columbia River white sturgeon are not ESA listed and may be incidentally caught in some Chinook gillnet fisheries, but retention was prohibited in the 2014 season (Joint Columbia River Management Staff 2015). Gillnets
occasionally capture aquatic birds, which may include the ESA-listed marbled murrelet. Anecdotally, bird bycatch rates are low (Profita 2012), although additional observer data would be useful for confirming bycatch rates (Wiedenfeld et al. 2012).

**Klamath River**
Coho salmon are caught incidentally in the Klamath tribal gillnet fishery targeting Chinook salmon. The primary ESA-listed coho stock that may be encountered in this area is Southern Oregon/Northern California Coast (SONCC) coho. The other ESA-listed species potentially caught in this fishery is the southern DPS of green sturgeon. However, the susceptibility of green sturgeon to the fishery is likely very low. Other ESA-listed stocks are unlikely to be encountered in the Klamath River fishery.

**Puget Sound**
Puget Sound coho, chum, and sockeye salmon fisheries harvest some Puget Sound ESA-listed Chinook salmon to the extent that these fisheries overlap in time and space with Chinook salmon. Very few Hood Canal summer chum, which are ESA listed as threatened, are captured in chum salmon fisheries because their migration timing earlier and location is separate from most fisheries. Other species listed under ESA or determined to be threatened/endangered under COSEWIC that might be incidentally captured in Puget Sound salmon fisheries include Puget Sound steelhead, Ozette Lake sockeye salmon, Cultus sockeye salmon, Interior Fraser coho salmon, southern DPS of green sturgeon, bocaccio, canary rockfish, yelloweye rockfish, and marbled murrelet (NMFS 2014)(US FWS 2014). Natural Resources Consultants conducted bycatch research in some Puget Sound gillnet and purse seine fisheries and found that the susceptibility of these species to the fisheries is low.

**Washington Inside Coast Fisheries**
The ESA-listed Chinook and coho stocks encountered in these fisheries originate from the Lower Columbia River, Oregon coast, California coast, and Puget Sound (Kassler and Marshall 2004). As with Puget Sound, other ESA-listed species that might be incidentally captured include Ozette Lake sockeye salmon, southern DPS of green sturgeon, and marbled murrelet (NMFS 2014)(US FWS 2014). However, the susceptibility of these fish species to drift gillnets is very low. Anecdotally, bird bycatch rates are also low, although additional observer data would be useful for confirming bycatch rates (Wiedenfeld et al. 2012).

**Pacific Fishery Management Council Ocean Fisheries (US/Mexico border to North of Cape Falcon)**
PFMC ocean fisheries encounter ESA-listed stocks of Chinook and coho salmon, and the specific stocks that are incidentally caught vary by area. To help protect ESA-listed coho stocks, coho salmon cannot be retained in fisheries operating south of Cape Falcon. Bycatch of other ESA-listed species, such as sockeye, steelhead, and chum is likely to be very low because they are less susceptible to troll gear.
Criterion 2 Assessment

CHINOOK SALMON: Minor Stocks

Factor 2.1–Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

Cape Falcon to Humbug Mt. North Pacific, Trolling Lines–Chinook
Columbia River, Gillnet, Drift–Chinook
Columbia River, Gillnet, Drift–Coho
Columbia River, Gillnet, Drift–Sockeye
Horse Mt. to U.S./Mexico Border North Pacific, Trolling Lines–Chinook
Humbug Mt. to Horse Mt. North Pacific, Trolling Lines–Chinook
North of Cape Falcon North Pacific, Trolling Lines–Chinook
North of Cape Falcon North Pacific, Trolling Lines–Coho
Puget Sound, Gillnet, Drift–Chum
Puget Sound, Gillnet, Drift–Coho
Puget Sound, Gillnet, Drift–Pink
Puget Sound, Gillnet, Drift–Sockeye
Puget Sound, Purse seine–Chum
Puget Sound, Purse seine–Coho
Puget Sound, Purse seine–Pink
Puget Sound, Purse seine–Sockeye
Puget Sound, Trolling Lines–Coho
Puget Sound, Trolling Lines–Pink
Washington North Pacific, Gillnet, Drift–Chinook
Washington North Pacific, Gillnet, Drift–Chum
The FishBase vulnerability score for Chinook salmon is 68, which corresponds to high inherent vulnerability. However, productivity susceptibility analysis (PSA) suggests moderate vulnerability based on attributes including age at maturity, maximum size, reproductive strategy, and trophic level (see Table 2 for estimates used). We rated inherent vulnerability as 'Medium.'

**Rationale**
The FishBase score is based on life history traits and ecological characteristics including maximum length, age at first maturity, and geographic range (Cheung et al. 2005). Data used for the productivity susceptibility analysis were obtained from Fishbase.org and are shown in Table 2.

<table>
<thead>
<tr>
<th>Trait</th>
<th>Estimate</th>
<th>Score</th>
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<tbody>
<tr>
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<td>3</td>
</tr>
<tr>
<td>Average maximum age (years)</td>
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<tr>
<td>Average maximum size (cm)</td>
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<td>2</td>
</tr>
<tr>
<td>Average size at maturity (cm)</td>
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<td>2</td>
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<tr>
<td>Trophic level</td>
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<td>1</td>
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<tr>
<td>Average score</td>
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<td>2.17</td>
</tr>
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</table>

Table 2. Table of Chinook salmon trait estimates and scores used for determining inherent vulnerability using productivity and susceptibility analysis.

**Factor 2.2–Abundance**

*Scoring Guidelines (same as Factor 1.2 above)*

California Coastal (CC) Chinook, lower Columbia River (LCR) natural tule Chinook, and Snake River Wild (SRW) fall Chinook are ESA-listed stocks landed in this fishery (PFMC 2014a). All of these ESUs are listed as threatened (NOAA 2014a), and thus conservation concern regarding abundance is ‘Very High Concern.’
Very High Concern

There are five ESA (Endangered Species Act)-listed Chinook stocks in the Columbia River fishery management areas. Upper Columbia spring Chinook are listed as endangered, while Snake River fall, Snake River spring/summer, Lower Columbia River spring/fall, and Upper Willamette spring Chinook are listed as threatened (NOAA 2014a). Okanagan Chinook, which are listed as threatened under the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2014), may be encountered as well. Since these stocks are federally listed, they are a ‘Very High’ conservation concern.

Rationale

Three populations are monitored in the Upper Columbia spring Chinook evolutionarily significant unit: Wentachee River, Entiat River, and Methow River. Population abundances for natural-origin adults have been quite low in recent years (Fig. 26), but hatchery-produced fish contribute to abundances in natural spawning areas.

Returns of Snake River fall Chinook have been stable and increasing, with an especially high return in 2013 (Joint Columbia River Management Staff 2014a). There is substantial hatchery supplementation of this stock as part of the conservation strategy, and the proportion of wild-origin fish has been below 40% from at least 2002 until 2008 (NOAA 2014c).
Columbia River, Gillnet, Drift–Coho

**Very High Concern**

There are 5 ESA (Endangered Species Act)-listed Chinook stocks and 1 COSEWIC-listed Chinook stock that occur in Columbia River fishery management areas. Of these stocks, 3 may be caught in Columbia River coho gillnet fisheries: Snake River fall, Lower Columbia River spring/fall, and Okanagan Chinook. Since these stocks are federally listed as threatened, they are a ‘Very High’ conservation concern.
Columbia River, Gillnet, Drift–Sockeye

**Very High Concern**

There are 5 ESA (Endangered Species Act)-listed Chinook stocks and 1 COSEWIC-listed Chinook stock that occur in Columbia River fishery management areas. Some of these stocks do not overlap in run timing with Columbia River sockeye stocks, which migrate through the Lower Columbia River in June and July (Joint Columbia River Management Staff 2014b). Those that do overlap slightly in timing are fall stocks: Snake River fall, Lower Columbia River spring/fall, and Okanagan Chinook. All three are listed as threatened (NOAA 2014a)(COSEWIC 2014). Since these stocks are federally listed, they are a 'Very High' conservation concern.

**Rationale**
The Upper Columbia River summer Chinook stock, which overlaps more substantially with Columbia River sockeye in run timing, is considered a healthy stock and is not ESA-listed (Joint Columbia River Management Staff 2014b).

Horse Mt. to U.S./Mexico Border North Pacific, Trolling Lines–Chinook

**Very High Concern**

Central Valley spring-run (CVS) Chinook, California Coastal (CC) Chinook, and Sacramento River winter-run (SRWC) Chinook are ESA (Endangered Species Act)-listed stocks landed in this fishery (PFMC 2011). CVS and CC Chinook are listed as threatened, and SRWC Chinook are listed as endangered (NOAA 2014a). Conservation concern regarding abundance is therefore ‘Very High.’

Humbug Mt. to Horse Mt. North Pacific, Trolling Lines–Chinook

**Very High Concern**

California Coastal (CC) Chinook is an ESA (Endangered Species Act)-listed stock landed in this fishery (PFMC 2014a). CC Chinook are listed as threatened (NOAA 2014), and thus conservation concern regarding abundance is ‘Very High.’

North of Cape Falcon North Pacific, Trolling Lines–Chinook

**Very High Concern**

Lower Columbia River natural tule Chinook and Snake River wild Chinook are ESA-listed (Endangered
Species Act) stocks that are landed in these fisheries (PFMC 2014a). Both stocks are listed as threatened (NOAA 2014a), and thus conservation concern regarding abundance is ‘Very High.’

Puget Sound, Gillnet, Drift–Chum
Puget Sound, Gillnet, Drift–Coho
Puget Sound, Gillnet, Drift–Pink
Puget Sound, Gillnet, Drift–Sockeye
Puget Sound, Purse seine–Chum
Puget Sound, Purse seine–Coho
Puget Sound, Purse seine–Pink
Puget Sound, Purse seine–Sockeye

**Very High Concern**

Puget Sound coho, chum, pink and sockeye salmon fisheries harvest some Puget Sound ESA-listed Chinook salmon to the extent that these fisheries overlap in time and space with Chinook salmon. Some fisheries reduce Chinook impacts via live-release. This abundance factor receives a “Very High conservation concern” because the gillnet fisheries take some ESA-listed Chinook salmon, whose status is threatened.

**Rationale**

ESA-listed species that might be incidentally captured in Puget Sound salmon fisheries in addition to Puget Sound Chinook include Puget Sound steelhead, Hood Canal summer chum, Ozette Lake sockeye salmon, southern DPS of green sturgeon, bocaccio, canary rockfish, yelloweye rockfish, and marbled murrelet(NMFS 2014)(US FWS 2014). The conservation concern for all of these species is very high, but the susceptibility of these species to drift gillnets is very low.

Puget Sound, Trolling Lines–Coho
Puget Sound, Trolling Lines–Pink

**Very High Concern**

The Puget Sound troll fishery occurs in the Strait of Juan de Fuca. It is a relatively small fishery that targets Chinook and coho, many of which are headed to places other than Puget Sound, including the Columbia River (CDFO/NMFS/WDFW 1988)(PFMC 2014a)(PSC 2012)(PSC 2013c). Puget Sound ESA-
listed Chinook are scored under Criterion 1 in the troll fishery because they likely represent more than 5% of the overall catch of Chinook salmon given that many hatchery stocks are ESA-listed. Genetic data indicate that Columbia River Chinook are a dominant stock taken in this troll fishery although most of these Chinook are not ESA listed (CDFO/NMFS/WDFW 1988). Given the high presence of Columbia River Chinook, we assumed some ESA-listed Chinook from the Columbia River, such as Snake River fall Chinook and Lower Columbia River natural tule Chinook (NOAA 2014a), may be taken in the troll fishery. Therefore, the conservation concern regarding abundance is ‘Very High.’

Rationale
ESA-listed species that might be incidentally captured in Puget Sound salmon fisheries in addition to Puget Sound Chinook include Puget Sound steelhead, Hood Canal summer chum, Ozette Lake sockeye salmon, southern DPS of green sturgeon, bocaccio, canary rockfish, yelloweye rockfish, and marbled murrelet (NMFS 2014)(US FWS 2014). The conservation concern for all of these species is very high, but the susceptibility of the species to salmon trolling is negligible.

| Washington North Pacific, Gillnet, Drift–Chinook |
| Washington North Pacific, Gillnet, Drift–Chum |
| Washington North Pacific, Gillnet, Drift–Coho |
| Washington North Pacific, Gillnet, Drift–Sockeye |

Very High Concern
Although quantities are small, Washington coastal fisheries incidentally catch some ESA-listed stocks. A genetic analysis conducted on Chinook salmon sampled in the 2003 Willapa Bay summer fishery found that approximately 20% of the harvest was of Columbia Basin Chinook stocks, and 9% was of Puget Sound, Oregon Coast, and Northern California Chinook stocks (Kassler and Marshall 2004). ESA-listed stocks that may be caught therefore include California Coastal, Lower Columbia River natural, and Puget Sound Chinook. These stocks are listed as threatened, and thus conservation concern regarding abundance is 'Very High.'

Factor 2.3–Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

| Cape Falcon to Humbug Mt. North Pacific, Trolling Lines–Chinook |

Moderate Concern
ESA-listed Chinook stocks caught in this fishery include California Coastal (CC) Chinook, lower Columbia River (LCR) natural tule Chinook, and Snake River Wild (SRW) fall Chinook. Salmon fisheries in this area are managed using a weak stock approach, where total harvest is contained to meet management
objectives for all stocks, including weak and sometimes ESA-listed stocks. For example, the CC Chinook ESA consultation standard requires a forecast ocean harvest rate on a proxy stock group (age-4 Klamath River fall Chinook) to be no greater than 16%, and there is a combined marine and freshwater exploitation rate limit of 41% for LCR Chinook. The forecast ocean harvest rate on age-4 KRF Chinook was 16% or less from 2001 to 2014, although the postseason harvest rates exceeded 16% in six of these fifteen years (PFMC 2015a). In 2014, a 41% total exploitation rate on LCR natural tules was projected (18% in PFMC-area fisheries) (PFMC 2015b). The ESA-listed stocks caught in this region have shown varying abundance trends, with some populations that are stable but continuing to be at risk of extinction, and SRW escapements being high in recent years. Because depleted populations are subject to some fishing mortality, but most stocks are not declining, conservation concern was rated ‘Moderate.’

Rationale
California Coastal (CC), Lower Columbia River (LCR) natural tule, and Snake River Wild (SRW) fall Chinook are all listed under the Endangered Species Act as threatened. The Pacific Fishery Management Council structured this fishery to meet the following objectives: 1) a combined marine and freshwater exploitation rate limit of 41% for LCR Chinook, 2) at least a 30% reduction in the total ocean age-3 and age-4 exploitation rate from the 1988-1993 average, and 3) an Individual Stock-Based Management index at or below 60% of the 1979-1982 base period average for select Chinook stocks. Objective 1 was the primary constraint for 2013 fisheries in this area, and Council area fisheries were projected to harvest 19.8% of LCR Chinook in 2013 (PFMC 2014a). Additionally, the limited abundance data available for the California Coastal Chinook stock indicate that the population is still at risk of extinction, with temporal trends in abundance being unclear (Fig. 27)(NMFS 2011c). Numbers of Snake River Wild fall Chinook have increased since the stock was listed, but the proportion of hatchery-origin adults has increased dramatically in recent years, making wild stock status somewhat uncertain (NMFS 2011d). Nearly all LCR fall Chinook populations continue to be at risk of extinction (NMFS 2011e).
Figure 27: Chinook salmon population estimates, counts, and indices for populations in the California Coastal Chinook Salmon Evolutionarily Significant Unit. From Williams et al. 2011.

Columbia River, Gillnet, Drift–Chinook
Moderate Concern

The five ESA (Endangered Species Act)-listed Chinook stocks that occur in Columbia River fishery management areas are: Upper Columbia spring, Snake River natural fall (SRW), Snake River spring/summer, Lower Columbia River spring/fall, and Upper Willamette spring Chinook. Okanagan Chinook, which are listed as threatened under the Committee on the Status of Endangered Wildlife in Canada, may be encountered as well. Upper Columbia spring Chinook are the most poorly performing stock since they are listed as endangered (NOAA 2014a). To help protect these stocks from further depletion, non-treaty and treaty fisheries are managed to meet harvest rate schedules provided in the U.S. v. Oregon 2008-2017 Management Agreement. The harvest rate limits were met in 2013 (Joint Columbia River Management Staff 2014a)(Joint Columbia River Management Staff 2014b). However, the population status of listed stocks has not yet improved, because habitat and hydro system conditions have not yet improved sufficiently. Although many hatchery-released fish released in the Columbia Basin are marked, and marked fish are recorded at Bonneville Dam, hatchery- and natural-origin fish are managed together as composite stocks (i.e., they are managed as one stock). Because depleted populations are subject to some fishing mortality, but there is management aimed at maintaining abundances, conservation concern was rated 'Moderate.'

Rationale

Upper Columbia River spring Chinook are harvested by treaty Indian fisheries as part of the ceremonies and subsistence (C&S) entitlement to 10,000 spring and summer Chinook, which does not include tributary harvests. The majority of the entitlement is often taken in treaty Indian fisheries during the winter and spring management periods (January 1 through June 15). The harvest rate limit for spring Chinook is determined by either the Upper Columbia River spring/summer Chinook run size or the Snake River natural spring/summer Chinook run size, depending on whether the forecasted run size for the Snake River stock is more or less than 10% of the total Upper Columbia River run size (Joint Columbia River Management Staff 2014b). Three populations are monitored in the Upper Columbia spring Chinook evolutionarily significant unit: Wentachee River, Entiat River, and Methow River. Population abundances for natural-origin adults have been quite low in recent years (Fig. 26), but hatchery-produced fish contribute to abundances in natural spawning areas (Ford et al. 2011).
Figure 26: Estimated spawning abundances by year for the Upper Columbia River spring Chinook evolutionarily significant unit. The dark line indicates counts of natural-origin adults, and the orange line indicates counts of adults spawning in natural areas, including naturally spawning hatchery-origin fish. The dotted line is the long-term mean of the total adult counts, and the green shaded area indicates plus or minus one standard deviation around the mean. Figure from Ford et al. 2011.

Columbia River, Gillnet, Drift–Coho
Columbia River, Gillnet, Drift–Sockeye

Moderate Concern

Three threatened Chinook stocks may be caught in Columbia River coho and sockeye gillnet fisheries: Snake River fall, Lower Columbia River spring/fall, and Okanagan Chinook. To help protect these stocks from further depletion, non-Indian and treaty Indian fisheries are managed to meet harvest rate schedules provided in the U.S. v. Oregon 2008-2017 Management Agreement. However, the population status of listed stocks has not yet improved, because habitat and hydro system conditions have not yet
improved sufficiently. Although many hatchery-released fish released in the Columbia Basin are marked, and marked fish are recorded at Bonneville Dam, hatchery- and natural-origin fish are managed together as composite stocks (i.e., they are managed as one stock). Because depleted populations are subject to some fishing mortality, but there is management aimed at maintaining abundances, conservation concern was rated 'Moderate.'

**Rationale**
Data for Lower Columbia River fall Chinook index populations indicate that these stocks continue to have low abundances.
Figure 29: Estimated spawning abundances by year for the Chinook salmon coastal major population group in the lower Columbia River evolutionarily significant unit. The dark line indicates counts of natural-origin adults, and the orange line indicates counts of adults spawning in natural areas, including naturally spawning hatchery-origin fish. The dotted line is the long-term mean of the total adult counts, and the green shaded area indicates plus or minus one standard deviation around the mean. Figure from Ford et al. 2011.
High Concern

ESA-listed (Endangered Species Act) Chinook stocks caught in this fishery include Central Valley spring-run (CVS) Chinook, California Coastal (CC) Chinook, and Sacramento River winter-run (SRWC) Chinook. Salmon fisheries in this area are managed using a weak stock approach, where total harvest is contained to meet management objectives for all stocks, including weak and sometimes ESA-listed stocks. For example, ESA consultation standards require the forecast ocean harvest rate on a proxy stock group for CC Chinook (age-4 Klamath River fall Chinook) to be no greater than 16%, and a 2014 maximum forecast age-3 impact rate of 15.4% for SRWC Chinook in the area south of Point Arena (PFMC 2015b). The forecast ocean harvest rate on age-4 KRF Chinook was 16% or less from 2001 to 2014, although the postseason harvest rates exceeded 16% in six of these fifteen years (PFMC 2015a). The population status of listed stocks has not yet improved, presumably due to multiple factors including harvest and availability of suitable spawning habitat. Additionally, ocean harvests of Chinook are substantial in this region, with over 150,000 fish landed each year since 2012 (PFMC 2014a). Because depleted populations are subject to some fishing mortality, and management aimed at maintaining abundances may not be wholly effective, conservation concern was rated ‘High Concern.’

Rationale

Management for Chinook fisheries in this area is guided by the Pacific Fishery Management Council’s Pacific Coast Salmon Fishery Management Plan. The constraining management objectives in 2013 for this area were: 1) a marine exploitation rate limit of 16% on age-4 Klamath River Fall Chinook and 2) measures for limiting harvest of Sacramento River winter-run Chinook (SRWC). Objective 1 aims to limit harvest of California Coastal Chinook. Objective 2 includes an exploitation rate limit on age-3 SRWC salmon south of Point Arena based on escapement counts in previous years, minimum sizes for fish that can be caught, and a maximum range of fishery opening and closing dates (PFMC 2015a). These objectives were projected to be met in 2013 (PFMC 2014a). Despite the presence of management measures, the status of Central Valley Spring-run (CVS) Chinook salmon has likely deteriorated since 2005, with some independent populations showing an increase in extinction risk (NMFS 2011a). Estimated escapements for Sacramento River winter-run (SRWC) Chinook showed a substantial decline of about 90% from 2005 to 2010 (Fig. 28)(NMFS 2011b). There are limited escapement data for the California Coastal Chinook stock (NMFS 2011c). NMFS has drafted but not yet finalized a recovery plan for CVS and SRW Chinook.
Humbug Mt. to Horse Mt. North Pacific, Trolling Lines—Chinook

**High Concern**

ESA (Endangered Species Act)-listed Chinook stocks caught in this fishery include California Coastal (CC) Chinook. Salmon fisheries in this area are managed using a weak stock approach, where total harvest is contained to meet management objectives for all stocks, including weak and sometimes ESA-listed stocks. For example, the CC Chinook ESA consultation standard requires a forecast ocean harvest rate on a proxy stock group (age-4 Klamath River fall Chinook) to be no greater than 16%. The forecast ocean harvest rate on age-4 KRF Chinook was 16% or less from 2001 to 2014, although the postseason harvest rates exceeded 16% in six of these fifteen years (PFMC 2015a). CC Chinook continue to be at risk of extinction, presumably due to multiple factors including harvest and availability of suitable spawning habitat. Because depleted populations are subject to some fishing mortality, and management aimed at maintaining abundances may not be wholly effective, conservation concern was rated ‘High.’

**Rationale**

Management for Chinook fisheries in this area is guided by the Pacific Fishery Management Council's Pacific Coast Salmon Fishery Management Plan and by Endangered Species Act consultation standards developed by the National Marine Fisheries Service. The constraining management objective in 2013 for this area was a marine exploitation rate limit of 16% on age-4 Klamath River Fall Chinook (KRFC) designed to limit exploitation of California Coastal Chinook. The projected 2013 coast-wide ocean fishery exploitation rate on KRFC was 16% (PFMC 2014a). The limited abundance data available for the California Coastal Chinook stock indicate that the population is still at risk of extinction, with temporal trends in abundance being unclear (NMFS 2011c).

Figure 28: Escapement time series for the Sacramento River winter-run Chinook evolutionarily significant unit (ESU). Escapement counts are the average of counts at Red Bluff Dam and estimates from carcass surveys. From Williams et al. 2011.
Figure 27: Chinook salmon population estimates, counts, and indices for populations in the California Coastal Chinook Salmon Evolutionarily Significant Unit. From Williams et al. 2011.
High Concern

ESA-listed (Endangered Species Act) Chinook stocks caught in this fishery include Lower Columbia River (LCR) natural tule Chinook and Snake River wild (SRW) Chinook. The Pacific Fishery Management Council implements ocean fishery regulations to reduce incidental harvest of ESA-listed stocks by restricting ocean harvest of associated indicator stocks. However, exploitation rates can still be substantial; for instance, the combined marine and freshwater exploitation rate limit on LCR Chinook is 41%, with about 20% harvested by Council fisheries in 2013 (PFMC 2014a). The population status of listed stocks has not yet improved, presumably due to multiple factors, including harvest and availability of suitable spawning habitat. Because depleted populations are subject to some fishing mortality, and management aimed at maintaining abundances may not be wholly effective, conservation concern was rated ‘High.’

Rationale

Management for Chinook fisheries in this area is guided by the Pacific Fishery Management Council’s Pacific Coast Salmon Fishery Management Plan and by Endangered Species Act consultation standards developed by the National Marine Fisheries Service. The primary management constraint in 2013 for this area was: 1) a combined marine and freshwater exploitation rate limit of 41% for Lower Columbia River (LRC) natural tule Chinook. Council area fisheries were projected to harvest 19.8% of LCR Chinook in 2013 (PFMC 2014a). Nearly all LCR fall Chinook populations continue to be at risk of extinction (Fig. 29)(NMFS 2011e), and some populations are subjected to potential genetic and ecological impacts associated with large hatchery releases (NMFS 2012c). Numbers of natural-origin SRW Chinook have increased since the stock was listed, but the proportion of hatchery-origin adults has increased dramatically in recent years, making wild stock status somewhat uncertain (NMFS 2011d).

One concern related to exploitation rates is that hatchery stocks and ESA-listed wild stocks are harvested together in this fishery. The productivity of wild stocks may be lower than that of the hatchery stocks (Winship et al. 2014), and if harvest rates do not account for these productivity differences, the wild stocks can be depleted more rapidly than the hatchery stocks.
Figure 29: Estimated spawning abundances by year for the Chinook salmon coastal major population group in the Lower Columbia River evolutionarily significant unit. The dark line indicates counts of natural-origin adults, and the orange line indicates counts of adults spawning in natural areas, including naturally spawning hatchery-origin fish. The dotted line is the long-term mean of the total adult counts, and the green shaded area indicates plus or minus one standard deviation around the mean. Figure from Ford et al. 2011.
Puget Sound, Gillnet, Drift–Chum

Puget Sound, Gillnet, Drift–Coho

Puget Sound, Gillnet, Drift–Pink

Puget Sound, Gillnet, Drift–Sockeye

**Moderate Concern**

Puget Sound coho, chum, and sockeye salmon fisheries harvests some Puget Sound ESA-listed Chinook salmon to the extent that these fisheries overlap in time and space with Chinook salmon. Some gillnet fisheries reduce Chinook impacts via live-release after holding the fish in live boxes and by altering time and area of fisheries (WDFW 2013). Management assumes a catch and release mortality rate of 52% for gillnet caught Chinook (Puget Sound Indian Tribes and the Washington Department of Fish and Wildlife. 2010.). This fishing mortality factor receives a Moderate Concern’ because the gillnet fisheries take some ESA-listed Chinook salmon, whose status is threatened, and natural-origin abundance of Chinook has been relatively stable over the past 10 years (Ford et al. 2011).

Puget Sound, Purse seine–Chum

Puget Sound, Purse seine–Coho

Puget Sound, Purse seine–Pink

Puget Sound, Purse seine–Sockeye

**Moderate Concern**

Purse seines in Puget Sound typically target the more abundant sockeye, pink and chum salmon rather than Chinook (Puget Sound Indian Tribes and the Washington Department of Fish and Wildlife. 2010.) (WDFW 2013). The non-treaty purse seine fishery live releases all Chinook salmon after recovery in live boxes in all areas, except for the directed fishery in 7B (near Nooksack R), prior to Oct 20. A 33% morality rate is applied to the monitored release. Chinook are often retained in the treaty fishery. This factor is judged to be a ‘Moderate Concern’ rather than high concern because some incidentally caught Chinook are live-released, seiners typically do not target Chinook except in local areas (7B) with high hatchery abundance, and Chinook abundance trends have been somewhat stable over the past 10 years (Ford et al. 2011).

Puget Sound, Trolling Lines–Coho
Puget Sound, Trolling Lines–Pink

High Concern

The Puget Sound troll fishery is limited to the Strait of Juan de Fuca, and harvests are moderate to small. For example, in 2010, only 2,910 Chinook were harvested (WDFW & PSTIT 2013). In recent years, annual harvests ranged from 400 to over 20,600 in the winter fishery, and from 100 to 4,500 in the spring/summer fishery. Limited genetic data indicate Columbia River and Puget Sound Chinook salmon are the primary stocks taken in this fishery, which occurs over multiple seasons. Given that many Chinook returning to Puget Sound (including some hatchery stocks) and the Columbia River are ESA listed, we assume a portion of the troll catch is on ESA Chinook, though we are not aware of specific estimates. Cumulative harvest rates on these ESA salmon in the fisheries is high, e.g., 56% for brood years 2002 to 2006 (Table 3) (Ford et al. 2011)(PSIT/WDFW 2013). Trends in catch versus predicted catch have been relatively constant (flat) over the past 6 years, indicating catch is meeting preseason expectations. Long-term annual catch statistics for this fishery were not readily available in reports. However, there is no attempt to reduce mortality on natural fish by live-releasing unmarked salmon even though many Puget Sound populations are not meeting escapement goals for natural-origin fish. Although the NMFS Biological Opinion on the Pacific Salmon Treaty fisheries concludes that the fisheries are achieving recovery exploitation rates and that fisheries would not cause jeopardy to the Puget Sound Chinook ESU, the fisheries are still having a negative impact (NMFS 2008). Therefore, given high harvest rates on an ESA-listed stock and no attempt to live-release ESA salmon, fishing mortality is judged to have a high concern.

Rationale

Table 4.3 – Brood year adult-equivalent exploitation rate ranges and medians for the five 5-year intervals (mixed-maturity) and terminal (mature) fisheries and total exploitation rate estimated for each of the 22 Puget Sound, inside Puget Sound, and all fisheries combined.
Very Low Concern

Fishing mortality on ESA-listed stocks is probably negligible. Summer fisheries have the greatest likelihood of catching ESA-listed Chinook based on migration timing, and a genetic analysis of the 2003 Willapa Bay summer fishery found that 20% of the harvest was of Columbia Basin Chinook stocks, and 9% was of Puget Sound, Oregon Coast, and Northern California Chinook stocks (Kassler and Marshall 2004). In the only Columbia River commercial fishery that catches ESA-listed Lower Columbia River wild (LRW) Chinook, 5% of the 2013 catch was LRW Chinook (Joint Columbia River Management Staff 2014a). Thus, as an example, the catch of ESA-listed Columbia River Chinook may be on the order of 1% (20% x 5%) for Washington coastal summer fisheries. Additionally, the policy document for Grays Harbor Basin salmon management includes objectives for implementation of mark-selective fisheries that release unmarked (natural-origin) fish (WDFW 2014c), and exploitation rates on fall Chinook are limited to 5% when escapements to natural spawning areas are relatively low. Conservation concern regarding fishing mortality was rated ‘Very Low Concern.’

Rationale

Columbia River stock composition data were obtained from Table 19 in the 2014 Joint Columbia River Management Staff Report (Joint Columbia River Management Staff 2014a). The proportion of ESA-listed stocks was calculated as the LRW Chinook stock catch divided by the total catch for the September/October non-treaty commercial fishery, which was the only fishery that caught LRW Chinook.

Exploitation rates on Chinook stocks are estimated using the Chinook Fishery Regulation Assessment Model (FRAM), which uses data from fish that have been marked using coded wire tags.

CHUM SALMON: Minor Stocks

Factor 2.1—Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

Puget Sound, Gillnet, Drift–Chum
Puget Sound, Purse Seine–Chum

Medium

The FishBase vulnerability score for chum salmon is 49, making inherent vulnerability ‘Medium.’ The FishBase score is based on life history traits and ecological characteristics including maximum length, age at first maturity, and geographic range (Cheung et al. 2005). Chum salmon have medium vulnerability because although they are a relatively large salmon, they have the widest natural geographic distribution of all Pacific salmon species.

Factor 2.2–Abundance

Scoring Guidelines (same as Factor 1.2 above)

Puget Sound, Gillnet, Drift–Chum
Puget Sound, Purse Seine–Chum

Very High Concern

Hood Canal summer chum salmon have undergone a significant decline in abundance, leading to being listed as a threatened species under the Endangered Species Act. This ESU includes summer chum in the Strait of Juan de Fuca. Hood Canal summer chum have increased from less than 1,000 spawners in the early 1990s to 10,000 to 60,000 in the early 2000s, and to 7,000 to 30,000 during 2009 to 2012 (WDFW 2014b). Abundance has improved, in part, from conservation hatchery efforts, i.e., hatchery propagation specifically designed to improve summer chum status rather than to provide some harvest (WDFW 2013)(WDFW 2014b)(WDFW and Point No Point Treaty Tribes 2000). The abundance of Hood Canal summer chum is judged to have a ‘Very High’ conservation concern it remains listed as threatened under ESA.

Factor 2.3–Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

Puget Sound, Gillnet, Drift–Chinook
Puget Sound, Gillnet, Drift–Chum

Low Concern

The fisheries management goal for ESA-listed summer chum in Puget Sound is to keep fishing mortality to less than 10%. During 2003 to 2012, fishing mortality of Hood Canal summer chum averaged 9% per year whereas fishing mortality of Strait of Juan de Fuca summer chum was less than 1% (WDFW
As noted previously, abundance of summer chum has increased over time. Based on improved abundance and low harvest rates on summer chum, fishing mortality is judged to have a ‘Low’ conservation concern.

Puget Sound, Purse Seine-Chum

Low Concern

The fisheries management goal for ESA-listed summer chum in Puget Sound is to keep fishing mortality to less than 10%. During 2003 to 2012, fishing mortality of Hood Canal summer chum averaged 9% per year whereas fishing mortality of Strait of Juan de Fuca summer chum was less than 1% (WDFW 2013)(WDFW 2014b). As noted previously, abundance of summer chum has increased over time. Based on improved abundance and low harvest rates on summer chum, fishing mortality is judged to have a ‘Low’ conservation concern.

COHO SALMON: Minor Stocks

Factor 2.1–Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

Cape Falcon to Humbug Mt. North Pacific, Trolling Lines
Cape Falcon to Humbug Mt. North Pacific, Trolling Lines–Chinook
Columbia River, Gillnet, Drift–Chinook
Horse Mt. to U.S./Mexico Border North Pacific, Trolling Lines–Chinook
Humbug Mt. to Horse Mt. North Pacific, Trolling Lines–Chinook
Klamath River, Gillnet, Drift–Chinook
North of Cape Falcon North Pacific, Trolling Lines–Chinook
North of Cape Falcon North Pacific, Trolling Lines–Coho
Puget Sound, Gillnet, Drift–Chinook
Puget Sound, Gillnet, Drift–Coho
Puget Sound, Gillnet, Drift–Sockeye
The FishBase vulnerability score for coho salmon is 53, making inherent vulnerability ‘Medium.’ The FishBase score is based on life history traits and ecological characteristics including maximum length, age at first maturity, and geographic range (Cheung et al. 2005). Coho salmon have medium vulnerability because they widely distributed but occur in somewhat small and isolated populations.

**Factor 2.2–Abundance**

*Scoring Guidelines (same as Factor 1.2 above)*

Cape Falcon to Humbug Mt. North Pacific, Trolling Lines

- **Very High Concern**

Coho salmon caught in this area are managed as a mixture of stocks termed the Oregon Production Index (OPI), which includes all Washington, Oregon, and California natural and hatchery stocks originating from streams south of Leadbetter Point, Washington. Some stocks produced north of Leadbetter point are intercepted also (PFMC 2011). The largest naturally produced coho stock is the Oregon Coast Natural (OCN) stock. OCN and two other stocks (Lower Columbia Natural coho and Southern Oregon/Northern California Coast coho) in the OPI area are all listed as threatened under the Endangered Species Act (ESA) (NOAA 2014a). Because the major natural coho stocks are ESA listed, conservation concern was rated ‘Very High Concern.’

**Rationale**

The OCN coho evolutionarily significant unit includes salmon originating from coastal rivers south of the Columbia River and north of Cape Blanco, and also coho salmon from the Cow Creek Hatchery Program. OCN escapements have fluctuated over the past fifteen years (1999 to 2013), with relatively low counts in 2012 and 2013 (PFMC 2014a). Southern Oregon/Northern California Coast coho includes naturally spawned coho originating from coastal streams and rivers between Cape Blanco, Oregon, and Punta Gorda, California, and coho from three artificial propagation programs. Lower Columbia River natural coho includes naturally spawned coho originating from the Columbia River and its tributaries downstream from the Big White Salmon and Hood rivers (inclusive), coho originating from the Willamette River and its tributaries below Willamette Falls, and coho from 21 artificial propagation
Cape Falcon to Humbug Mt. North Pacific, Trolling Lines–Chinook

Very High Concern

Coho salmon caught in this area are managed as a mixture of stocks termed the Oregon Production Index (OPI), which includes all Washington, Oregon, and California natural and hatchery stocks originating from streams south of Leadbetter Point, Washington. Some stocks produced north of Leadbetter point are intercepted also (PFMC 2011). The largest naturally produced coho stock is the Oregon Coast Natural (OCN) stock. OCN and two other stocks (Lower Columbia Natural coho and Southern Oregon/Northern California Coast coho) in the OPI area are all listed as threatened under the Endangered Species Act (ESA) (NOAA 2014a). Because the major natural coho stocks are ESA listed, conservation concern was rated ‘Very High.’

Rationale

The OCN coho evolutionarily significant unit includes salmon originating from coastal rivers south of the Columbia River and north of Cape Blanco, and also coho salmon from the Cow Creek Hatchery Program. OCN escapements have fluctuated over the past fifteen years (1999 to 2013), with relatively low counts in 2012 and 2013 (PFMC 2014a). Southern Oregon/Northern California Coast coho includes naturally spawned coho originating from coastal streams and rivers between Cape Blanco, Oregon, and Punta Gorda, California, and coho from three artificial propagation programs. Lower Columbia River natural coho includes naturally spawned coho originating from the Columbia River and its tributaries downstream from the Big White Salmon and Hood rivers (inclusive), coho originating from the Willamette River and its tributaries below Willamette Falls, and coho from 21 artificial propagation programs.

Columbia River, Gillnet, Drift–Chinook

Very High Concern

Wild coho populations were largely extirpated from Columbia River tributaries by the 1930s (Joint Columbia River Management Staff 2014a). The only remaining natural stock is Lower Columbia River coho, which is listed under the Endangered Species Act as threatened (NOAA 2014a). The Lower Columbia River coho evolutionarily significant unit (ESU) includes both naturally spawned and hatchery-produced fish, with a large majority being hatchery produced. Management does not differentiate between natural- and hatchery-origin fish when determining whether escapement goals are met, but efforts are being made to monitor proportions of hatchery fish in some Columbia River tributaries. Because this stock is listed as threatened, conservation concern was deemed ‘Very High.’
Rationale
The lower Columbia River coho ESU includes naturally spawned coho salmon originating from the Columbia River and its tributaries downstream from the Big White Salmon and Hood Rivers (inclusive), and from the Willamette River and its tributaries below Willamette Falls. Coho produced in 21 artificial propagation programs are included as well. Unmarked, naturally produced coho have also been returning to the Columbia River system in increasing numbers since 2000, but they are of unknown origin (Joint Columbia River Management Staff 2014a).

One positive management development is that the Yakama Nation has re-introduced coho to the Yakima, Wenatchee, and Methow River basins (Bonneville Power Administration et al. 2012). These fish are not marked because they are attempting to rebuild the stocks, and some fisheries target marked fish.

Horse Mt. to U.S./Mexico Border North Pacific, Trolling Lines–Chinook
Very High Concern
ESA-listed coho salmon caught in this area include Central California Coast, Southern Oregon/Northern California Coast, and Oregon Coast Natural (OCN) coho. Oregon Coast Natural and Southern Oregon/Northern California Coast coho are listed as threatened, while Central California Coast coho are listed as endangered (NOAA 2014a). Because these stocks are ESA listed, conservation concern was rated ‘Very High.’

Rationale
The Oregon Coast Natural (OCN) coho evolutionarily significant unit includes salmon originating from coastal rivers south of the Columbia River and north of Cape Blanco, and also coho salmon from the Cow Creek Hatchery Program. OCN escapements have fluctuated over the past fifteen years (1999 to 2013), with relatively low counts in 2012 and 2013 (PFMC 2014a). Central California Coast coho includes naturally spawned coho originating from rivers south of Punta Gorda, California to and including Aptos Creek, coho originating from tributaries to San Francisco Bay, and coho from three artificial propagation programs. Southern Oregon/Northern California Coast coho includes naturally spawned coho originating from coastal streams and rivers between Cape Blanco, Oregon, and Punta Gorda, California, and coho from three artificial propagation programs.

Humbug Mt. to Horse Mt. North Pacific, Trolling Lines–Chinook
Very High Concern
ESA (Endangered Species Act)-listed coho salmon caught in this area include Lower Columbia River
natural (LCN), Central California Coast (CCC), Southern Oregon/Northern California Coast (SONCC), and Oregon Coast Natural (OCN) coho. LCN, OCN, and SONCC coho are listed as threatened, while CCC coho are listed as endangered (NOAA 2014a). Because these stocks are ESA listed, conservation concern was rated ‘Very High.’

**Rationale**
The Oregon Coast Natural (OCN) coho evolutionarily significant unit includes salmon originating from coastal rivers south of the Columbia River and north of Cape Blanco, and also coho salmon from the Cow Creek Hatchery Program. OCN escapements have fluctuated over the past fifteen years (1999 to 2013), with relatively low counts in 2012 and 2013 (PFMC 2014a). Central California Coast coho includes naturally spawned coho originating from rivers south of Punta Gorda, California to and including Aptos Creek, coho originating from tributaries to San Francisco Bay, and coho from three artificial propagation programs. Southern Oregon/Northern California Coast coho includes naturally spawned coho originating from coastal streams and rivers between Cape Blanco, Oregon, and Punta Gorda, California, and coho from three artificial propagation programs. Lower Columbia River natural coho includes naturally spawned coho originating from the Columbia River and its tributaries downstream from the Big White Salmon and Hood rivers (inclusive), coho originating from the Willamette River and its tributaries below Willamette Falls, and coho from 21 artificial propagation programs.

**Klamath River, Gillnet, Drift–Chinook**

**Very High Concern**

Klamath River coho are part of the Southern Oregon/Northern California Coastal (SONCC) classified as ‘Threatened’ under the Endangered Species Act (ESA) (NOAA 2014a). Therefore, the conservation concern was deemed “Very High.”

**Rationale**

Klamath River coho are part of the Southern Oregon/Northern California Coastal (SONCC) coho that were classified as ‘Threatened’ under ESA in 1997 (NOAA 2014b). Long-term data on SONCC coho abundance are scarce, but the available evidence from limited monitoring efforts indicates that populations continued to decline between 2005 and 2010 (NOAA 2011f). Coho salmon are released at two hatcheries in the Klamath Basin, but hatchery and wild components are managed together.

**North of Cape Falcon North Pacific, Trolling Lines–Chinook**

**Very High Concern**

ESA (Endangered Species Act)-listed coho salmon caught in this area include Lower Columbia River
natural (LCN) and Oregon Coast Natural (OCN) coho. Both LCN and OCN coho are listed as threatened (NOAA 2014a). Interior Fraser River coho, which are listed as endangered under Canada’s ‘Species At Risk Act,’ may also be intercepted (PSC 2013c). Because these stocks are considered depleted, conservation concern was rated ‘Very High.’

**Rationale**
The Oregon Coast Natural (OCN) coho evolutionarily significant unit includes salmon originating from coastal rivers south of the Columbia River and north of Cape Blanco, and also coho salmon from the Cow Creek Hatchery Program. OCN escapements have fluctuated over the past fifteen years (1999 to 2013), with relatively low counts in 2012 and 2013 (PFMC 2014a). Lower Columbia River natural coho includes naturally spawned coho originating from the Columbia River and its tributaries downstream from the Big White Salmon and Hood rivers (inclusive), coho originating from the Willamette River and its tributaries below Willamette Falls, and coho from 21 artificial propagation programs. Interior Fraser River coho spawn in the Fraser River watershed in Canada. Based on reconstructed escapements for naturally produced fish, the short-term escapement target of 20,000 fish has been exceeded every year since 2008, and the long-term target of 40,000 was exceeded in 2012 and 2013 (CSAS 2014).

**Puget Sound, Gillnet, Drift–Chinook**

**Puget Sound, Gillnet, Drift–Coho**

**Puget Sound, Gillnet, Drift–Sockeye**

**Puget Sound, Purse Seine–Chinook**

**Puget Sound, Purse Seine–Coho**

**Puget Sound, Purse Seine–Sockeye**

**Puget Sound, Trolling Lines–Chinook**

**Puget Sound, Trolling Lines–Coho**

**Very High Concern**

The Interior Fraser River population of coho salmon was determined to be Endangered by COSEWIC in 2002, and this status continues to present ((COSEWIC 2014)(Decker et al. 2014)). Interior Fraser River coho are captured in Puget Sound salmon fisheries. Escapement of interior coho declined sharply from the late 1980s to mid-1990s; escapement has improved since 2010, and escapement during 2012 and 2013 appears to have exceeded the long-term objective (i.e., 20,000 spawners). Although there are some indications of increasing escapement, the abundance of Interior Fraser coho salmon is judged to be a ‘Very High’ conservation concern because it remains an endangered species.
Factor 2.3–Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

Cape Falcon to Humbug Mt. North Pacific, Trolling Lines

Very Low Concern

ESA (Endangered Species Act)-listed coho stocks caught in this fishery include Oregon Coast Natural (OCN), Southern Oregon/Northern California Coast (SONCC), and Lower Columbia Natural (LCN) coho. Commercial troll fisheries south of Cape Falcon have not been allowed to retain coho salmon since 1993, with the exception of limited fisheries in 2007 and 2009 that were not selective for marked hatchery fish (PFMC 2008b). However, some bycatch mortality occurs. In 2013, observed bycatch mortality from commercial troll fisheries south of Cape Falcon was 8,700 fish (PFMC 2014b). Estimated exploitation rates on OCN coho were under management-determined rate limits in 93% of the past fifteen years (1999-2013), and LCN coho exploitation rates were under limits in 78% of the years from 2005 to 2013 (PFMC 2014a). Because it is highly likely that fishing mortality is at or below a sustainable level that will maintain current population abundances, conservation concern regarding fishery mortality was deemed 'Very Low.'

Rationale

Postseason estimates of exploitation rates on Oregon Coast Natural coho are obtained from the Pacific Fishery Management Council’s Fishery Regulation Assessment (FRAM) model. These estimates are for exploitation from all fisheries (commercial and recreational) and are based on estimated discard mortality (PFMC 2008a). Escapement data for Oregon Coast Natural coho suggests that spawner abundances have fluctuated over the past fifteen years (1999 to 2013), with relatively low counts in 2012 and 2013 (Fig. 30) (PFMC 2014a). Escapement counts include hatchery-origin salmon produced at Cow Creek Hatchery.

Cape Falcon to Humbug Mt. North Pacific, Trolling Lines–Chinook

Very Low Concern

ESA-listed coho stocks caught in this fishery include Oregon Coast Natural (OCN), Southern Oregon/Northern California Coast (SONCC), and Lower Columbia Natural (LCN) coho. Commercial troll fisheries south of Cape Falcon have not been allowed to retain coho salmon since 1993, with the exception of limited fisheries in 2007 and 2009 that were not selective for marked hatchery fish (PFMC 2008b). However, some bycatch mortality occurs. In 2013, observed bycatch mortality from commercial troll fisheries south of Cape Falcon was 8,700 fish (PFMC 2014b). Estimated exploitation rates on OCN coho were under management-determined rate limits in 93% of the past fifteen years (1999-2013), and LCN coho exploitation rates were under limits in 78% of the years from 2005 to 2013 (PFMC 2014a). Because it is highly likely that fishing mortality is at or below a sustainable level that will maintain
current population abundances, conservation concern regarding fishery mortality was deemed 'Very Low.'

Rationale
Postseason estimates of exploitation rates on Oregon Coast Natural coho are obtained from the Pacific Fishery Management Council’s Fishery Regulation Assessment (FRAM) model. These estimates are for exploitation from all fisheries (commercial and recreational) and are based on estimated discard mortality (PFMC 2008a). Escapement data for Oregon Coast Natural coho suggests that spawner abundances have fluctuated over the past fifteen years (1999 to 2013), with relatively low counts in 2012 and 2013 (Fig. 30)(PFMC 2014a). Escapement counts include hatchery-origin salmon produced at Cow Creek Hatchery.

![Oregon Coast Natural escapements](image)

Figure 30: Oregon Coast Natural coho escapements (blue line). The escapement counts are for fish spawning in natural areas but may include both hatchery and natural-origin fish.

Columbia River, Gillnet, Drift–Chinook

Moderate Concern
The only major Columbia River coho stock is Lower Columbia River natural (LCN) coho, which is listed under the Endangered Species Act but harvested in fall Columbia gillnet fisheries. Lower Columbia River coho escapements do not appear to be declining, and estimated wild abundance was especially high in 2014 (see Fig. 19 in Detailed Rationale). Under the U.S. versus Oregon 2008-2017 Management
Agreement, fishery exploitation rates on specific stocks (including LCN coho) are managed using harvest rate schedules, where harvest limits are determined each year based on in-season monitoring of salmon abundances. For LCN coho these limits have ranged from 8% to 20%, and estimated exploitation rates on LCN coho did not exceed limits in 78% of the years from 2005 to 2013 (PFMC 2014a). Starting in 2015, a new harvest matrix that considers parameters of ocean survival and parental escapement has been used. The new matrix is designed to concentrate fishing in the 18%–23% range while allowing for exploitation rates up to 30% when marine survival is very high. At the same time, exploitation rates are supposed to be lowered in years when levels of artificial juvenile seeding is low (<30% of full seeding) (PFMC 2014f). This change may make harvest limits more responsive to stock status information, but the target exploitation rates do not appear more conservative than they have been since the ESA-listing of LCN coho. Additionally, fishing mortality is estimated on hatchery- and natural-origin fish combined, so there is some uncertainty regarding fishing mortality levels on the wild stock component. Conservation concern was rated 'Moderate.'

Rationale
Columbia River salmon fisheries are complex, spanning essentially all seasons (fall, summer, winter, spring), including multiple components (e.g., commercial and recreational, treaty and non-treaty), and catching both hatchery and non-hatchery stocks, many of which are listed under the Endangered Species Act. Hatcheries in the lower Columbia River mark the coho they produce. Columbia River treaty gillnet fisheries do not selectively harvest marked hatchery salmon, but select area commercial fisheries target hatchery-produced fish in off-channel areas, sometimes using tangle net gear and recovery boxes in more recent years (Joint Columbia River Management Staff 2015b). The allowable exploitation rate on LCN coho is for ocean and non-tribal Columbia River fisheries (downstream of Bonneville Dam) combined. The allocation of non-Indian catch and ESA impacts between ocean and in-river fisheries is determined annually by the states and occurs during the Pacific Fishery Management Council and North of Falcon meetings (Joint Columbia River Management Staff 2015b).

According to run reconstructions conducted by the Oregon Production Index Technical Team, wild LCN coho abundances have been stable and showed a large increase in 2014 (Fig. 19)(ODFW 2015a). Exploitation rates on this stock are estimated using the Coho Fishery Regulation Assessment Model (FRAM), which uses data from fish that have been marked using coded wire tags.
Figure 19: Estimated numbers of wild coho spawners (blue line) for the Oregon portion of the Lower Columbia River coho ESU. Data from Oregon Production Index Technical Team run reconstructions.

Horse Mt. to U.S./Mexico Border North Pacific, Trolling Lines–Chinook

Very Low Concern

ESA-listed coho stocks caught in this fishery include Central California Coast (CCC), Oregon Coast Natural (OCN), and Southern Oregon/Northern California Coast (SONCC) coho. Commercial troll fisheries south of Cape Falcon have not been allowed to retain coho salmon since 1993, with the exception of limited fisheries in 2007 and 2009 that were not selective for marked hatchery fish (PFMC 2008b). In other words, coho retention is entirely prohibited in California ocean salmon fisheries, although some bycatch mortality occurs. In 2013, observed bycatch mortality from commercial troll fisheries south of Cape Falcon was 8,700 fish (PFMC 2014b). Estimated exploitation rates on OCN coho were under management-determined rate limits in 93% of the past fifteen years (1999-2013). Ocean exploitation rates on CCC coho are not monitored but are thought to be comparable to exploitation rates on Rogue and Klamath River hatchery coho, which ranged from about 1% to 10% from 2000 to 2010 (NFMS 2011c). Because coho retention is prohibited in this area, it is highly likely that fishing mortality is at or below a level that will maintain current population abundances, and conservation concern regarding fishery mortality was deemed 'Very Low.'

Rationale
Postseason estimates of exploitation rates on Oregon Coast Natural coho are obtained from the Pacific Fishery Management Council’s Fishery Regulation Assessment (FRAM) model. These estimates are for exploitation from all fisheries (commercial and recreational) and are based on estimated discard mortality (PFMC 2008).

Escapement data for Oregon Coast Natural coho suggests that spawner abundances have fluctuated over the past fifteen years (1999 to 2013), with relatively low counts in 2012 and 2013 (Fig. 30)(PFMC 2014a). Escapement counts include hatchery-origin salmon produced at Cow Creek Hatchery.

<table>
<thead>
<tr>
<th>Humbug Mt. to Horse Mt. North Pacific, Trolling Lines–Chinook</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Very Low Concern</strong></td>
</tr>
<tr>
<td>ESA (Endangered Species Act)-listed coho stocks caught in this fishery include Central California Coast (CCC), Oregon Coast Natural (OCN), Southern Oregon/Northern California Coast (SONCC), and Lower Columbia River natural (LCN) coho. Commercial troll fisheries south of Cape Falcon have not been allowed to retain coho salmon since 1993, with the exception of limited fisheries in 2007 and 2009 that were not selective for marked hatchery fish (PFMC 2008b). However, some bycatch mortality occurs; in 2013, observed bycatch mortality from commercial troll fisheries south of Cape Falcon was 8,700 fish (PFMC 2014b). Estimated exploitation rates on OCN coho were under management-determined rate limits in 93% of the past fifteen years (1999-2013), and LCN coho exploitation rates were under limits in 78% of the years from 2005 to 2013 (PFMC 2014a). Ocean exploitation rates on CCC coho are not monitored but are thought to be comparable to exploitation rates on Rogue and Klamath River hatchery coho, which ranged from about 1% to 10% from 2000 to 2010 (NFMS 2011c). Because it is highly likely that fishing mortality is at or below a sustainable level that will maintain current population abundances, conservation concern regarding fishery mortality was deemed 'Very Low.'</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rationale</th>
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</thead>
<tbody>
<tr>
<td>Postseason estimates of exploitation rates on Oregon Coast Natural coho are obtained from the Pacific Fishery Management Council’s Fishery Regulation Assessment (FRAM) model. These estimates are for exploitation from all fisheries (commercial and recreational) and are based on estimated discard mortality (PFMC 2008). Escapement data for Oregon Coast Natural coho suggests that spawner abundances have fluctuated over the past fifteen years (1999 to 2013), with relatively low counts in 2012 and 2013 (Fig. 30)(PFMC 2014a). Escapement counts include hatchery-origin salmon produced at Cow Creek Hatchery.</td>
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</tbody>
</table>
Coho salmon are caught incidentally in the Klamath tribal gillnet fishery targeting Chinook salmon. The primary ESA-listed coho stock that may be encountered in this area is Southern Oregon/Northern California Coast (SONCC) coho. Commercial fishers are prohibited from selling coho salmon, and regulations are designed to reduce incidental catches. Total fishing mortality (either retained for subsistence use, or catch and release mortality) on SONCC coho in the commercial fishery may be on the order of 5% based on reported Yurok fishery exploitation rates on Klamath coho. During the most recent SONCC status review, the available spawning information indicated that SONCC coho populations were declining (NOAA 2011f). Because the fishery contribution to mortality is unknown and the population is depleted, fishing mortality is considered a ‘Moderate’ conservation concern.

Rationale
Commercial fishers are prohibited from selling coho salmon and are required to physically attend the gear to allow for efficient release of non-target species. In addition, the number of days per week the fishery is open is reduced during the coho migration to reduce fishing impacts (Yurok Tribal Council 2013). Coho salmon may be retained for subsistence and ceremonial purposes. Total Yurok fishery harvest rates on Klamath coho averaged 4% from 1992 to 2005 and 5% from 2006 to 2009, but harvest rates for the other two Klamath basin tribal fisheries were not provided (NOAA 2011f). For the non-tribal commercial fishery, forecasted exploitation rates on Rogue/Klamath coho are the best available
measure of the ocean exploitation rate on Southern Oregon/Northern California Coast coho. The exploitation rate averaged 3% from 2000 to 2009. Despite the low harvest rates, available spawning information led the National Marine Fisheries Service to conclude that abundance of coho salmon had decreased for many populations in the ESU since the last status review (NOAA 2011f).

<table>
<thead>
<tr>
<th>North of Cape Falcon North Pacific, Trolling Lines–Chinook</th>
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</thead>
<tbody>
<tr>
<td>North of Cape Falcon North Pacific, Trolling Lines–Coho</td>
</tr>
<tr>
<td>Moderate Concern</td>
</tr>
</tbody>
</table>

ESA-listed coho stocks caught in this fishery include Lower Columbia River natural (LCN) and Oregon Coast Natural (OCN) coho. Interior Fraser River coho, which are listed as endangered under Canada’s ‘Species At Risk Act,’ are also intercepted. Estimated exploitation rates on Oregon Coast natural coho were under management-determined rate limits in 93% of the past fifteen years (1999-2013), and Lower Columbia Natural coho exploitation rates were under limits in 78% of the years from 2005 to 2013 (PFMC 2014a). The 2013 exploitation rate on Interior Fraser River coho from U.S. fisheries was under the limit mandated by the Pacific Salmon Commission (PFMC 2014b). However, coho (potentially including natural-origin fish from ESA-listed stocks) can be retained in ocean fisheries north of Cape Falcon, whereas fisheries south of Cape Falcon prohibit retention. Because depleted populations are subject to some fishing mortality, but there is management aimed at maintaining abundances, conservation concern was rated 'Moderate.'

**Rationale**

Non-Indian commercial troll fisheries from Cape Falcon to the U.S./Canada border had an overall quota of 14,220 coho in 2013, and fishers were allowed to retain only coho with marks indicating that the fish originated from hatcheries. Treaty Indian fisheries north of Cape Falcon targeting all salmon species had a 2013 quota of 47,500 coho, and they were not restricted to retaining only marked coho (PFMC 2014a). Under the Pacific Salmon Treaty Southern Coho Management Plan for the United States (U.S.) and Canada, U.S. fisheries have been limited to a 10% exploitation rate on Interior Fraser coho. Interior Fraser coho include Upper Fraser and Thompson River coho. Postseason estimates of exploitation rates on Oregon Coast natural and Lower Columbia River natural coho are obtained from the Pacific Fishery Management Council’s Fishery Regulation Assessment (FRAM) model. These estimates are for exploitation from all fisheries (commercial and recreational) and are based on estimated discard mortality (PFMC 2008). Escapement data for Oregon Coast Natural coho suggests that spawner abundances have fluctuated over the past fifteen years (1999 to 2013), with relatively low counts in 2012 and 2013 (Fig. 30)(PFMC 2014a). Escapement counts include hatchery-origin salmon produced at Cow Creek Hatchery.
Figure 30: Oregon Coast Natural coho escapements (blue line). The escapement counts are for fish spawning in natural areas but may include both hatchery and natural-origin fish.

Puget Sound, Gillnet, Drift–Chinook
Puget Sound, Gillnet, Drift–Coho
Puget Sound, Gillnet, Drift–Sockeye
Puget Sound, Purse Seine–Chinook
Puget Sound, Purse Seine–Coho
Puget Sound, Purse Seine–Sockeye
Puget Sound, Trolling Lines–Chinook
Puget Sound, Trolling Lines–Coho

Moderate Concern

Interior Fraser coho are taken as bycatch in Puget Sound salmon fisheries ((PSC 2013c)(Decker et al. 2014)). Modeled total exploitation rate averaged 11% during 2005-2009, of which 2.9% occurred in Canadian fisheries (i.e., within the goal of 3% or less) and 8.1% occurred in US fisheries. Exploitation occurs in fisheries along the Washington coast (troll) and the San Juan Islands (net). Fishing mortality on Interior Fraser coho salmon in Puget Sound fisheries is judged to be a ‘Moderate Concern’ because the exploitation rate in Puget Sound has remained relatively stable over time, yet about 75% of total
mortality occurs in the US versus BC fisheries.

**SOCKEYE SALMON: Minor Stocks**

**Factor 2.1–Inherent Vulnerability**

*Scoring Guidelines (same as Factor 1.1 above)*

| Puget Sound, Gillnet, Drift–Pink |
| Puget Sound, Gillnet, Drift–Sockeye |
| Puget Sound, Purse Seine–Pink |
| Puget Sound, Purse Seine–Sockeye |

*Low*

The FishBase vulnerability score for sockeye salmon is 32, making inherent vulnerability ‘Low.’ The FishBase score is based on life history traits and ecological characteristics including maximum length, age at first maturity, and geographic range (Cheung et al. 2005). Sockeye salmon have low vulnerability because they have high diversity in life history traits.

**Factor 2.2–Abundance**

*Scoring Guidelines (same as Factor 1.2 above)*

| Puget Sound, Gillnet, Drift–Pink |
| Puget Sound, Gillnet, Drift–Sockeye |
| Puget Sound, Purse Seine–Pink |
| Puget Sound, Purse Seine–Sockeye |

*Very High Concern*

Fraser sockeye salmon is the primary stock targeted by the Puget Sound sockeye fishery. Fraser sockeye salmon consists of many populations but it is managed according to four migration timing groups; spawning escapements are monitored on about 18 populations. Although the major stocks have been relatively abundant (Fraser River Panel 2012), some smaller stocks have been depressed (CSAS 2013). For example, the Cultus population was classified as endangered by COSEWIC (Committee on the Status of Endangered Wildlife in Canada), leading to actions to reduce harvest rates to some extent.
Cultus sockeye abundance and other small Fraser populations are judged to have a Very High conservation concern regarding abundance. Very few, if any, Ozette Lake sockeye (listed under the Endangered Species Act as threatened) are likely to be captured by this fishery.

Factor 2.3—Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

| Puget Sound, Gillnet, Drift–Pink  |
| Puget Sound, Gillnet, Drift–Sockeye  |
| Moderate Concern  |

Cultus Lake sockeye and other small, depressed sockeye populations are harvested along with the more abundant Fraser sockeye populations in the Puget Sound sockeye fishery. These populations have declined even though total spawning escapement of sockeye salmon to the Fraser River has increased over the past 20 years (Connors et al. 2010)(CSAS 2013). Management is attempting to balance the need to conserve these populations while also allowing harvest of the abundant populations. Accordingly, the maximum allowable exploitation rate for Cultus Lake Sockeye is “the greater of a) the low abundance exploitation rate identified for Late Run Sockeye, or b) the exploitation rate that is consistent with continued rebuilding of the population based on inseason information on returns and potential numbers of effective spawners” (DFO 2013a)(Fraser River Panel 2012). Management has taken some action to reduce harvests on Cultus sockeye, and fishing mortality is judged to have a ‘Moderate’ conservation concern. Very few, if any, Ozette Lake sockeye (ESA Threatened) are likely to be captured by this fishery.

| Puget Sound, Purse seine–Pink  |
| Puget Sound, Purse seine–Sockeye  |
| Moderate Concern  |

Cultus Lake sockeye and other small, depressed sockeye populations are harvested along with the more abundant Fraser sockeye populations in the Puget Sound sockeye fishery. These populations have declined even though total spawning escapement of sockeye salmon to the Fraser River has increased over the past 20 years (Connors et al. 2010)(CSAS 2013). Management is attempting to balance the need to conserve these populations while also allowing harvest of the abundant populations. Accordingly, the maximum allowable exploitation rate for Cultus Lake Sockeye is “the greater of a) the low abundance exploitation rate identified for Late Run Sockeye, or b) the exploitation rate that is consistent with continued rebuilding of the population based on inseason information on
returns and potential numbers of effective spawners” (DFO 2013a)(Fraser River Panel 2012). Management has taken some action to reduce harvests on Cultus sockeye, and fishing mortality is judged to have a ‘Moderate’ conservation concern. Very few, if any, Ozette Lake sockeye (ESA Threatened) are likely to be captured by this fishery.

**Factor 2.4—Discard Rate**

<table>
<thead>
<tr>
<th>Area</th>
<th>Trolling Lines—Salmon</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cape Falcon to Humbug Mt. North Pacific</td>
<td>Chinook</td>
</tr>
<tr>
<td>Horse Mt. to U.S./Mexico Border North Pacific</td>
<td>Chinook</td>
</tr>
<tr>
<td>Humbug Mt. to Horse Mt. North Pacific</td>
<td>Chinook</td>
</tr>
<tr>
<td>North of Cape Falcon North Pacific</td>
<td>Chinook, Coho</td>
</tr>
</tbody>
</table>

< 20%

The large majority of discards in the commercial troll fisheries are non-target salmon. Across all Pacific Fishery Management Council ocean commercial troll fisheries, the 2013 estimated bycatch mortality for Chinook salmon was 77,100 fish, and the catch was 500,100 fish (PFMC 2014b). For coho salmon, estimated bycatch mortality was 19,400 fish, and the catch was 54,200 fish (PFMC 2014b). The ratio of dead discards to landings across both species was therefore 17.4%.

**Rationale**

The total hook and release mortality rate used for both Chinook and coho in commercial troll fisheries is 26% (PFMC 2014a). Management also considers drop-off mortality for both Chinook and coho salmon as follows: 5% of total encounters south of Cape Falcon and 5% of legal encounters north of Cape Falcon (PFMC 2014b). These estimated drop-off mortality rates include predation on hooked fish. Projected and estimated bycatch mortality of salmon is reported for each management area each year (separated by fishery: treaty Indian troll, non-Indian commercial troll, and recreational). Some bycatch estimates are based on reported releases of fish.
Most Columbia River gillnet fisheries are not mark-selective (releasing unmarked, wild-origin fish), so the majority of fish are retained. There are some exceptions, such as commercial spring Chinook tangle net fisheries that are required to release unmarked spring Chinook. Estimated incidental mortality in 2012 Columbia River fisheries was 13,672 fish, and 245,140 fish were landed (PSC 2013b), making the overall discard rate less than 20%.

**Rationale**
The Willamette River spring Chinook Fishery Management Evaluation Plan requires release of unmarked spring Chinook to minimize fishery impacts on this ESA listed, threatened stock. Thus a non-treaty, mark-selective spring Chinook commercial fishery using tangle nets was implemented starting in 2001 (Joint Columbia River Management Staff 2014a). The tangle net fishery had live-capture fishing regulations such as a 3.75-inch maximum mesh size and 30-minute maximum soak time. Preliminary data from the 2014 non-treaty Columbia River spring Chinook fishery indicated that 5,751 fish were handled, 3,557 fish were harvested, and 2,194 fish were released (R. Roler, pers. comm.). Treaty fisheries in the Columbia River are not mark-selective. A study by the Independent Fisheries Science Panel estimated Chinook release mortality rates for gillnets and tangle nets in Grays Harbor and Willapa Bay. Assuming 90% compliance with fishery regulations, which would be consistent with observer data and testimonies from commercial fishermen, estimated rates were 31% for tangle nets, 56% for small mesh gillnets, and 62% for large mesh gillnets (IFSP 2014). These rates did not include drop-off mortality.

**Klamath River, Gillnet, Drift–Chinook**

< 20%

Fish that are caught and not sold in the Klamath tribal fishery are typically retained for subsistence or ceremonial purposes. In 2004 an estimated 21,109 Chinook salmon, 1,289 coho salmon, 217 steelhead and 14 green sturgeon were harvested in the Klamath estuary where commercial fishing is allowed (Williams 2007). The harvest of non-Chinook species represented 6.8% of the total landings. The Klamath tribal fishery is considered a full-retention fishery so there is very little, if any discard mortality.

**Puget Sound, Gillnet, Drift–Chinook**

**Puget Sound, Gillnet, Drift–Chum**

**Puget Sound, Gillnet, Drift–Coho**

**Puget Sound, Gillnet, Drift–Pink**

**Puget Sound, Gillnet, Drift–Sockeye**
The great majority of fish captured by gillnet are retained, therefore the discard rate is considerably less than 20%. The management system has a strategy to reduce bycatch of seabirds, such as the ESA-listed marbled murrelet, and some salmon species at specific times and locations. For example, a seabird strip is used in gillnets during sockeye fisheries in Area 7/7A (Puget Sound Indian Tribes and the Washington Department of Fish and Wildlife 2010)(WDFW & PSTIT 2013)(WDFW 2013). Some salmon species must be released from gillnets in specific locations and time periods, e.g., Chinook and coho in area 7/7A and Chinook and chum in area 12A. Gillnet fisheries using this strategy are typically limited to short duration sets (60 or 90 minutes). Prior to release, salmon must be revived in functional live boxes. In some areas, on-board observers are required to monitor bycatch. Catch and release mortality is estimated and considered in the management of the fishery.

Puget Sound, Purse Seine–Chinook
Puget Sound, Purse Seine–Chum
Puget Sound, Purse Seine–Coho
Puget Sound, Purse Seine–Pink
Puget Sound, Purse Seine–Sockeye

The great majority of fish captured by purse seine are retained, therefore the discard rate is less than 20%. The management system has a strategy to reduce bycatch of seabirds, such as the marbled murrelet, and specific salmon species at specific times and locations (Puget Sound Indian Tribes and the Washington Department of Fish and Wildlife 2010)(WDFW 2013). For example, a seabird strip is used in seines during sockeye and pink salmon fisheries. Some salmon species must be released from seines in specific locations and time periods. Seines are often required to use brailers as a means to reduce injury. Prior to release, salmon must be revived in functional live boxes. In some areas, on-board observers are required to monitor bycatch. Catch and release mortality is estimated and considered in the management of the fishery.

Puget Sound, Trolling Lines–Chinook
Puget Sound, Trolling Lines–Coho
Puget Sound, Trolling Lines–Pink

< 20%
The Puget Sound troll fishery (Strait of Juan de Fuca) typically retains all salmon species while targeting Chinook or coho salmon. However, during some periods and locations, chum or coho salmon must be released (WDFW and NWIFC 2015). Overall, although discard data are not readily available, discards likely represent much less than 20% of the total catch.

| Washington North Pacific, Gillnet, Drift–Chinook |
| Washington North Pacific, Gillnet, Drift–Chum |
| Washington North Pacific, Gillnet, Drift–Coho |
| Washington North Pacific, Gillnet, Drift–Sockeye |

< 20%

There are mark-selective commercial gillnet fisheries (releasing unmarked, wild-origin fish) for coho salmon in Grays Harbor and for Chinook salmon in Willapa Bay (PSC 2013a). In the 2012 Chinook fishery, there were an estimated 585 incidental mortalities and a total of 29,232 fish landed (PSC 2013b). Washington coastal tribal fisheries retain all salmon caught. Thus overall discard mortality was less than 20%.

**Rationale**

A study by the Independent Fisheries Science Panel estimated Chinook release mortality rates for gillnets and tangle nets in Grays Harbor and Willapa Bay. Assuming 90% compliance with fishery regulations, which would be consistent with observer data and testimonies from commercial fishermen, estimated rates were 31% for tangle nets, 56% for small mesh gillnets, and 62% for large mesh gillnets (IFSP 2014). These rates did not include drop-off mortality.
Criterion 3: Management effectiveness

Management is separated into management of retained species (harvest strategy) and management of non-retained species (bycatch strategy).

The final score for this criterion is the geometric mean of the two scores. The Criterion 3 rating is determined as follows:

- Score >3.2=Green or Low Concern
- Score >2.2 and <=3.2=Yellow or Moderate Concern
- Score <=2.2 or either the Harvest Strategy (Factor 3.1) or Bycatch Management Strategy (Factor 3.2) is Very High Concern = Red or High Concern

Rating is Critical if either or both of Harvest Strategy (Factor 3.1) and Bycatch Management Strategy (Factor 3.2) ratings are Critical.

Criterion 3 Summary

<table>
<thead>
<tr>
<th>Region / Method</th>
<th>Management of Retained Species</th>
<th>Management of Non-Retained Species</th>
<th>Overall Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Columbia River</td>
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<td>3.000</td>
<td>Yellow(3.000)</td>
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<tr>
<td>Gillnet, Drift--Chinook</td>
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Management Context

The fisheries discussed in this report are part of a complex management system co-managed by federal, state, tribal, and international agencies. The Pacific Fishery Management Council developed and implemented the Fishery Management Plan for Commercial and Recreational Salmon Fisheries Off the Coasts of Washington, Oregon and California (the FMP) in 1978. The FMP has been periodically updated through a series of amendments, most recently amendment 18 was adopted in 2014 (PFMC 2014e). The FMP provides the overarching framework under which ocean salmon fisheries (targeting primarily Chinook, coho and to a lesser extent pink salmon) are managed. The FMP has two central themes: 1) conservation objectives centered on ensuring sufficient escapement of salmon to spawning areas to maintain sustainable populations, and 2) allocation objectives for commercial, recreational, tribal, ocean and inland...
fisheries. Fisheries for sockeye and chum salmon are managed cooperatively by Washington Department of Fish and Wildlife and the tribal governments.

In compliance with the Magnuson-Stevens Fishery Conservation and Management Act (MSA), stocks are managed through a series of overfishing limits (OFLs), acceptable biological catches (ABCs) and annual catch limits (ACLs). Managers often set minimum stock size thresholds (MSSTs) and maximum fishing mortality thresholds (MFMTs) based on spawning abundance at maximum sustainable yield ($S_{MSY}$) and fishing mortality at maximum sustainable yield ($F_{MSY}$), respectively. In the context of the FMP, overfishing is considered to be occurring when the MFMT is exceeded in any given year which is typically calculated postseason when full catch data and escapement data are available. Stocks are considered to be overfished when the 3-year geometric mean of spawning escapement falls below the MSST.

Management through the FMP aims to allow harvest of abundant stocks while minimizing harvest of depleted and ESA listed stocks. Prior to the start of the fishing season each year, the PFMC will set quotas and allocations for salmon based on forecasted returns for each stock component and modeled fishery impacts. Typically, fisheries are constrained by allowable impacts on endangered and threatened stocks under the Endangered Species Act. Fishery catches are monitored continuously throughout the fishing season and managers use time and area restrictions to meet preseason harvest limits set for the fishery. While there is significant effort to avoid overharvest of salmon stocks, there is still uncertainty in basing ocean harvests on preseason forecasted returns.

The following discussions refer to the regional management strategies and implementation of these strategies within the context of the overarching FMP.

Factor 3.1: Harvest Strategy

Scoring Guidelines

Seven subfactors are evaluated: Management Strategy, Recovery of Species of Concern, Scientific Research/Monitoring, Following of Scientific Advice, Enforcement of Regulations, Management Track Record, and Inclusion of Stakeholders. Each is rated as ‘Ineffective,’ ‘Moderately Effective,’ or ‘Highly Effective.’

- 5 (Very Low Concern)—Rated as ‘Highly Effective’ for all seven subfactors considered.
- 4 (Low Concern)—Management Strategy and Recovery of Species of Concern rated ‘Highly Effective’ and all other subfactors rated at least ‘Moderately Effective.’
- 3 (Moderate Concern)—All subfactors rated at least ‘Moderately Effective.’
• 2 (High Concern)—At minimum, meets standards for ‘Moderately Effective’ for Management Strategy and Recovery of Species of Concern, but at least one other subfactor rated ‘Ineffective.’

• 1 (Very High Concern)—Management exists, but Management Strategy and/or Recovery of Species of Concern rated ‘Ineffective.’

• 0 (Critical)—No management exists when there is a clear need for management (i.e., fishery catches threatened, endangered, or high concern species), OR there is a high level of Illegal, unregulated, and unreported fishing occurring.

Factor 3.1 Summary

<table>
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<tr>
<th>Region / Method</th>
<th>Strategy</th>
<th>Recovery</th>
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### Subfactor 3.1.1 – Management Strategy and Implementation

**Considerations:** What type of management measures are in place? Are there appropriate management goals, and is there evidence that management goals are being met? To achieve a **Highly Effective rating**, there must be appropriate management goals, and evidence that the measures in place have been successful at maintaining/rebuilding species.

Columbia River, Gillnet, Drift
Columbia River, Gillnet, Drift–Chinook
Columbia River, Gillnet, Drift–Coho
Columbia River, Gillnet, Drift–Sockeye

Moderately Effective

Columbia River salmon fisheries are co-managed by the Columbia River treaty fishing tribes and the states of Washington and Oregon, who work together to ensure that harvest rate limits and sharing agreements between treaty and non-treaty fisheries are met. A restricted number of commercial fishing licenses are issued each year, and to meet harvest limits and escapement goals, co-managers adjust ocean and in-river fishery harvest openings and closures. Natural spawning escapement goals have been developed for many Columbia River Chinook and sockeye salmon stocks (PFMC 2014a)(Joint Columbia River Management Staff 2014a)(Joint Columbia River Management Staff 2014b). Broodstock goals have been established for Chinook, sockeye and coho hatchery populations, and ‘select area’ commercial fisheries have been established in lower river off-channel areas to target hatchery-produced coho and Chinook returning to release sites (Joint Columbia River Management Staff 2014a). Data provided by the Pacific Fishery Management Council and the Oregon and Washington Departments of Fish and Wildlife indicate that escapement goals typically have been met during the past 10 years, but escapement counts often include an unknown number of hatchery-origin salmon spawning in the streams (PFMC 2014a)(Joint Columbia River Management Staff 2014a)(Joint Columbia River Management Staff 2014b). This may be appropriate in cases where hatchery-produced fish are part of a stock recovery strategy, but in other cases, hatchery production is aimed primarily at supporting harvest, and inclusion of hatchery-produced fish in escapement counts may obscure estimation of wild fish abundance. The management strategy is judged to be ‘Moderately Effective’ because a generally appropriate strategy is in place, but escapement management is not always precautionary with regard to management of wild-origin fish.

Klamath River, Gillnet, Drift–Chinook

Moderately Effective

The Klamath in-river commercial salmon fishery is managed by Klamath tribal authorities. Total harvest limits on KRF Chinook are established each year through the PFMC process based on forecasted run strength and escapement requirements. Klamath River tribal fisheries are allocated 50% of the total harvest. The in-river commercial fishery occurs in the Klamath estuary and is limited to tribal members (Yurok Tribal Council 2013). Tribal authorities manage the fishery through the number of days fishing is allowed or closed. Commercial sales are recorded on fish tickets which are turned into tribal authorities to monitor the harvest relative to the allocation. Escapement goals have been established for the main target stock (Klamath River fall Chinook), and this stock has generally met its escapement goal the majority of the past fifteen years. However, Klamath River spring Chinook stocks do not have escapement goals, and the Klamath River Fall Chinook escapement goal does not distinguish between wild and hatchery-origin fish spawning in natural areas (PFMC 2011).
Puget Sound, Gillnet, Drift–Chinook
Puget Sound, Gillnet, Drift–Chum
Puget Sound, Gillnet, Drift–Coho
Puget Sound, Gillnet, Drift–Pink
Puget Sound, Gillnet, Drift–Sockeye
Puget Sound, Purse seine–Chinook
Puget Sound, Purse seine–Chum
Puget Sound, Purse seine–Coho
Puget Sound, Purse seine–Pink
Puget Sound, Purse seine–Sockeye

Moderately Effective

Spawning escapement goals have been developed for Chinook, coho, chum, pink and sockeye salmon in most of the major Puget Sound watersheds. The co-managers attempt to meet these goals by adjusting fishery harvests in commercial, tribal and recreational fisheries. Fisheries management incorporates harvest information on salmon harvested outside Puget Sound. Data provided by the Pacific Fishery Management Council and Washington Department of Fish and Wildlife indicate that the escapement goals for most species and stocks have been met during the past 10 or more years, but escapement counts often include an unknown number of hatchery-origin salmon spawning in the streams (Puget Sound Indian Tribes and the Washington Department of Fish and Wildlife 2010)(WDFW 2014b). However, escapement goals for sockeye are often not met even though harvests are small. Also, escapement goals for natural-origin Chinook (excluding hatchery fish) have not been consistently met; escapement goals are more likely to be met when hatchery fish are counted against the goal. Escapements to hatcheries are monitored. The management strategy is judged to be ‘Moderately Effective’ because there is a strategy along with objectives and monitoring, but hatchery salmon often contribute to the achievement of escapement goals.

Rationale
The Chinook Harvest Management Plan’s objectives are to “Ensure that fishery-related mortality will not impede rebuilding of natural Puget Sound Chinook salmon populations, consistent with the capacity of properly functioning habitat, to levels that will sustain fisheries, enable ecological functions, and are consistent with treaty-reserved fishing rights.” The plan guides the implementation of fisheries in Washington while considering the total harvest impacts on Puget Sound Chinook of fisheries in Washington, Oregon, British Columbia, and Alaska. The plan sets fisheries exploitation rate (ER) ceilings as the principle mechanism for achieving spawning escapement levels that are consistent with current
habitat function. Exploitation rate management was first implemented in the late 1990s for Puget Sound Chinook (i.e., before the evolutionarily significant unit was listed), because the former harvest strategy, based on fixed escapement goals, was not adequately conservative, and was not consistently applicable across fisheries when the run sizes were lower than escapement goals. Fishery Regulation Assessment Model (FRAM) estimates of exploitation rate are more accurate than its projections of spawning escapement. The co-managers determined that exploitation rate management was more averse to risk than a fixed escapement goal management strategy, because estimates of exploitation rates were considered more reliable and more amenable to postseason assessment. When escapement is projected to be less than the lower abundance threshold, fishing-related mortality is further constrained by implementing a lower, critical exploitation rate (CER) ceiling to increase escapement. The management strategy has developed objectives for exploitation rates in order to meet Chinook spawning escapement thresholds. The strategy also recognizes the need to rebuild ESA-listed salmon, though it notes that rebuilding will take considerable time because habitat has been degraded. The management strategy recognizes a balance between conservation of natural-origin Chinook and providing harvest. However, NOAA Fisheries estimates that the recent total exploitation (all fisheries) rate is 42% and the exploitation rate in Puget Sound is 16%. The exploitation rate in Puget Sound in recent years (brood years 2002-2006) is higher than it has been since 1982. Escapement data indicate that natural spawners are often not meeting the lower or upper abundance thresholds. Spawning escapement goals have been developed for coho, chum, pink and sockeye salmon in most of the major Puget Sound watersheds. The co-managers attempt to meet these goals by adjusting fishery harvests in commercial, tribal and recreational fisheries. Data provided by the PFMC and WDFW indicates that the spawning goals typically have been met during the past 10 or more years. However, for Lake Washington sockeye, the goal is not often met even though harvests have been small. Escapements to hatcheries are monitored. However, in watersheds with hatcheries, the contribution of hatchery salmon to the natural salmon spawning counts is typically not monitored. The management strategy is judged to be ‘Moderately Effective’ because it does have a strategy along with objectives and monitoring. Spawning goals are typically achieved for chum, coho and pink salmon but evidence indicates that the goals are not consistently achieved for natural origin Chinook.

Puget Sound, Trolling Lines

Moderately Effective

Spawning escapement goals have been developed for Chinook, coho, chum, pink and sockeye salmon in most of the major Puget Sound watersheds. The co-managers attempt to meet these goals by adjusting fishery harvests in commercial, tribal and recreational fisheries. Fisheries management incorporates harvest information on salmon harvested outside Puget Sound. Data provided by the Pacific Fishery Management Council and Washington Department of Fish and Wildlife indicate that the escapement goals have been typically met during the past 10 or more years, but escapement counts often include an unknown number of hatchery-origin salmon spawning in the streams (Puget Sound Indian Tribes and the Washington Department of Fish and Wildlife 2010)(WDFW 2014b). Escapement goals for sockeye...
are often not met even though harvests are small. Escapement goals for natural-origin Chinook (excluding hatchery fish) have not been consistently met. Escapements to hatcheries are monitored. The management strategy is judged to be 'Moderately Effective' because there is a strategy along with objectives and monitoring, but hatchery salmon often contribute to the achievement of escapement goals.

Rationale

The Chinook Harvest Management Plan’s objectives are to “Ensure that fishery-related mortality will not impede rebuilding of natural Puget Sound Chinook salmon populations, consistent with the capacity of properly functioning habitat, to levels that will sustain fisheries, enable ecological functions, and are consistent with treaty-reserved fishing rights.” The plan guides the implementation of fisheries in Washington while considering the total harvest impacts on Puget Sound Chinook of fisheries in Washington, Oregon, British Columbia, and Alaska.

The plan sets fisheries exploitation rate (ER) ceilings as the principle mechanism for achieving spawning escapement levels that are consistent with current habitat function. Exploitation rate management was first implemented in the late 1990s for Puget Sound Chinook (i.e., before the evolutionarily significant unit was listed), because the former harvest strategy, based on fixed escapement goals, was not adequately conservative, and was not consistently applicable across fisheries when the run sizes were lower than escapement goals. Fishery Regulation Assessment Model (FRAM) estimates of exploitation rate are more accurate than its projections of spawning escapement. The co-managers determined that exploitation rate management was more averse to risk than a fixed escapement goal management strategy, because estimates of exploitation rates were considered more reliable and more amenable to postseason assessment. When escapement is projected to be less than the lower abundance threshold, fishing-related mortality is further constrained by implementing a lower, critical exploitation rate (CER) ceiling to increase escapement. The management strategy has developed objectives for exploitation rates in order to meet Chinook spawning escapement thresholds. The strategy also recognizes the need to rebuild ESA-listed salmon, though it notes that rebuilding will take considerable time because habitat has been degraded. The management strategy recognizes a balance between conservation of natural-origin Chinook and providing harvest. However, NOAA Fisheries estimates that the recent total (all fisheries) exploitation rate is 42% and the exploitation rate in Puget Sound is 16%. The exploitation rate in Puget Sound in recent years (brood years 2002-2006) is higher than it has been since 1982.

Escapement data indicate that natural spawners are often not meeting the lower or upper abundance thresholds. Spawning escapement goals have been developed for coho, chum, pink and sockeye salmon in most of the major Puget Sound watersheds. The co-managers attempt to meet these goals by adjusting fishery harvests in commercial, tribal and recreational fisheries. Data provided by the PFMC and WDFW indicates that the spawning goals typically have been met during the past 10 or more years. However, for Lake Washington sockeye the goal is often not met even though harvests have been small. Escapements to hatcheries are monitored. However, in watersheds with hatcheries, the contribution of hatchery salmon to the natural salmon spawning counts is typically not monitored. The management strategy is judged to be ‘Moderately Effective’ because it does have a strategy along with objectives and monitoring. Typically, spawning goals are achieved for chum, coho and pink salmon, but evidence
indicates that the goals are not consistently achieved for natural-origin Chinook.

| Puget Sound, Trolling Lines–Chinook |
| Puget Sound, Trolling Lines–Coho |
| Puget Sound, Trolling Lines–Pink |

**Moderately Effective**

Spawning escapement goals have been developed for Chinook, coho, chum, pink and sockeye salmon in most of the major Puget Sound watersheds. The co-managers attempt to meet these goals by adjusting fishery harvests in commercial, tribal and recreational fisheries. Fisheries management incorporates harvest information on salmon harvested outside Puget Sound. Data provided by the Pacific Fishery Management Council and Washington Department of Fish and Wildlife indicate that the escapement goals for most species and stocks have been met during the past 10 or more years, but escapement counts often include an unknown number of hatchery-origin salmon spawning in the streams (Puget Sound Indian Tribes and the Washington Department of Fish and Wildlife 2010)(WDFW 2014b). However, escapement goals for sockeye are not often met, even though harvests are small. Also, escapement goals for natural-origin Chinook (excluding hatchery fish) have not been met consistently; escapement goals are more likely to be met when hatchery fish are counted against the goal. Escapements to hatcheries are monitored. The management strategy is judged to be ‘Moderately Effective’ because there is a strategy along with objectives and monitoring, but hatchery salmon often contribute to the achievement of escapement goals.

**Rationale**

The Chinook Harvest Management Plan objectives are to “Ensure that fishery-related mortality will not impede rebuilding of natural Puget Sound Chinook salmon populations, consistent with the capacity of properly functioning habitat, to levels that will sustain fisheries, enable ecological functions, and are consistent with treaty-reserved fishing rights.” The plan guides the implementation of fisheries in Washington while considering the total harvest impacts on Puget Sound Chinook of fisheries in Washington, Oregon, British Columbia, and Alaska. The plan sets fisheries exploitation rate (ER) ceilings as the principle mechanism for achieving spawning escapement levels that are consistent with current habitat function. Exploitation rate management was first implemented in the late 1990s for Puget Sound Chinook (i.e., before the evolutionarily significant unit was listed), because the former harvest strategy, based on fixed escapement goals, was not adequately conservative, and was not consistently applicable across fisheries when the run sizes were lower than escapement goals. Fishery Regulation Assessment Model (FRAM) estimates of exploitation rate are more accurate than its projections of spawning escapement. The co-managers determined that exploitation rate management was more averse to risk than a fixed escapement goal management strategy, because estimates of exploitation rates were considered more reliable and more amenable to postseason assessment. When escapement is projected to be less than the lower abundance threshold, fishing-related mortality is further constrained
by implementing a lower, critical exploitation rate (CER) ceiling to increase escapement. The management strategy has developed objectives for exploitation rates in order to meet Chinook spawning escapement thresholds. The strategy also recognizes the need to rebuild ESA-listed salmon, though it notes that rebuilding will take considerable time because habitat has been degraded. The management strategy recognizes a balance between conservation of natural-origin Chinook and providing harvest. However, NOAA Fisheries estimates that the recent total (all fisheries) exploitation rate is 42% and the exploitation rate in Puget Sound is 16%. The exploitation rate in Puget Sound in recent years (brood years 2002-2006) is higher than it has been since 1982. Escapement data indicate that natural spawners are not often meeting the lower or upper abundance thresholds. Spawning escapement goals have been developed for coho, chum, pink and sockeye salmon in most of the major Puget Sound watersheds. The co-managers attempt to meet these goals by adjusting fishery harvests in commercial, tribal and recreational fisheries. Data provided by the PFMC and WDFW indicate that the spawning goals typically have been met during the past 10 or more years. However, for Lake Washington sockeye, the goal is not often met, even though harvests have been small. Escapements to hatcheries are monitored. However, in watersheds with hatcheries, the contribution of hatchery salmon to the natural salmon spawning counts is not typically monitored. The management strategy is judged to be ‘Moderately Effective’ because it does have a strategy along with objectives and monitoring. Spawning goals are typically achieved for chum, coho and pink salmon, but evidence indicates that the goals are not consistently achieved for natural-origin Chinook.

Cape Falcon to Humbug Mt. North Pacific, Trolling Lines
Cape Falcon to Humbug Mt. North Pacific, Trolling Lines–Chinook
Horse Mt. to U.S./Mexico Border North Pacific, Trolling Lines–Chinook
Humbug Mt. to Horse Mt. North Pacific, Trolling Lines–Chinook
North of Cape Falcon North Pacific, Trolling Lines–Chinook
North of Cape Falcon North Pacific, Trolling Lines–Coho

Moderately Effective

These ocean salmon fisheries are co-managed by the Pacific Fishery Management Council and federal and state agencies to meet objectives described in the Pacific Coast Salmon Fishery Management Plan. The plan includes escapement goals for some Chinook and coho indicator stocks, and escapement monitoring suggests that the goals have generally been met in the majority of the past fifteen years (PFMC 2014a). However, escapement counts typically do not distinguish between wild and hatchery-origin fish spawning in natural areas (PFMC 2014e). For depleted stocks that are listed under the Endangered Species Act, exploitation rate limits are set to help ensure that harvest does not impede population recovery (PFMC 2014e). Available data indicate that these limits typically are not exceeded. Co-managers respond to projected salmon abundances and use fishery time and area restrictions to
meet management objectives, and in some cases they may use fishing quotas as well (PFMC 2014e).

The management strategy is judged to be ‘Moderately Effective’ because a strategy exists along with objectives and monitoring, but hatchery-produced salmon often contribute to the achievement of escapement goals.

Washington North Pacific, Gillnet, Drift–Chinook  
Washington North Pacific, Gillnet, Drift–Chum  
Washington North Pacific, Gillnet, Drift–Coho  
Washington North Pacific, Gillnet, Drift–Sockeye

**Moderately Effective**

Washington Coast ‘inside’ fisheries are managed by the Washington Department of Fish and Wildlife and treaty Indian tribes to meet spawning escapement goals for Washington coastal Chinook and coho salmon stocks. Escapement monitoring suggests that the goals have been generally met in the majority of the past fifteen years (PFMC 2014a). However, escapement counts typically do not distinguish between wild and hatchery-origin fish spawning in natural areas (PFMC 2014e). The policy document for Grays Harbor Basin salmon management includes objectives for focusing harvest on hatchery fish and reducing fishing mortality on natural stocks by implementing mark-selective fisheries that release unmarked (natural-origin) fish (WDFW 2014c). In addition, exploitation rates on Chinook and coho are limited to 5% when escapements to natural spawning areas are relatively low. Managers use fishery time and area restrictions to meet management objectives.

The management strategy is judged to be ‘Moderately Effective’ because a strategy exists along with objectives and monitoring, but hatchery-produced salmon often contribute to the achievement of escapement goals.

**Subfactor 3.1.2 – Recovery of Species of Concern**

Considerations: When needed, are recovery strategies/management measures in place to rebuild overfished/threatened/endangered species or to limit fishery’s impact on these species and what is their likelihood of success? To achieve a rating of Highly Effective, rebuilding strategies that have a high likelihood of success in an appropriate timeframe must be in place when needed, as well as measures to minimize mortality for any overfished/threatened/endangered species.
The co-managers and the National Marine Fisheries Service have developed strategies for recovering threatened or endangered salmon listed under the Endangered Species Act. These strategies involve harvest and hatchery management as well as factors beyond fisheries management such as habitat restoration. Significant progress in fisheries management has been made in the past 10-15 years, and harvest rates on listed species are often greatly reduced. Recovery is not yet evident in many depleted populations, but factors besides harvest, such as habitat availability and ocean conditions, also influence recovery. However, the recovery strategy is considered to be ‘Moderately Effective’ because the need for recovery of ESA-listed salmon is balanced with the need to provide harvest.

Southern Oregon/Northern California Coast (SONCC) coho salmon are caught and retained in this fishery although they may not be sold. Management strategies are in place to reduce fishery mortality on these stocks, and a recovery plan was adopted in 2014. Despite these efforts, SONCC coho populations have continued to decline due to overfishing, loss of freshwater and estuarine habitat, hydropower development, poor ocean conditions, and hatchery practices (NOAA 2011f). Although management has appropriate intentions and may be effective at reducing fishing mortality, other non-fishing factors are substantial contributors to making the SONCC recovery outcomes uncertain.
The co-managers and NOAA Fisheries have developed strategies for recovering Puget Sound Chinook salmon, Hood Canal summer chum, and Ozette Lake sockeye, and an initial planning document (outline) for the recovery of Puget Sound Steelhead has been developed (NMFS 2014c), all of which are listed as threatened under the Endangered Species Act. These strategies involve many factors beyond fisheries management, e.g., habitat restoration, but they also involve strategies for harvest management and hatchery management. Significant progress in fisheries management has been made in the past 10-15 years. Harvest rates on listed species are greatly reduced, e.g., Hood Canal summer chum, steelhead, Ozette Lake sockeye. Nevertheless, the recovery strategy is considered to be only ‘Moderately Effective’ because the needs of the ESA-listed salmon are sometimes balanced with the need to provide harvest.
The co-managers and NOAA Fisheries have developed strategies for recovering Puget Sound Chinook salmon, Hood Canal summer chum, and Ozette Lake sockeye, and an initial planning document (outline) for the recovery of Puget Sound Steelhead has been developed (NMFS 2014c), all of which are listed as threatened under the Endangered Species Act. These strategies involve many factors beyond fisheries management, e.g., habitat restoration, but they also involve strategies for harvest management and hatchery management. Significant progress in fisheries management has been made in the past 10-15 years. Harvest rates on listed species are often greatly reduced, e.g., Hood Canal summer chum, steelhead, Ozette Lake sockeye. Nevertheless, the recovery strategy is considered to be only ‘Moderately Effective’ because the needs of the ESA-listed salmon are sometimes balanced with the need to provide harvest.

Cape Falcon to Humbug Mt. North Pacific, Trolling Lines
Cape Falcon to Humbug Mt. North Pacific, Trolling Lines–Chinook
Horse Mt. to U.S./Mexico Border North Pacific, Trolling Lines–Chinook
Humbug Mt. to Horse Mt. North Pacific, Trolling Lines–Chinook
North of Cape Falcon North Pacific, Trolling Lines–Chinook
North of Cape Falcon North Pacific, Trolling Lines–Coho

Moderately Effective

A large component of fisheries management region is the ESA consultation standard for depleted stocks such as California Coastal Chinook salmon. Thus management strategies are in place to reduce fishery mortality on these stocks, and recovery plans have been developed for some ESA-listed stocks. Results thus far are mixed; one depleted stock had its ‘overfished’ status removed in 2013 (NOAA 2014b), whereas few ESA-listed stocks have shown signs of recovery. Management has appropriate intentions and may be effective at reducing fishing mortality on depleted stocks, but recovery outcomes are uncertain, especially since factors other than ocean harvest (such as availability of quality habitat) may also affect escapement levels (O’Farrell et al. 2012a).

Washington North Pacific, Gillnet, Drift–Chinook
Washington North Pacific, Gillnet, Drift–Chum
Washington North Pacific, Gillnet, Drift–Coho
Washington North Pacific, Gillnet, Drift–Sockeye
Moderately Effective

Some ESA-listed stocks are caught in this fishery, but management has implemented regulations that appear effective at limiting harvest of these stocks. Fishery openings and closures (in time and area) are designed to minimize encounters of ESA-listed stocks, and there are mark-selective fisheries (PSC 2013a). The population statuses of listed stocks remain uncertain, but recovery will take time and may be affected by factors other than ocean harvest, such as habitat quantity and quality (O'Farrell et al. 2012a).

Subfactor 3.1.3 – Scientific Research and Monitoring

Considerations: How much and what types of data are collected to evaluate the health of the population and the fishery’s impact on the species? To achieve a Highly Effective rating, population assessments must be conducted regularly and they must be robust enough to reliably determine the population status.

Columbia River, Gillnet, Drift
Columbia River, Gillnet, Drift–Chinook
Columbia River, Gillnet, Drift–Coho
Columbia River, Gillnet, Drift–Sockeye

Moderately Effective

Fisheries co-managers have made good strides in developing and implementing monitoring and evaluation programs for Columbia River salmon stocks. Escapements are monitored inseason at Bonneville Dam and estimated for numerous spawning and hatchery locations. Harvests are monitored inseason as well. Some salmon stocks (mostly hatchery fish) receive coded wire tags (CWT), acoustic tags or passive integrated transponder (PIT) tags that are used to evaluate stock-specific distribution, survival, and exploitation rate. Otoliths and scales may be used for age determination in addition to CWT. The majority (but not all) of hatchery Chinook and coho salmon are mass-marked with adipose fin clips that allow hatchery fish to be identified in harvests, dam monitoring sites, and spawning areas (Washington Fish and Wildlife Commission 2009). Estimated proportions of hatchery versus natural-origin fish on the spawning grounds have been monitored, in recent years, for many Columbia River tributaries, and parentage based tagging (PBT) methods for estimating pHOS are being developed and tested (Steele et al. 2014)(Cassinelli et al. 2013). However, pHOS monitoring is not yet fully implemented and integrated into management. For example, pHOS is generally not being monitored in catches. Research and monitoring was judged to be 'Moderately Effective.'

Rationale
Both the Oregon and Washington Departments of Fish and Wildlife have management plans and
objectives for their hatcheries that consider hatchery impacts on wild fish. The specific objectives can vary by hatchery, but some describe an intent to enumerate wild-origin fish in tributaries (ODFW 2005). The WDFW Hatchery and Fishery Reform Policy describes an intent to use the principles and recommendations of the Hatchery Scientific Review Group, which include monitoring the proportion of returning hatchery fish that escape to natural spawning grounds and the reproductive contribution of hatchery fish spawning in the wild (Washington Fish and Wildlife Commission 2009).

Klamath River, Gillnet, Drift–Chinook

**Moderately Effective**

There is escapement monitoring for naturally spawning stocks, and fishery exploitation rates are estimated for some ESA-listed stocks to help ensure that fishery impacts do not impede population recovery. Escapement monitoring is conducted in the Klamath and Trinity River mainstreams and tributaries by tribal, federal and state agencies. This information is compiled annually by joint staff to estimate total natural (including hatchery-origin) escapements to measure management performance against the natural spawning escapement goal. There are some efforts to estimate hatchery contributions to select natural spawning areas. However, escapement counts and goals in general do not differentiate between wild- and hatchery-origin fish spawning in natural areas. Klamath hatcheries release coho salmon listed as Threatened under ESA. However, the hatchery programs were implemented to mitigate for lost habitat (due to dams) and have not fully implemented integrated hatchery practices to minimize genetic and ecological impacts to natural stocks. Failing to exclude hatchery-origin fish from the escapement counts inflates escapement numbers and can mask the impact of a high harvest rate on the natural-origin stock. Therefore, this factor was deemed to be ‘Moderately Effective.’

Puget Sound, Gillnet, Drift–Chinook

Puget Sound, Gillnet, Drift–Chum

Puget Sound, Gillnet, Drift–Coho

Puget Sound, Gillnet, Drift–Pink

Puget Sound, Gillnet, Drift–Sockeye

Puget Sound, Purse Seine–Chinook

Puget Sound, Purse Seine–Chum

Puget Sound, Purse Seine–Coho
Puget Sound, Purse Seine–Pink

Puget Sound, Purse Seine–Sockeye

**Moderately Effective**

Fisheries managers have a ‘Moderately Effective’ monitoring and evaluation program for Puget Sound salmon. Recovery plans have been developed for depleted stocks. Salmon spawning in streams are enumerated and counts are expanded using past tagging data to estimate total spawning abundance in the major watershed. Escapements to hatcheries are recorded. Harvests are monitored and recorded. Catch-and-release has been used to selectively harvest surplus hatchery salmon (adipose clipped), while also considering catch-and-release mortality of the unmarked salmon. Some Chinook and coho salmon (mostly hatchery fish) receive coded wire tags (CWT) that are used to evaluate stock-specific distribution, survival, and exploitation rate. Otoliths and scales may be used for age determination in addition to CWT. Estimated proportions of hatchery- versus natural-origin Chinook on the spawning grounds have been developed in recent years in some of the watersheds. However, most salmon escapement counts include hatchery-origin spawners in the totals (see Criterion 1 for each species). The presence of numerous hatchery fish on the spawning grounds may mask the viability of the natural population and confound its status. Some hatchery programs, for endangered stocks or reintroduction of extirpated stocks, encourage hatchery-origin fish to spawn naturally to rebuild these populations. However, in many of the hatchery programs, the intent is to increase or maintain the number of fish available for harvest. Failing to exclude hatchery-origin fish from the escapement counts inflates escapement numbers and can mask the impact of a high harvest rate on the natural-origin stock.

**Rationale**

Commercial, ceremonial, and subsistence, harvest, and test fisheries in Washington catch areas 1–13, and associated subareas and freshwater areas, are recorded on sales receipts (=fish tickets’), and compiled in a jointly maintained database. Catch is monitored inseason for all fisheries. Non-landed mortality of Chinook is significant for commercial troll, recreational hook-and-line fisheries. Regulations for these fisheries may require release of sub-adult Chinook, or all Chinook, during certain periods. Studies are conducted to estimate encounter rates and hooking mortality for these fisheries. Estimates of encounter rates will be derived from onboard observations, angler interviews at landing ports or marinas, and remote observation of some recreational fisheries. These findings are used to validate, or adjust, the encounter rates and release mortality rates used in the FRAM. =Drop-out’ mortality in gillnet fisheries is accounted as 3% or 2% of landed catch in preterminal and terminal fisheries, respectively. Chinook non-retention regulations govern certain non-treaty seine fisheries; WDFW monitors Chinook encounters in these fisheries. Sampling terminal-area fisheries to collect biological information about mature Chinook has been prioritized. Collection of scales, sex, and length data will supplement similar information collected from spawners to characterize the age and size composition of the local population.
Fisheries managers have a ‘Moderately Effective’ monitoring and evaluation program for Puget Sound salmon. Recovery plans have been developed for depleted stocks. Salmon spawning in streams are enumerated and counts are expanded using past tagging data to estimate total spawning abundance in the major watershed. Escapements to hatcheries are recorded. Harvests are monitored and recorded. Catch-and-release has been used to selectively harvest surplus hatchery salmon (adipose clipped), while also considering catch and release mortality of the unmarked salmon. Some Chinook and coho salmon (mostly hatchery fish) receive coded wire tags (CWT) that are used to evaluate stock-specific distribution, survival, and exploitation rate. Otoliths and scales may be used for age determination in addition to CWT. Estimated proportions of hatchery- versus natural-origin Chinook on the spawning grounds have been developed in recent years in some of the watersheds. However, most salmon escapement counts include hatchery-origin spawners in the totals (see Criterion 1 for each species). The presence of numerous hatchery fish on the spawning grounds may mask the viability of the natural population and confound its status.
inflates escapement numbers and can mask the impact of a high harvest rate on the natural-origin stock.

**Rationale**

Commercial, ceremonial, and subsistence, harvest, and test fisheries, in Washington catch areas 1–13, and associated subareas and freshwater areas, are recorded on sales receipts (=fish tickets’), and compiled in a jointly maintained database. Catch is monitored in season for all fisheries. Non-landed mortality of Chinook is significant for commercial troll, recreational hook-and-line fisheries. Regulations for these fisheries may require release of sub-adult Chinook, or all Chinook, during certain periods. Studies are conducted to estimate encounter rates and hooking mortality for these fisheries. Estimates of encounter rates will be derived from on-board observations, angler interviews at landing ports or marinas, and remote observation of some recreational fisheries. These findings are used to validate, or adjust, the encounter rates and release mortality rates used in the FRAM. ‘Drop-out’ mortality (fish caught in the net but lost prior to being brought aboard the vessel) in gillnet fisheries is accounted as 3% or 2% of landed catch in preterminal and terminal fisheries, respectively. Chinook non-retention regulations govern certain non-treaty seine fisheries; WDFW monitors Chinook encounters in these fisheries. Sampling terminal-area fisheries to collect biological information about mature Chinook has been prioritized. Collection of scales, sex, and length data will supplement similar information collected from spawners to characterize the age and size composition of the local population.

**Cape Falcon to Humbug Mt. North Pacific, Trolling Lines**

**Cape Falcon to Humbug Mt. North Pacific, Trolling Lines—Chinook**

**Horse Mt. to U.S./Mexico Border North Pacific, Trolling Lines—Chinook**

**Humbug Mt. to Horse Mt. North Pacific, Trolling Lines—Chinook**

**North of Cape Falcon North Pacific, Trolling Lines—Chinook**

**North of Cape Falcon North Pacific, Trolling Lines—Coho**

**Moderately Effective**

Fishery exploitation rates are estimated for some ESA-listed stocks to help ensure that fishery impacts do not impede population recovery. There is escapement monitoring for fish spawning in some natural areas, but in-season monitoring of escapements is not used for harvest management. In addition, escapement counts often do not differentiate between wild and hatchery-origin fish. These include some hatchery programs for endangered species or reintroduction of extirpated stocks that encourage hatchery-origin fish to spawn naturally to rebuild these populations. However, in many of the hatchery programs, the intent is to increase or maintain the number of fish available for harvest. Failing to exclude hatchery-origin fish from the escapement counts inflates escapement numbers and can mask
the impact of a high harvest rate on the natural-origin stock.

**Washington North Pacific, Gillnet, Drift–Chinook**

**Washington North Pacific, Gillnet, Drift–Chum**

**Washington North Pacific, Gillnet, Drift–Coho**

**Washington North Pacific, Gillnet, Drift–Sockeye**

**Moderately Effective**

Commercial catches for Washington Department of Fish and Wildlife (WDFW) marine fisheries are subject to dockside catch sampling at major ports. Commercial fishers in coastal marine areas have on-board observer coverage. Fishery exploitation rates are estimated for some ESA-listed stocks to help ensure that fishery impacts do not impede population recovery.

Escapements are monitored in-season in natural spawning areas, and if escapements appear especially low, WDFW can close a fishery by emergency rule. However, escapement counts do not differentiate between wild- and hatchery-origin fish spawning in natural areas. With the exception of the Lake Ozette sockeye salmon (ESA Threatened) hatchery, hatchery programs along the Washington Coast are intended, primarily, to increase the number of fish available to harvest. Failing to exclude hatchery-origin fish from the escapement counts inflates escapement numbers and can mask the impact of a high harvest rate on the natural-origin stock. Therefore, research/monitoring was deemed ‘Moderately Effective.’

**Subfactor 3.1.4 – Management Record of Following Scientific Advice**

*Considerations: How often (always, sometimes, rarely) do managers of the fishery follow scientific recommendations/advice (e.g., do they set catch limits at recommended levels)? A Highly Effective rating is given if managers nearly always follow scientific advice.*

**Columbia River, Gillnet, Drift**

**Highly Effective**

Co-managers incorporate scientific information, such as forecasts and in-season run size estimates, into management decisions when setting exploitation rates in Columbia River and in ocean fisheries that intercept Columbia River salmon (PFMC 2014a)(Joint Columbia River Management Staff 2014a)(Joint Columbia River Management Staff 2014b). This process is part of a legal requirement under the U.S. v. Oregon management agreement (United States v. Oregon 2008). There is no evidence that scientific advice is disregarded, or that managers are setting exploitation rates higher than recommended by
fishery scientists 50% of the time. Therefore, this indicator is judged to be ‘Highly Effective.’

Columbia River, Gillnet, Drift–Chinook
Columbia River, Gillnet, Drift–Coho
Columbia River, Gillnet, Drift–Sockeye
Klamath River, Gillnet, Drift–Chinook
Puget Sound, Gillnet, Drift–Chinook
Puget Sound, Gillnet, Drift–Chum
Puget Sound, Gillnet, Drift–Coho
Puget Sound, Gillnet, Drift–Pink
Puget Sound, Gillnet, Drift–Sockeye
Puget Sound, Purse Seine–Chinook
Puget Sound, Purse Seine–Chum
Puget Sound, Purse Seine–Coho
Puget Sound, Purse Seine–Pink
Puget Sound, Purse Seine–Sockeye

Moderately Effective

Co-managers incorporate scientific information, such as forecasts, into management decisions when setting harvest limits (e.g., PFMC 2011, WDFW & PSIT 2013b). Escapement goals are often achieved, but this achievement typically is based on spawning of hatchery-origin salmon along with natural-origin salmon. Scientific evidence indicates that intermixing of natural-origin and hatchery-origin salmon reduces reproductive success (Chilcote et al. 2013), indicating the need to reduce the proportion of hatchery-origin fish in natural spawning areas. The goal for spawning salmon is not met every year and the proportion of spawners originating from hatcheries is sometimes higher than suggested by scientists. Co-managers balance the needs of fishermen to harvest fish with that of achieving spawner abundance thresholds. However, they typically follow scientific advice when setting exploitation rates. Based on the information available this indicator is judged to be ‘Moderately Effective.’

Puget Sound, Trolling Lines
Highly Effective

Co-managers incorporate scientific information, such as forecasts, into management decisions when setting exploitation rates in Puget Sound and in outside fisheries that intercept Puget Sound salmon (Puget Sound Indian Tribes and the Washington Department of Fish and Wildlife. 2010.). Escapement goals typically are achieved, but this achievement is based on spawning hatchery-origin salmon along with natural-origin salmon. Some watersheds do not achieve the goal for natural-origin Chinook. Co-managers balance the needs of fishermen to harvest fish with that of achieving spawner-abundance thresholds; however, they typically follow scientific advice when setting exploitation rates. This indicator is judged to be ‘Highly Effective’ because there is little evidence that managers are setting exploitation rates higher than recommended by fishery scientists 50% of the time.

Puget Sound, Trolling Lines–Chinook
Puget Sound, Trolling Lines–Coho
Puget Sound, Trolling Lines–Pink
Cape Falcon to Humbug Mt. North Pacific, Trolling Lines
Cape Falcon to Humbug Mt. North Pacific, Trolling Lines- Chinook
Horse Mt. to U.S./Mexico Border North Pacific, Trolling Lines- Chinook
Humbug Mt. to Horse Mt. North Pacific, Trolling Lines- Chinook
North of Cape Falcon North Pacific, Trolling Lines- Chinook
North of Cape Falcon North Pacific, Trolling Lines- Coho
Washington North Pacific, Gillnet, Drift- Chinook
Washington North Pacific, Gillnet, Drift- Chum
Washington North Pacific, Gillnet, Drift- Coho
Washington North Pacific, Gillnet, Drift- Sockeye

Moderately Effective

Co-managers incorporate scientific information such as forecasts into management decisions when setting harvest limits (e.g., PFMC 2011, WDFW & PSIT 2013b). Escapement goals are often achieved, but this achievement is based typically on spawning of hatchery-origin salmon along with natural-origin salmon. Scientific evidence indicates that intermixing of natural-origin and hatchery-origin salmon
reduces reproductive success (Chilcote et al. 2013), indicating the need to reduce the proportion of hatchery origin fish in natural spawning areas. The goal for spawning salmon is not met every year and the proportion of spawners originating from hatcheries is sometimes higher than suggested by scientists. Co-managers balance the needs of fishermen to harvest fish with that of achieving spawner abundance thresholds. However, they typically follow scientific advice when setting exploitation rates. Based on the information available this indicator is judged to be ‘Moderately Effective.’

Subfactor 3.1.5 – Enforcement of Management Regulations

Considerations: Do fishermen comply with regulations, and how is this monitored? To achieve a Highly Effective rating, there must be regular enforcement of regulations and verification of compliance.

Columbia River, Gillnet, Drift
Columbia River, Gillnet, Drift–Chinook
Columbia River, Gillnet, Drift–Coho
Columbia River, Gillnet, Drift–Sockeye

Moderately Effective

State, federal and tribal authorities are responsible for enforcement and monitoring of catch to meet goals and objectives of fisheries management. However, the complexity of the fishery involving multiple federal, state and tribal jurisdictions and landing sites makes it difficult to maintain consistent enforcement effort across the entire fishery during all fishery openings. Therefore, although enforcement of management regulations is in place, the effectiveness of enforcement and monitoring is somewhat uncertain, and this indicator was judged to be ‘Moderately Effective.’

Rationale

To obtain a Highly Effective score, demonstration of independent verification and adequate enforcement using appropriate methods is needed, and that level of evidence was not found. A report submitted to the Independent Scientific Review Panel mentioned some enforcement challenges for tribal fisheries, such as the large size of the enforcement area, lack of boats suitable for night patrols and high-wave conditions, and the need for more public education about conservation (Independent Scientific Review Panel 2010). The biggest compliance issues for tribal fisheries are illegal nets and poaching of salmon, steelhead, and sturgeon (Independent Scientific Review Panel 2010).

Klamath River, Gillnet, Drift- Chinook
**Moderately Effective**

Enforcement is in place to monitor compliance with regulations. All fish harvested for commercial sale must be examined by the checkpoint clerk at the boat dock prior to leaving the river, and sales are reported on fish tickets that are submitted to tribal authorities (Yurok Tribal Council 2013). However, it is unclear whether the level of enforcement effort is sufficient to control illegal sales from non-commercial fisheries. This indicator was judged to be 'Moderately Effective.'

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Puget Sound, Gillnet, Drift–Chinook
Puget Sound, Gillnet, Drift–Chum
Puget Sound, Gillnet, Drift–Coho
Puget Sound, Gillnet, Drift–Pink
Puget Sound, Gillnet, Drift–Sockeye
Puget Sound, Purse Seine–Chinook
Puget Sound, Purse Seine–Chum
Puget Sound, Purse Seine–Coho
Puget Sound, Purse Seine–Pink
Puget Sound, Purse Seine–Sockeye

**Moderately Effective**

Enforcement and monitoring of catch are in place to effectively meet goals and objectives of the fisheries management. Catch is required to be reported on sales slips in both treaty and non-treaty fisheries (Puget Sound Indian Tribes and the Washington Department of Fish and Wildlife. 2010.) (WDFW & PSIT 2013b). However, the complexity of the fishery involving multiple federal, state and tribal jurisdictions and landing sites makes it difficult to maintain consistent enforcement effort across the fishery. Therefore, the effectiveness of enforcement and monitoring is uncertain and this indicator was judged to be ‘Moderately Effective.’

**Rationale**

Enforcement and monitoring of catch are in place to effectively meet goals and objectives of the fisheries management. Catch is required to be reported on sales slips in both treaty and non-treaty fisheries. According to the Harvest Management Plan, “Individual tribes promulgate and enforce regulations for fisheries in their usual and accustomed fishing areas, and WDFW promulgates and enforces non-Indian fishery regulations, consistent with the principles and procedures set forth in the
PSSMP. To achieve conservation and sharing objectives all fisheries shall be regulated based on four fundamental elements: (1) acceptably accurate determinations of the appropriate exploitation rate, harvest rate, or numbers of fish available for harvest; (2) the ability to evaluate the effects of specific fishing regulations; (3) a means to monitor fishing activity in a sufficient, timely and accurate fashion; and (4) effective regulation of fisheries, and enforcement, to meet objectives for spawning escapement, harvest sharing, and fishery impacts." Non-treaty commercial and recreational fishery regulations are enforced by the WDFW Enforcement Program. The Enforcement Program 137 General Authority commissioned fish police officers to provide protection for the state fish and wildlife habitats and species, to prevent and manage human/wildlife contacts, and to conduct outreach and education activities for both the citizens and resource users of Washington state. The mission and responsibilities of the Enforcement Program originate with statutes promulgated in several titles of the Revised Code of Washington (RCW) and Washington Administrative Code (WAC). Primary among these is RCW Title 77 - Fish and Wildlife, and Title 10 - Criminal Procedure. Commissioned Fish and Wildlife Officers, (FWOs) stationed in six regions throughout the state, work with a variety of state and federal agencies to enforce all fish and wildlife laws, general authority laws, and WDFW rules. Each tribe exercises authority to enforce tribal fishing regulations, whether fisheries occur on or off their reservation. Enforcement officers of one tribal agency may be cross-deputized by another tribal agency, where those tribes fish in common areas. Some tribes have increased enforcement activity to reduce illegal fishing in some areas. Tribal and WDFW agencies coordinate enforcement for some fisheries. Prosecution of violations of tribal regulations occurs through tribal courts and governmental structures.

Puget Sound, Trolling Lines

**Moderately Effective**

‘Enforcement and monitoring of catch’ are in place to effectively meet goals and objectives of the fisheries management. Catch is required to be reported on sales slips in both treaty and non-treaty fisheries (Puget Sound Indian Tribes and the Washington Department of Fish and Wildlife. 2010.)[WDFW PSIT 2013b].

**Rationale**

‘Enforcement and monitoring of catch’ is in place to effectively meet goals and objectives of the fisheries management. Catch is required to be reported on sales slips in both treaty and non-treaty fisheries. According to the Harvest Management Plan, “Individual tribes promulgate and enforce regulations for fisheries in their usual and accustomed fishing areas, and WDFW promulgates and enforces non-Indian fishery regulations, consistent with the principles and procedures set forth in the PSSMP. To achieve conservation and sharing objectives all fisheries shall be regulated based on four fundamental elements: (1) acceptably accurate determinations of the appropriate exploitation rate, harvest rate, or numbers of fish available for harvest; (2) the ability to evaluate the effects of specific fishing regulations; (3) a means to monitor fishing activity in a sufficient, timely and accurate fashion; and (4) effective regulation of fisheries, and enforcement, to meet objectives for spawning escapement,
Non-treaty commercial and recreational fishery regulations are enforced by the WDFW Enforcement Program. The Enforcement Program’s ‘137 general authority commissioned fish police officers’ provide protection for the state’s fish and wildlife habitats and species, prevent and manage human/wildlife contacts, and conduct outreach and education activities for both the citizens and resource users of Washington state. The mission and responsibilities of the Enforcement Program originate with statutes promulgated in several titles of the Revised Code of Washington (RCW) and Washington Administrative Code (WAC). Primary among these is RCW Title 77 - Fish and Wildlife, and Title 10 - Criminal Procedure. Commissioned Fish and Wildlife Officers (FWOs) stationed in six regions throughout the state work with a variety of state and federal agencies to enforce all fish and wildlife laws, general authority laws, and WDFW rules. Each tribe exercises authority to enforce tribal fishing regulations, whether fisheries occur on or off their reservation. Enforcement officers of one tribal agency may be cross-deputized by another tribal agency, where those tribes fish in common areas. Some tribes have increased enforcement activity to reduce illegal fishing in some areas. Tribal and WDFW agencies coordinate enforcement for some fisheries. Prosecution of violations of tribal regulations occurs through tribal courts and governmental structures. Commercial, ceremonial, and subsistence, harvest, and test fisheries in Washington catch areas 1–13, and associated sub-areas and freshwater areas, are recorded on sales receipts (=fish tickets’), and compiled in a jointly maintained database. Catch is monitored inseason for all fisheries. Non-landed mortality of Chinook is significant for commercial troll, recreational hook-and-line fisheries. Regulations for these fisheries may require release of sub-adult Chinook, or all Chinook, during certain periods. Studies are conducted to estimate encounter rates and hooking mortality for these fisheries. Estimates of encounter rates will be derived from on-board observations, angler interviews at landing ports or marinas, and remote observation of some recreational fisheries. These findings are used to validate, or adjust, the encounter rates and release mortality rates used in the FRAM. ‘Drop-out’ mortality in gillnet fisheries is accounted as 3% or 2% of landed catch in pre-terminal and terminal fisheries, respectively. Chinook non-retention regulations govern certain non-treaty seine fisheries; WDFW monitors Chinook encounters in these fisheries. Sampling terminal area fisheries to collect biological information about mature Chinook has been prioritized. Collection of scales, sex, and length data will supplement similar information collected from spawners to characterize the age and size composition of the local population.
jurisdictions and landing sites makes it difficult to maintain consistent enforcement effort across the fishery. Therefore, the effectiveness of enforcement and monitoring is uncertain and this indicator was judged to be ‘Moderately Effective.’

**Rationale**

Enforcement and monitoring of catch are in place to effectively meet goals and objectives of the fisheries management. Catch is required to be reported on sales slips in both treaty and non-treaty fisheries. According to the Harvest Management Plan, “Individual tribes promulgate and enforce regulations for fisheries in their usual and accustomed fishing areas, and WDFW promulgates and enforces non-Indian fishery regulations, consistent with the principles and procedures set forth in the PSSMP. To achieve conservation and sharing objectives all fisheries shall be regulated based on four fundamental elements: (1) acceptably accurate determinations of the appropriate exploitation rate, harvest rate, or numbers of fish available for harvest; (2) the ability to evaluate the effects of specific fishing regulations; (3) a means to monitor fishing activity in a sufficient, timely and accurate fashion; and (4) effective regulation of fisheries, and enforcement, to meet objectives for spawning escapement, harvest sharing, and fishery impacts.” Non-treaty commercial and recreational fishery regulations are enforced by the WDFW Enforcement Program. The Enforcement Program’s ‘137 general authority commissioned fish police officers’ provide protection for the state’s fish and wildlife habitats and species, prevent and manage human/wildlife contacts, and conduct outreach and education activities for both the citizens and resource users of Washington state. The mission and responsibilities of the Enforcement Program originate with statutes promulgated in several titles of the Revised Code of Washington (RCW) and Washington Administrative Code (WAC). Primary among these is RCW Title 77 - Fish and Wildlife, and Title 10 - Criminal Procedure. Commissioned Fish and Wildlife Officers (FWOs) stationed in six regions throughout the state work with a variety of state and federal agencies to enforce all fish and wildlife laws, general authority laws, and WDFW rules. Each tribe exercises authority to enforce tribal fishing regulations, whether fisheries occur on or off their reservation. Enforcement officers of one tribal agency may be cross-deputized by another tribal agency, where those tribes fish in common areas. Some tribes have increased enforcement activity to reduce illegal fishing in some areas. Tribal and WDFW agencies coordinate enforcement for some fisheries. Prosecution of violations of tribal regulations occurs through tribal courts and governmental structures.

**Cape Falcon to Humbug Mt. North Pacific, Trolling Lines**

**Moderately Effective**

State and tribal authorities are responsible for enforcement and monitoring of catch to meet goals and objectives of fisheries management. However, the complexity of the fishery involving both state and tribal jurisdictions and multiple landing sites/points of sale make it difficult to maintain consistent enforcement effort across the fishery. Therefore, the effectiveness of enforcement and monitoring is uncertain and this indicator was judged to be ‘Moderately Effective.’
Moderately Effective

Enforcement is in place to monitor compliance with regulations. Landings are sampled daily during the fishing season, and fish tickets and fisher logbooks are submitted (PFMC 1997). Management measures are enforced by the National Oceanic and Atmospheric Administration Office of Law Enforcement, the U.S. Coast Guard 11th District, and local enforcement agencies. However, due to the dispersed nature of the fishery over a large area with multiple ports of landing it is difficult to maintain consistent enforcement effort across the fishery. Therefore, the effectiveness of enforcement and monitoring is uncertain and this indicator was judged to be ‘Moderately Effective.’

Moderately Effective

State and Tribal authorities are responsible for enforcement and monitoring of catch to meet goals and objectives of fisheries management. However, the complexity of the fishery involving both state and tribal jurisdictions and multiple landing sites/points of sale make it difficult to maintain consistent enforcement effort across the fishery. Therefore, the effectiveness of enforcement and monitoring is uncertain and this indicator was judged to be ‘Moderately Effective.’

Subfactor 3.1.6 – Management Track Record

Considerations: Does management have a history of successfully maintaining populations at sustainable levels or a history of failing to maintain populations at sustainable levels? A Highly
**Effective rating is given if measures enacted by management have been shown to result in the long-term maintenance of species overtime.**

<table>
<thead>
<tr>
<th>Region</th>
<th>Species</th>
<th>Rating</th>
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<tbody>
<tr>
<td>Columbia River, Gillnet, Drift</td>
<td>Chinook</td>
<td>Moderately Effective</td>
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<tr>
<td>Columbia River, Gillnet, Drift</td>
<td>Coho</td>
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<tr>
<td>Columbia River, Gillnet, Drift</td>
<td>Sockeye</td>
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Numerous changes in harvest management were enacted following the ESA-listing of many Columbia River salmon stocks, to help enable population rebuilding. These management objectives have generally been met (Joint Columbia River Management Staff 2015b). However, it cannot be said that management measures have resulted in long-term maintenance of ecosystem integrity. Although harvest on ESA-listed stocks has been constrained, hatchery production has not, and the large numbers of hatchery fish in the river system may negatively affect wild populations. The management track record was rated ‘Moderately Effective.’

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<tr>
<th>Region</th>
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<th>Rating</th>
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<tbody>
<tr>
<td>Klamath River, Gillnet, Drift</td>
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<td>Moderately Effective</td>
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Management measures have been in place for many years, although the track record is somewhat uncertain and has had mixed results in terms of recovery of depleted stocks, largely because much salmon habitat remains degraded or blocked to anadromous migration. Factors that have contributed to the decline of SONCC stocks include, overfishing, loss of freshwater and estuarine habitat, hydropower development, poor ocean conditions, and hatchery practices (NOAA 2011f). There is no evidence that measures have maintained ecosystem integrity in the long term.

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<thead>
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<tr>
<td>Puget Sound, Gillnet, Drift</td>
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<td>Puget Sound, Gillnet, Drift</td>
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<td>Puget Sound, Gillnet, Drift</td>
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<td>Puget Sound, Gillnet, Drift</td>
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<tr>
<td>Puget Sound, Gillnet, Drift</td>
<td>Sockeye</td>
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<tr>
<td>Puget Sound, Purse Seine</td>
<td>Chinook</td>
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<tr>
<td>Puget Sound, Gillnet, Drift</td>
<td>Chinook</td>
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### Puget Sound, Purse Seine–Chum

**Moderately Effective**

The management track record has been Moderately Effective. Many changes in the management system were enacted after the ESA-listing of Puget Sound Chinook, Hood Canal summer chum, Puget Sound steelhead and Ozette Lake sockeye, therefore the track record is somewhat recent. The intentions of fisheries management are to enable population rebuilding to the extent that reduced fishing will contribute to rebuilding. Escapement goals for non-listed populations are often met, but hatchery salmon are often used to supplement these populations.

### Puget Sound, Purse Seine–Coho

### Puget Sound, Purse Seine–Pink

### Puget Sound, Purse Seine–Sockeye

### Puget Sound, Trolling Lines

**Moderately Effective**

The management track record has been ‘Moderately Effective.’ Many changes in the management system were enacted after the ESA-listing of Puget Sound Chinook, Hood Canal summer chum, Puget Sound steelhead and Ozette Lake sockeye, therefore the track record is somewhat recent. The intentions of fisheries management are to enable population rebuilding to the extent that reduced fishing will contribute to rebuilding. Escapement goals for non-listed populations are often met, but hatchery salmon are often used to supplement these populations.

### Puget Sound, Trolling Lines–Chinook

### Puget Sound, Trolling Lines–Coho

### Puget Sound, Trolling Lines–Pink

**Moderately Effective**

The management track record has been ‘Moderately Effective.’ Many changes in the management system were enacted after the ESA-listing of Puget Sound Chinook, Hood Canal summer chum, Puget Sound steelhead and Ozette Lake sockeye, therefore the track record is somewhat recent. The intentions of fisheries management are to enable population rebuilding to the extent that reduced fishing will contribute to rebuilding. Escapement goals for non-listed populations are often met, but hatchery salmon are often used to supplement these populations.
Cape Falcon to Humbug Mt. North Pacific, Trolling Lines

Cape Falcon to Humbug Mt. North Pacific, Trolling Lines–Chinook

Horse Mt. to U.S./Mexico Border North Pacific, Trolling Lines–Chinook

Humbug Mt. to Horse Mt. North Pacific, Trolling Lines–Chinook

North of Cape Falcon North Pacific, Trolling Lines–Chinook

North of Cape Falcon North Pacific, Trolling Lines–Coho

**Moderately Effective**

Management has implemented measures to reduce fishery impacts on ESA-listed stocks, aiming to target abundant hatchery fish. These measures have been in place for many years, although the track record is somewhat uncertain and has had mixed results in terms of recovery of depleted stocks, largely because much salmon habitat remains degraded. Restoration of populations may take considerable time. There is no evidence that measures have maintained ecosystem integrity in the long term.

Washington North Pacific, Gillnet, Drift–Chinook

Washington North Pacific, Gillnet, Drift–Chum

Washington North Pacific, Gillnet, Drift–Coho

Washington North Pacific, Gillnet, Drift–Sockeye

**Moderately Effective**

Management has implemented measures to reduce fishery impacts on ESA-listed stocks, aiming to target abundant hatchery and naturally produced stocks through strategic fishery openings and closures and implementing mark-selective fisheries that release non-marked (wild) fish. There are indications that Washington coastal fisheries catch minimal numbers of fish from ESA-listed stocks (Kassler and Marshall 2004). However, there is not sufficient evidence to determine whether management measures have resulted in long-term maintenance of ecosystem integrity. Thus the management track record was rated 'Moderately Effective.'

**Subfactor 3.1.7 – Stakeholder Inclusion**

*Considerations: Are stakeholders involved/included in the decision-making process?*

*Stakeholders are individuals/groups/organizations that have an interest in the fishery or that*
may be affected by the management of the fishery (e.g., fishermen, conservation groups, etc.). A **Highly Effective** rating is given if the management process is transparent and includes stakeholder input.

<table>
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<th>Columbia River, Gillnet, Drift</th>
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<tbody>
<tr>
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**Management is transparent, and the inclusion of stakeholders in the management process is judged to be Highly Effective.** Annual planning of Columbia River fisheries proceeds concurrently with that of ocean fisheries, from February through early-April each year, in the Pacific Fishery Management Council forum. This offers the public access to salmon status information and opportunity to interact with the co-managers in developing annual fishing regimes. Conservation concerns for any management unit are identified early in the process.

<table>
<thead>
<tr>
<th>Klamath River, Gillnet, Drift–Chinook</th>
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**Highly Effective**

The Klamath Fishery is managed in coordination with the Pacific Fishery Management Council. Fishery management practices are described in publicly available reports, and stakeholder input has been sought for recovery plans (NMFS 2014b).

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<tr>
<td>Puget Sound, Purse Seine–Chinook</td>
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<td>Puget Sound, Purse Seine–Chum</td>
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</tbody>
</table>
Puget Sound, Purse Seine-Coho

Puget Sound, Purse Seine-Pink

Puget Sound, Purse Seine-Sockeye

Highly Effective

Management is transparent and the inclusion of stakeholders in the management process is judged to be Highly Effective. Annual planning of Puget Sound fisheries proceeds concurrently with that of coastal fisheries, from February through early-April each year, in the Pacific Fishery Management Council and North of Cape Falcon (NOF) forums (Puget Sound Indian Tribes and the Washington Department of Fish and Wildlife 2010) (WDFW & PSIT 2013b). These offer the public, particularly commercial and recreational fishing interest groups, access to salmon status information and opportunity to interact with the co-managers in developing annual fishing regimes. Conservation concerns for any management unit are identified early in the process. Meeting schedules are posted on the Washington Department of Fish and Wildlife web page (http://wdfw.wa.gov/fishing/northfalcon/).

Rationale
Abundance forecasts are developed for Puget Sound, Washington coastal, and Columbia River Chinook management units in advance of the management planning process. Preliminary abundance forecasts for Canadian Chinook stocks, and expected catch ceilings in Alaska and British Columbia, are obtained through the Pacific Salmon Commission or directly from Canada Department of Fisheries and Oceans. The Pacific Fishery Management Council’s annual planning process begins in March by establishing a range of allowable catches for each coastal fishery. An initial harvest regime for Puget Sound fishing is evaluated. Recreational fisheries are initially set at levels similar to the previous year’s regime. Incidental Chinook harvest in preterminal net fisheries is projected from recent-year catch data, and the anticipated scope of fisheries for other species in the upcoming year. Terminal area net fisheries in Chinook management periods are scaled to harvest surplus production and achieve natural and / or hatchery escapement objectives. The fishery regimes for preterminal and terminal net fisheries directed at other salmon species are initially set to meet management objectives for those species.

Puget Sound, Trolling Lines

Highly Effective

Management is transparent and the inclusion of stakeholders in the management process is judged to be Highly Effective. Annual planning of Puget Sound fisheries proceeds concurrently with that of coastal fisheries, from February through early-April each year, in the Pacific Fishery Management Council and North of Cape Falcon (NOF) forums (Puget Sound Indian Tribes and the Washington Department of Fish and Wildlife 2010) (WDFW & PSIT 2013b). These offer the public, particularly commercial and recreational fishing interest groups, access to salmon status information and opportunity to interact
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**Puget Sound, Trolling Lines–Chinook**

**Puget Sound, Trolling Lines–Coho**

**Puget Sound, Trolling Lines–Pink**

**Highly Effective**
Management is transparent and the inclusion of stakeholders in the management process is judged to be ‘Highly Effective.’ Annual planning of Puget Sound fisheries proceeds concurrently with that of coastal fisheries, from February through early-April each year, in the Pacific Fishery Management Council and North of Cape Falcon (NOF) forums (Puget Sound Indian Tribes and the Washington
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**Cape Falcon to Humbug Mt. North Pacific, Trolling Lines**

- **Cape Falcon to Humbug Mt. North Pacific, Trolling Lines—Chinook**
- **Horse Mt. to U.S./Mexico Border North Pacific, Trolling Lines—Chinook**
- **Humbug Mt. to Horse Mt. North Pacific, Trolling Lines—Chinook**
- **North of Cape Falcon North Pacific, Trolling Lines—Chinook**
- **North of Cape Falcon North Pacific, Trolling Lines—Coho**

**Highly Effective**

Fishery management practices are described in publicly available reports, and stakeholder input has been sought for recovery plans (NMFS 2009).

**Washington North Pacific, Gillnet, Drift—Chinook**

**Washington North Pacific, Gillnet, Drift—Chum**
Fishery management practices are described in publicly available reports, and stakeholder input is actively sought. For example, meetings were held to encourage public involvement in the development of the Grays Harbor salmon management policy (WDFW 2014).

### Bycatch Strategy

<table>
<thead>
<tr>
<th>Region / Method</th>
<th>All Kept</th>
<th>Critical</th>
<th>Strategy</th>
<th>Research</th>
<th>Advice</th>
<th>Enforce</th>
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<tbody>
<tr>
<td>Columbia River</td>
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<td>No</td>
<td>Moderately Effective</td>
<td>Moderately Effective</td>
<td>Highly Effective</td>
<td>Moderately Effective</td>
</tr>
<tr>
<td>Purse seine–Sockeye</td>
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<tr>
<td>Puget Sound</td>
<td>Yes</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Trolling Lines–Chinook</td>
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<tr>
<td>Puget Sound</td>
<td>Yes</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
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</tr>
<tr>
<td>Subfactor 3.2.1 – Management Strategy and Implementation</td>
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<tr>
<td><strong>Considerations:</strong> What type of management strategy/measures are in place to reduce the impacts of the fishery on bycatch species and how successful are these management measures? To achieve a Highly Effective rating, the primary bycatch species must be known and there must be clear goals and measures in place to minimize the impacts on bycatch species (e.g., catch limits, use of proven mitigation measures, etc.).</td>
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<tr>
<td><strong>Columbia River, Gillnet, Drift</strong></td>
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</tr>
<tr>
<td><strong>Columbia River, Gillnet, Drift–Chinook</strong></td>
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</tr>
<tr>
<td><strong>Columbia River, Gillnet, Drift–Coho</strong></td>
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</tr>
<tr>
<td><strong>Columbia River, Gillnet, Drift–Sockeye</strong></td>
<td></td>
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<td></td>
</tr>
<tr>
<td><strong>Moderately Effective</strong></td>
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</tr>
<tr>
<td>Bycatch of ESA-listed Columbia River salmon and steelhead stocks is allowed under a 2008 Biological Opinion issued by NMFS (Joint Columbia River Management Staff 2014a)(Joint Columbia River Management Staff 2014a).</td>
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</tr>
</tbody>
</table>
Management Staff 2014b). The co-managers attempt to keep fishery impact rates on ESA-listed stocks within allowable limits in commercial, tribal and recreational fisheries, and generally they have been successful (PFMC 2014a)(Joint Columbia River Management Staff 2014a)(Joint Columbia River Management Staff 2014b). However, salmon from ESA-listed stocks are being retained in some fisheries, and so bycatch is not minimized to the greatest extent possible. This suggests a ‘Moderately Effective’ rather than ‘Highly Effective’ bycatch strategy.

**Klamath River, Gillnet, Drift–Chinook**

**Moderately Effective**

Bycatch reduction techniques are used but are of unknown or uncertain effectiveness. For example, fishing effort is reduced during the migration timing of ESA-listed coho salmon. These fish cannot be sold but may be retained for subsistence or ceremonial purposes. Southern Oregon/Northern California Coast coho populations have continued to decline despite efforts to reduce incidental harvests.

**Puget Sound, Gillnet, Drift–Chinook**

**Puget Sound, Gillnet, Drift–Chum**

**Puget Sound, Gillnet, Drift–Coho**

**Puget Sound, Gillnet, Drift–Pink**

**Puget Sound, Gillnet, Drift–Sockeye**

**Moderately Effective**

The management system has a strategy to reduce bycatch of seabirds, such as the marbled murrelet, and salmon species at specific times and locations (WDFW 2013). For example, a seabird strip is used in gillnets during sockeye fisheries in Area 7/7A. Some salmon species must be released from gillnets in specific locations and time periods (e.g., Chinook and coho in area 7/7A and Chinook and chum in area 12A). Gillnet fisheries using this strategy are typically limited to short duration sets (60 or 90 minutes). Prior to release, salmon must be revived in functional live boxes. In some areas, on-board observers are required to monitor bycatch. The bycatch strategy is not considered to be ‘Highly Effective’ because, for example, it is impractical to live-release all ESA-listed salmonids with a high degree of success. Instead the bycatch strategy for the gillnet fishery is judged to be ‘Moderately Effective.’

**Puget Sound, Purse Seine–Chinook**
Puget Sound, Purse Seine–Chum

Puget Sound, Purse Seine–Coho

Puget Sound, Purse Seine–Pink

Puget Sound, Purse Seine–Sockeye

**Moderately Effective**

Purse seiners must brail salmon and live-release Chinook, coho, and/or chum salmon in specific locations and time periods. A live box must be used to revive the released salmon. Management monitors bycatch and applies a mortality factor to fish that are released (Puget Sound Indian Tribes and the Washington Department of Fish and Wildlife 2010)(WDFW & PSTIT 2013)(WDFW 2013). The strategy is deemed to be ‘Moderately Effective’ rather than ‘Highly Effective’ because the bycatch species often involve ESA-listed species.

Cape Falcon to Humbug Mt. North Pacific, Trolling Lines

**Moderately Effective**

ESA-listed stocks may be caught as bycatch species in US West Coast salmon fisheries. To protect ESA-listed coho stocks, retention of coho caught off the California coast has been prohibited since 1993 (NMFS 1999), and fisheries south of Cape Falcon have not targeted coho except in 2007 and 2009. The bycatch strategy for coho is therefore precautionary, but Chinook are retained even though fish from ESA-listed stocks may occasionally be caught. Co-managers have generally been successful at using seasonal fishery closures to maintain exploitation rates on ESA-listed stocks within specified limits (PFMC 2014a). The bycatch strategy is considered ‘Moderately Effective.’

North of Cape Falcon North Pacific, Trolling Lines–Coho

**Moderately Effective**

Coho salmon are a bycatch species in this area, because the fishery encounters stocks listed under the Endangered Species Act or Committee on the Status of Endangered Wildlife in Canada (e.g., Lower
Columbia Natural, Oregon Coast Natural, and Interior Fraser coho). Coho salmon are retained in Pacific Fishery Management Council ocean troll fisheries operating north of Cape Falcon (essentially Washington state), except in May and June (PFMC 2014a). In 2013, about 43% of Chinook landings in Washington (in fish numbers) were caught from July through September (PFMC 2014a), suggesting that a substantial portion of the Chinook fishery retains coho. In contrast, troll fisheries south of Cape Falcon are always required to release coho to reduce harvest impacts on listed stocks. Management generally meets exploitation rate limits on listed stocks (PFMC 2014a), but this strategy is considered ‘Moderately’ precautionary.

Washington North Pacific, Gillnet, Drift–Chinook
Washington North Pacific, Gillnet, Drift–Chum
Washington North Pacific, Gillnet, Drift–Coho
Washington North Pacific, Gillnet, Drift–Sockeye

**Moderately Effective**

Bycatch in Washington coastal inside fisheries primarily consists of ESA-listed salmon stocks from other regions, such as the Columbia River. None of the local Washington Coast Chinook and coho salmon stocks is ESA-listed. To better target these local stocks, managers use strategic fishery openings and closures and have implemented mark-selective fisheries in some areas (K. Hughes, pers. comm.). Some ESA-listed salmon may be encountered (Kassler and Marshall 2004), but actual catches of ESA-listed salmon are probably minimal. Additional monitoring would help confirm whether this is the case, especially for coho salmon. This indicator was judged to be ‘Moderately Effective.'

**Rationale**

Across the U.S. West Coast, co-managers attempt to keep fishery impact rates on ESA-listed stocks within allowable limits in commercial, tribal and recreational fisheries, and they have generally been successful (PFMC 2014a)(Joint Columbia River Management Staff 2014a)(Joint Columbia River Management Staff 2014b).

Subfactor 3.2.2 – Scientific Research and Monitoring

**Considerations:** Is bycatch in the fishery recorded/documentied and is there adequate monitoring of bycatch to measure fishery’s impact on bycatch species? To achieve a Highly Effective rating, assessments must be conducted to determine the impact of the fishery on species of concern, and an adequate bycatch data collection program must be in place to ensure bycatch management goals are being met.
**Columbia River, Gillnet, Drift**

<table>
<thead>
<tr>
<th>Species</th>
<th>Bycatch Effectiveness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chinook</td>
<td>Moderately Effective</td>
</tr>
<tr>
<td>Coho</td>
<td>Outcome not specified</td>
</tr>
<tr>
<td>Sockeye</td>
<td>Outcome not specified</td>
</tr>
</tbody>
</table>

Co-managers are required to evaluate commercial fishery impacts on ESA-listed species and stocks caught as bycatch (Joint Columbia River Management Staff 2014a). To accomplish this, data are collected from fish tickets, creel surveys, and biological sampling. In addition, genetic stock identification and parentage based tagging are starting to be used for estimating stock abundances and proportions of hatchery-origin fish for Chinook salmon and steelhead (Hess et al. 2014)(Steele et al. 2014). Research and monitoring programs have made good strides, but until marking of hatchery salmon is more complete, via either physical or parentage based tagging, there will be some gaps in monitoring coverage. Bycatch research was deemed "Moderately Effective."

**Klamath River, Gillnet, Drift–Chinook**

<table>
<thead>
<tr>
<th>Species</th>
<th>Bycatch Effectiveness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chinook</td>
<td>Moderately Effective</td>
</tr>
</tbody>
</table>

Tribal fishery monitoring is in place to estimate bycatch of coho salmon, but indices of natural coho escapements are very limited. Thus the effect of the fishery impacts on coho salmon are not well quantified. As a result, scientific research and monitoring were rated 'Moderately Effective.'

**Puget Sound, Gillnet, Drift–Chinook**

<table>
<thead>
<tr>
<th>Species</th>
<th>Bycatch Effectiveness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chinook</td>
<td>Moderately Effective</td>
</tr>
<tr>
<td>Chum</td>
<td>Outcome not specified</td>
</tr>
<tr>
<td>Coho</td>
<td>Outcome not specified</td>
</tr>
<tr>
<td>Pink</td>
<td>Outcome not specified</td>
</tr>
<tr>
<td>Sockeye</td>
<td>Outcome not specified</td>
</tr>
</tbody>
</table>

There has been some research on the effectiveness of live boxes and catch-and-release survival of salmon captured by gillnets (Baker, M.R. et al. 2013). One pink salmon fishery requires on-board observers. Estimates of salmon caught and live-released are not regularly reported. Research and monitoring of bycatch is judged to be ‘Moderately Effective.’
Puget Sound, Purse Seine–Chinook
Puget Sound, Purse Seine–Chum
Puget Sound, Purse Seine–Coho
Puget Sound, Purse Seine–Pink
Puget Sound, Purse Seine–Sockeye

**Moderately Effective**

Purse seiners must brail salmon and live-release Chinook, coho, and/or chum salmon in specific locations and time periods. A live box must be used to revive the released salmon. There is some monitoring of bycatch and management applies a mortality factor, based on some research, to fish estimated to be released (Puget Sound Indian Tribes and the Washington Department of Fish and Wildlife 2010) (WDFW & PSTIT 2013) (WDFW 2013). Research is deemed to be ‘Moderately Effective.’

Cape Falcon to Humbug Mt. North Pacific, Trolling Lines
Cape Falcon to Humbug Mt. North Pacific, Trolling Lines–Chinook
Horse Mt. to U.S./Mexico Border North Pacific, Trolling Lines–Chinook
Humbug Mt. to Horse Mt. North Pacific, Trolling Lines–Chinook
North of Cape Falcon North Pacific, Trolling Lines–Chinook
North of Cape Falcon North Pacific, Trolling Lines–Coho

**Moderately Effective**

There are insufficient data to estimate bycatch rates for some ESA-listed coho salmon stocks in Chinook salmon fisheries. Exploitation rates on other stocks, such as Rogue and Klamath River hatchery coho, are used as a proxy (NMFS 2012b). However, it is unclear if these stocks are representative of the ESA-listed stocks and sufficient for monitoring their stock status. In addition, most salmon escapement counts include hatchery-origin spawners in the totals (see Criterion 1 for each species). The presence of numerous hatchery fish on the spawning grounds may mask the viability of the natural population and confound its status. As a result, research and monitoring was judged to be ‘Moderately Effective.’

Washington North Pacific, Gillnet, Drift–Chinook
Moderately Effective

Exploitation rates on Lower Columbia River natural coho salmon, a bycatch species listed under the Endangered Species Act, are regularly estimated and monitored with the goal of staying within rate limits. However, salmon escapement counts include hatchery-origin spawners in the totals (see Criterion 1 for each species). The presence of numerous hatchery fish on the spawning grounds may mask the viability of the natural population and confound its status. As a result, research and monitoring was judged to be ‘Moderately Effective.’

Subfactor 3.2.3 – Management Record of Following Scientific Advice

Considerations: How often (always, sometimes, rarely) do managers of the fishery follow scientific recommendations/advice (e.g., do they set catch limits at recommended levels)? A Highly Effective rating is given if managers nearly always follow scientific advice.

Highly Effective

Co-managers incorporate scientific information, such as forecasts, into management decisions when setting exploitation rates in Columbia River and in ocean fisheries that intercept Columbia River salmon (PFMC 2014a)(Joint Columbia River Management Staff 2014a)(Joint Columbia River Management Staff 2014b). There is no evidence that scientific advice is disregarded. Therefore, this indicator is judged to be ‘Highly Effective.’

Highly Effective

Management generally follows scientific advice, and there is no evidence that scientific advice is
Puget Sound, Gillnet, Drift–Chinook
Puget Sound, Gillnet, Drift–Chum
Puget Sound, Gillnet, Drift–Coho
Puget Sound, Gillnet, Drift–Pink
Puget Sound, Gillnet, Drift–Sockeye

**Highly Effective**

The management system has implemented bycatch reduction in specific times and areas and is judged to be ‘Highly Effective’ in its use of scientific information (WDFW 2013). For example, live releases of some salmon species are required at certain times and in specific areas. Released salmon must be revived in live boxes. Estimates of bycatch mortality are considered in management.

Puget Sound, Purse Seine–Chinook
Puget Sound, Purse Seine–Chum
Puget Sound, Purse Seine–Coho
Puget Sound, Purse Seine–Pink
Puget Sound, Purse Seine–Sockeye

**Highly Effective**

The management system has implemented bycatch reduction in specific times and areas and is judged to be Highly Effective in its use of scientific information (WDFW 2013). For example, purse seiners are required to live-release all Chinook salmon prior to Oct 20 in nearly all areas. Chinook must be revived in live boxes. Estimates of bycatch mortality are considered in management.

Cape Falcon to Humbug Mt. North Pacific, Trolling Lines

Cape Falcon to Humbug Mt. North Pacific, Trolling Lines–Chinook

Horse Mt. to U.S./Mexico Border North Pacific, Trolling Lines–Chinook
Humbug Mt. to Horse Mt. North Pacific, Trolling Lines–Chinook
North of Cape Falcon North Pacific, Trolling Lines–Chinook
North of Cape Falcon North Pacific, Trolling Line–Coho
Washington North Pacific, Gillnet, Drift–Chinook
Washington North Pacific, Gillnet, Drift–Chum
Washington North Pacific, Gillnet, Drift–Coho
Washington North Pacific, Gillnet, Drift–Sockeye

Highly Effective
Management generally follows scientific advice on bycatch species, and status reviews are conducted every five years for ESA-listed stocks (NOAA 2014a).

Subfactor 3.2.4 – Enforcement of Management Regulations

Considerations: Is there a monitoring/enforcement system in place to ensure fishermen follow management regulations and what is the level of fishermen’s compliance with regulations? To achieve a Highly Effective rating, there must be consistent enforcement of regulations and verification of compliance.

Columbia River, Gillnet, Drift
Columbia River, Gillnet, Drift–Chinook
Columbia River, Gillnet, Drift–Coho
Columbia River, Gillnet, Drift–Sockeye

Moderately Effective
State, federal and tribal authorities are responsible for enforcement and monitoring of catch to meet goals and objectives of fisheries management. However, the complexity of the fishery involving multiple federal, state and tribal jurisdictions and landing sites makes it difficult to maintain consistent enforcement effort across the fishery. Therefore, the effectiveness of enforcement and monitoring is uncertain and this indicator was judged to be ‘Moderately Effective.’

Klamath River, Gillnet, Drift–Chinook
**Moderately Effective**

Enforcement is in place to monitor compliance with regulations. Special regulations in place to reduce impacts to ESA-listed coho salmon include closing the fishery two days per week during the fall coho migration, and prohibition on the sale of coho salmon (Yurok Tribal Council 2013). However, it is unclear whether the level of enforcement effort is sufficient to control illegal sales of coho salmon. This indicator was judged to be 'Moderately Effective.'

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**Puget Sound, Gillnet, Drift–Chinook**

**Puget Sound, Gillnet, Drift–Chum**

**Puget Sound, Gillnet, Drift–Coho**

**Puget Sound, Gillnet, Drift–Pink**

**Puget Sound, Gillnet, Drift–Sockeye**

**Puget Sound, Purse Seine–Chinook**

**Puget Sound, Purse Seine–Chum**

**Puget Sound, Purse Seine–Coho**

**Puget Sound, Purse Seine–Pink**

**Puget Sound, Purse Seine–Sockeye**

**Moderately Effective**

The management system has a record of enforcement that is judged to be ‘Moderately Effective.’ For example, fishermen must be able to demonstrate that their live box meets specific criteria when examined in the field by officials (WDFW 2013). However, the complexity of the fishery involving multiple federal, state and tribal jurisdictions and landing sites makes it difficult to maintain consistent enforcement effort across the fishery. Therefore, the effectiveness of enforcement and monitoring is uncertain and this indicator was judged to be ‘Moderately Effective.’

---

**Cape Falcon to Humbug Mt. North Pacific, Trolling Lines**

**Cape Falcon to Humbug Mt. North Pacific, Trolling Lines–Chinook**

**Horse Mt. to U.S./Mexico Border North Pacific, Trolling Lines–Chinook**

**Humbug Mt. to Horse Mt. North Pacific, Trolling Lines–Chinook**
**North of Cape Falcon North Pacific, Trolling Lines–Chinook**

**Moderately Effective**

Enforcement is in place to monitor compliance with regulations. Landings are sampled daily during the fishing season, and fish tickets and fisher logbooks are submitted (PFMC 1997). Management measures are enforced by the National Oceanic and Atmospheric Administration Office of Law Enforcement, the U.S. Coast Guard 11th District, and local enforcement agencies. However, due to the dispersed nature of the fishery over a large area with multiple ports of landing it is difficult to maintain consistent enforcement effort across the fishery. Therefore, the effectiveness of enforcement and monitoring is uncertain and this indicator was judged to be ‘Moderately Effective.’

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**Washington North Pacific, Gillnet, Drift–Chinook**

**Moderately Effective**

State and tribal authorities are responsible for enforcement and monitoring of catch to meet goals and objectives of fisheries management. However, the complexity of the fishery involving both state and tribal jurisdictions and multiple landing sites/points of sale make it difficult to maintain consistent enforcement effort across the fishery. Therefore, the effectiveness of enforcement and monitoring is uncertain and this indicator was judged to be ‘Moderately Effective.’
Criterion 4: Impacts on the habitat and ecosystem

This Criterion assesses the impact of the fishery on seafloor habitats, and increases that base score if there are measures in place to mitigate any impacts. The fishery’s overall impact on the ecosystem and food web and the use of ecosystem-based fisheries management (EBFM) principles is also evaluated. Ecosystem Based Fisheries Management aims to consider the interconnections among species and all natural and human stressors on the environment.

The final score is the geometric mean of the impact of fishing gear on habitat score (plus the mitigation of gear impacts score) and the Ecosystem Based Fishery Management score. The Criterion 2 rating is determined as follows:

- Score >3.2=Green or Low Concern
- Score >2.2 and <=3.2=Yellow or Moderate Concern
- Score <=2.2=Red or High Concern

Rating cannot be Critical for Criterion 4.

Criterion 4 Summary

<table>
<thead>
<tr>
<th>Region / Method</th>
<th>Gear Type and Substrate</th>
<th>Mitigation of Gear Impacts</th>
<th>EBFM</th>
<th>Overall Recomm.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Columbia River</td>
<td>Gillnet, Drift–Chinook</td>
<td>4.00:Very Low Concern</td>
<td>0.25:Minimal Mitigation</td>
<td>2.00:High Concern</td>
</tr>
<tr>
<td>Columbia River</td>
<td>Gillnet, Drift–Coho</td>
<td>4.00:Very Low Concern</td>
<td>0.25:Minimal Mitigation</td>
<td>2.00:High Concern</td>
</tr>
<tr>
<td>Columbia River</td>
<td>Gillnet, Drift–Sockeye</td>
<td>4.00:Very Low Concern</td>
<td>0.25:Minimal Mitigation</td>
<td>2.00:High Concern</td>
</tr>
<tr>
<td>Klamath River</td>
<td>Gillnet, Drift–Chinook</td>
<td>4.00:Very Low Concern</td>
<td>0.25:Minimal Mitigation</td>
<td>2.00:High Concern</td>
</tr>
<tr>
<td>Puget Sound</td>
<td>Gillnet, Drift–Chinook</td>
<td>4.00:Very Low Concern</td>
<td>0.25:Minimal Mitigation</td>
<td>2.00:High Concern</td>
</tr>
<tr>
<td>Puget Sound</td>
<td>Gillnet, Drift–Chum</td>
<td>4.00:Very Low Concern</td>
<td>0.25:Minimal Mitigation</td>
<td>2.00:High Concern</td>
</tr>
<tr>
<td>Puget Sound</td>
<td>Gillnet, Drift–Coho</td>
<td>4.00:Very Low Concern</td>
<td>0.25:Minimal Mitigation</td>
<td>2.00:High Concern</td>
</tr>
<tr>
<td>Puget Sound</td>
<td>Gillnet, Drift–Pink</td>
<td>4.00:Very Low Concern</td>
<td>0.25:Minimal Mitigation</td>
<td>2.00:High Concern</td>
</tr>
<tr>
<td>Puget Sound</td>
<td>Gillnet, Drift–Sockeye</td>
<td>4.00:Very Low Concern</td>
<td>0.25:Minimal Mitigation</td>
<td>2.00:High Concern</td>
</tr>
<tr>
<td>Puget Sound</td>
<td>Purse Seine–Chinook</td>
<td>4.00:Very Low Concern</td>
<td>0.25:Minimal Mitigation</td>
<td>2.00:High Concern</td>
</tr>
<tr>
<td>Puget Sound</td>
<td>Purse Seine–Chum</td>
<td>4.00:Very Low Concern</td>
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<td>2.00:High Concern</td>
</tr>
<tr>
<td>Puget Sound</td>
<td>Purse Seine–Coho</td>
<td>4.00:Very Low Concern</td>
<td>0.25:Minimal Mitigation</td>
<td>2.00:High Concern</td>
</tr>
<tr>
<td>Activity</td>
<td>Rank Concern</td>
<td>Mitigation</td>
<td>Category</td>
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</tr>
<tr>
<td>Puget Sound Purse Seine—Pink</td>
<td>4.00:Very Low</td>
<td>0.25:Minimal</td>
<td>Yellow (2.916)</td>
<td></td>
</tr>
<tr>
<td>Puget Sound Purse Seine—Sockeye</td>
<td>4.00:Very Low</td>
<td>0.25:Minimal</td>
<td>Yellow (2.916)</td>
<td></td>
</tr>
<tr>
<td>Puget Sound Trolling Lines—Chinook</td>
<td>5.00:None</td>
<td>0.00:Not Applicable</td>
<td>Yellow (3.162)</td>
<td></td>
</tr>
<tr>
<td>Puget Sound Trolling Lines—Coho</td>
<td>5.00:None</td>
<td>0.00:Not Applicable</td>
<td>Yellow (3.162)</td>
<td></td>
</tr>
<tr>
<td>Cape Falcon to Humbug Mt. North Pacific Trolling Lines—Chinook</td>
<td>5.00:None</td>
<td>0.00:Not Applicable</td>
<td>Green (3.873)</td>
<td></td>
</tr>
<tr>
<td>Horse Mt. to U.S./Mexico Border North Pacific Trolling Lines—Chinook</td>
<td>5.00:None</td>
<td>0.00:Not Applicable</td>
<td>Yellow (3.162)</td>
<td></td>
</tr>
<tr>
<td>Humbug Mt. to Horse Mt. North Pacific Trolling Lines—Chinook</td>
<td>5.00:None</td>
<td>0.00:Not Applicable</td>
<td>Yellow (3.162)</td>
<td></td>
</tr>
<tr>
<td>North of Cape Falcon North Pacific Trolling Lines—Chinook</td>
<td>5.00:None</td>
<td>0.00:Not Applicable</td>
<td>Yellow (3.162)</td>
<td></td>
</tr>
<tr>
<td>North of Cape Falcon North Pacific Trolling Lines—Coho</td>
<td>5.00:None</td>
<td>0.00:Not Applicable</td>
<td>Yellow (3.162)</td>
<td></td>
</tr>
<tr>
<td>Washington North Pacific Gillnet, Drift—Chinook</td>
<td>4.00:Very Low</td>
<td>0.25:Minimal</td>
<td>Yellow (2.916)</td>
<td></td>
</tr>
<tr>
<td>Washington North Pacific Gillnet, Drift—Chum</td>
<td>4.00:Very Low</td>
<td>0.25:Minimal</td>
<td>Yellow (2.916)</td>
<td></td>
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<tr>
<td>Washington North Pacific Gillnet, Drift—Coho</td>
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<td>0.25:Minimal</td>
<td>Yellow (2.916)</td>
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</tr>
<tr>
<td>Washington North Pacific Gillnet, Drift—Sockeye</td>
<td>4.00:Very Low</td>
<td>0.25:Minimal</td>
<td>Yellow (2.916)</td>
<td></td>
</tr>
</tbody>
</table>

**Justification of Ranking**

**Factor 4.1 – Impact of Fishing Gear on the Habitat/Substrate**

**Scoring Guidelines**

- 5 (None)—Fishing gear does not contact the bottom
- 4 (Very Low)—Vertical line gear
- 3 (Low)—Gears that contacts the bottom, but is not dragged along the bottom (e.g., gillnet, bottom longline, trap) and is not fished on sensitive habitats. Bottom seine on resilient mud/sand habitats. Midwater trawl that is known to contact bottom occasionally (
• 2 (Moderate)—Bottom dragging gears (dredge, trawl) fished on resilient mud/sand habitats. Gillnet, trap, or bottom longline fished on sensitive boulder or coral reef habitat. Bottom seine except on mud/sand
• 1 (High)—Hydraulic clam dredge. Dredge or trawl gear fished on moderately sensitive habitats (e.g., cobble or boulder)
• 0 (Very High)—Dredge or trawl fished on biogenic habitat, (e.g., deep-sea corals, eelgrass and maerl)

Note: When multiple habitat types are commonly encountered, and/or the habitat classification is uncertain, the score will be based on the most sensitive, plausible habitat type.

<table>
<thead>
<tr>
<th>Columbia River, Gillnet, Drift</th>
<th>Very Low Concern</th>
</tr>
</thead>
<tbody>
<tr>
<td>Columbia River, Gillnet, Drift–Chinook</td>
<td>Floating gillnets are used which rarely touch the bottom. Therefore, the impacts on substrate were considered 'Very Low Concern.'</td>
</tr>
<tr>
<td>Columbia River, Gillnet, Drift–Coho</td>
<td></td>
</tr>
<tr>
<td>Columbia River, Gillnet, Drift–Sockeye</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Klamath River, Gillnet, Drift–Chinook</th>
<th>Very Low Concern</th>
</tr>
</thead>
<tbody>
<tr>
<td>Klamath River, Gillnet, Drift–Chinook</td>
<td>Floating gillnets are used, which rarely touch the bottom. In addition, the fishery occurs in the estuary which is primarily sand substrate. Therefore, the impacts on substrate were considered 'Very Low Concern.'</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Puget Sound, Gillnet, Drift–Chinook</th>
</tr>
</thead>
<tbody>
<tr>
<td>Puget Sound, Gillnet, Drift–Chum</td>
</tr>
<tr>
<td>Puget Sound, Gillnet, Drift–Coho</td>
</tr>
<tr>
<td>Puget Sound, Gillnet, Drift–Pink</td>
</tr>
<tr>
<td>Puget Sound, Gillnet, Drift–Sockeye</td>
</tr>
</tbody>
</table>
**Very Low Concern**

Gillnets in the Puget Sound salmon fisheries are surface nets that rarely touch bottom substrate. Therefore, gillnets are judged to have ‘Very Low Concern’ regarding impacts to the substrate.

**Rationale**

Salmon gillnets are sometimes lost and not easily recovered by fishermen, but this issue is not addressed by this factor. Lost gillnets may continue to catch salmon, birds and other species (Gilardi et al. 2010)(Good et al. 2010). Although fishermen have incentives to retrieve lost nets, evidence shows that lost nets accumulate over time and they continue to fish. In Puget Sound, where there is an ongoing program to retrieve lost nets, this issue has a ‘Very Low Concern’ (Gilardi et al. 2010)(Good et al. 2010).

| Puget Sound, Purse Seine–Chinook | None |
| Puget Sound, Purse Seine–Chum | None |
| Puget Sound, Purse Seine–Coho | None |
| Puget Sound, Purse Seine–Coho | None |
| Puget Sound, Purse Seine–Pink | None |
| Puget Sound, Purse Seine–Sockeye | None |

**Very Low Concern**

Purse seines are often fished in relatively deep water and typically do not touch the bottom. Seines are rarely lost and when they are they do not continue to fish to the extent that gillnets do. This factor is scored ‘Very Low Concern.’

| Puget Sound, Trolling Lines | None |
| Puget Sound, Trolling Lines–Chinook | None |
| Puget Sound, Trolling Lines–Coho | None |
| Puget Sound, Trolling Lines–Coho | None |
| Puget Sound, Trolling Lines–Pink | None |

Salmon troll fishermen may fish near the bottom but they attempt to avoid touching the bottom with gear because it could become lost. There is no evidence of a habitat effect due to troll gear. Salmon
Salmon troll fishermen may fish near the bottom, especially for Chinook salmon, but they attempt to avoid touching the bottom with gear because it could become lost. Based on the low frequency at which gear contacts the seabed, and the low impact level of any contact that does occur, the habitat impact of salmon troll gear is judged to be negligible.

### Cape Falcon to Humbug Mt. North Pacific, Trolling Lines

<table>
<thead>
<tr>
<th>Zone</th>
<th>Gear Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td></td>
</tr>
</tbody>
</table>

### Cape Falcon to Humbug Mt. North Pacific, Trolling Lines–Chinook

<table>
<thead>
<tr>
<th>Zone</th>
<th>Gear Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horse Mt. to U.S./Mexico Border North Pacific, Trolling Lines–Chinook</td>
<td></td>
</tr>
<tr>
<td>Humbug Mt. to Horse Mt. North Pacific, Trolling Lines–Chinook</td>
<td></td>
</tr>
<tr>
<td>North of Cape Falcon North Pacific, Trolling Lines–Chinook</td>
<td></td>
</tr>
<tr>
<td>North of Cape Falcon North Pacific, Trolling Lines–Coho</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Zone</th>
<th>Gear Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td></td>
</tr>
</tbody>
</table>

### Washington North Pacific, Gillnet, Drift–Chinook

<table>
<thead>
<tr>
<th>Zone</th>
<th>Gear Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Washington North Pacific, Gillnet, Drift–Chum</td>
<td></td>
</tr>
<tr>
<td>Washington North Pacific, Gillnet, Drift–Coho</td>
<td></td>
</tr>
<tr>
<td>Washington North Pacific, Gillnet, Drift–Sockeye</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Zone</th>
<th>Gear Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Low Concern</td>
<td></td>
</tr>
</tbody>
</table>

Floating gillnets are used which rarely touch the bottom. Therefore, gillnets are judged to have very low concern regarding impacts to the substrate.

### Rationale
Salmon gillnets are sometimes lost and not easily recovered by fishermen, but this issue is not addressed by this factor. Lost gillnets may continue to catch salmon, birds and other species (Gilardi et al. 2010)(Good et al. 2010). Although fishermen have incentives to retrieve lost nets, evidence shows that lost nets accumulate over time and continue to fish. The Washington Department of Fish and Wildlife has an ongoing program to retrieve lost nets, so this issue has a low concern (Gilardi et al. 2010)(Good et al. 2010).

**Factor 4.2 – Mitigation of Gear Impacts**

*Scoring Guidelines*

- **+1 (Strong Mitigation)**—Examples include large proportion of habitat protected from fishing (>50%) with gear, fishing intensity low/limited, gear specifically modified to reduce damage to seafloor and modifications shown to be effective at reducing damage, or an effective combination of ‘moderate’ mitigation measures.
- **+0.5 (Moderate Mitigation)**—20% of habitat protected from fishing with gear or other measures in place to limit fishing effort, fishing intensity, and spatial footprint of damage caused from fishing.
- **+0.25 (Low Mitigation)**—A few measures are in place (e.g., vulnerable habitats protected but other habitats not protected); there are some limits on fishing effort/intensity, but not actively being reduced.
- **0 (No Mitigation)**—No effective measures are in place to limit gear impacts on habitats.

<table>
<thead>
<tr>
<th>Columbia River, Gillnet, Drift</th>
</tr>
</thead>
<tbody>
<tr>
<td>Columbia River, Gillnet, Drift–Chinook</td>
</tr>
<tr>
<td>Columbia River, Gillnet, Drift–Coho</td>
</tr>
<tr>
<td>Columbia River, Gillnet, Drift–Sockeye</td>
</tr>
</tbody>
</table>

**Minimal Mitigation**

Efforts are underway to change the spatial footprint of commercial fishing in the lower river but it is unclear whether this will reduce the overall footprint or just change it from the Columbia River mainstream to off-channel locations. Mitigation of gear impacts was judged be minimal because fishing effort is effectively controlled but not reduced.

<table>
<thead>
<tr>
<th>Klamath River, Gillnet, Drift–Chinook</th>
</tr>
</thead>
</table>

**Minimal Mitigation**
Commercial fishing is limited to the Klamath River estuary, where effort is effectively controlled but not reduced.

Puget Sound, Gillnet, Drift–Chinook
Puget Sound, Gillnet, Drift–Chum
Puget Sound, Gillnet, Drift–Coho
Puget Sound, Gillnet, Drift–Pink
Puget Sound, Gillnet, Drift–Sockeye

**Minimal Mitigation**
Gillnets have minimal contact with the substrate, and mitigation of this effect is minimal. Fishing effort is controlled but not reduced to limit habitat impacts.

**Rationale**
Salmon gillnets may be lost by fishermen and may continue to catch salmon and other species. Gillnets are tagged and registered as a means to link nets to the fishermen. Significant effort has been made in recent years to remove derelict gillnets (Gilardi et al. 2010)(Good et al. 2010).

Puget Sound, Purse Seine–Chinook
Puget Sound, Purse Seine–Chum
Puget Sound, Purse Seine–Coho
Puget Sound, Purse Seine–Pink
Puget Sound, Purse Seine–Sockeye

**Minimal Mitigation**
Purse seines have minimal contact with the substrate, and mitigation of this effect is minimal. Fishing effort is controlled but not reduced to limit habitat impacts.

Puget Sound, Trolling Lines
Puget Sound, Trolling Lines–Chinook
<table>
<thead>
<tr>
<th>Area</th>
<th>Gear Type</th>
<th>Mitigation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Puget Sound, Trolling Lines—Coho</td>
<td></td>
<td>Not Applicable</td>
</tr>
<tr>
<td>Puget Sound, Trolling Lines—Pink</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Troll gear has minimal contact</td>
<td></td>
</tr>
<tr>
<td></td>
<td>with the substrate, and mitigation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>of this effect is not applicable.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Area</th>
<th>Gear Type</th>
<th>Mitigation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cape Falcon to Humbug Mt. North Pacific, Trolling Lines</td>
<td></td>
<td>Not Applicable</td>
</tr>
<tr>
<td>Cape Falcon to Humbug Mt. North Pacific, Trolling Lines—Chinook</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Horse Mt. to U.S./Mexico Border North Pacific, Trolling Lines—Chinook</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Humbug Mt. to Horse Mt. North Pacific, Trolling Lines—Chinook</td>
<td></td>
<td></td>
</tr>
<tr>
<td>North of Cape Falcon North Pacific, Trolling Lines—Chinook</td>
<td></td>
<td></td>
</tr>
<tr>
<td>North of Cape Falcon North Pacific, Trolling Lines—Coho</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Not Applicable</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Area</th>
<th>Gear Type</th>
<th>Mitigation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Washington North Pacific, Gillnet, Drift—Chinook</td>
<td></td>
<td>Minimal Mitigation</td>
</tr>
<tr>
<td>Washington North Pacific, Gillnet, Drift—Chum</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Washington North Pacific, Gillnet, Drift—Coho</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Washington North Pacific, Gillnet, Drift—Sockeye</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Commercial fishing effort in this</td>
<td></td>
</tr>
<tr>
<td></td>
<td>area is effectively controlled</td>
<td></td>
</tr>
<tr>
<td></td>
<td>but is not being reduced. There</td>
<td></td>
</tr>
<tr>
<td></td>
<td>are efforts being made to remove</td>
<td></td>
</tr>
<tr>
<td></td>
<td>derelict gillnets, which are</td>
<td></td>
</tr>
<tr>
<td></td>
<td>primarily a bycatch concern but</td>
<td></td>
</tr>
<tr>
<td></td>
<td>may also impact habitat.</td>
<td></td>
</tr>
</tbody>
</table>

**Rationale**

Salmon gillnets may be lost by fishermen and may continue to catch salmon and other species via ghostfishing. Gillnets are tagged and registered as a means to link nets to the fishermen. Significant effort has been made in recent years to remove derelict gillnets, particularly in Puget Sound (Gilardi et al. 2010)(Good et al. 2010). Derelict gillnets have also been removed from Grays Harbor and the Quinault area.
Factor 4.3 – Ecosystem-Based Fisheries Management

Scoring Guidelines

- **5 (Very Low Concern)**—Substantial efforts have been made to protect species’ ecological roles and ensure fishing practices do not have negative ecological effects (e.g., large proportion of fishery area is protected with marine reserves, and abundance is maintained at sufficient levels to provide food to predators).

- **4 (Low Concern)**—Studies are underway to assess the ecological role of species and measures are in place to protect the ecological role of any species that plays an exceptionally large role in the ecosystem. Measures are in place to minimize potentially negative ecological effect if hatchery supplementation or fish aggregating devices (FADs) are used.

- **3 (Moderate Concern)**—Fishery does not catch species that play an exceptionally large role in the ecosystem, or if it does, studies are underway to determine how to protect the ecological role of these species, OR negative ecological effects from hatchery supplementation or FADs are possible and management is not place to mitigate these impacts.

- **2 (High Concern)**—Fishery catches species that play an exceptionally large role in the ecosystem and no efforts are being made to incorporate their ecological role into management.

- **1 (Very High Concern)**—Use of hatchery supplementation or fish aggregating devices (FADs) in the fishery is having serious negative ecological or genetic consequences, OR fishery has resulted in trophic cascades or other detrimental impacts to the food web.

### Columbia River, Gillnet, Drift

### Columbia River, Gillnet, Drift—Chinook

### Columbia River, Gillnet, Drift—Coho

### Columbia River, Gillnet, Drift—Sockeye

#### High Concern

Salmon are considered a species of exceptional importance because they are a keystone species in freshwater systems, providing an annual pulse of marine-derived nutrients and food for predators such as bears and birds (Helfield and Naiman 2006). They are also an important food source for predators in the ocean such as marine mammals, sharks, and piscivorous fish. For example, abundance of the Southern Resident killer whale population (currently listed an endangered) strongly depends on availability of Chinook salmon (Ford et al. 2010b). Research on ecosystem and food web impacts of salmon harvest is being conducted, although fishery management does not have explicit policies for protecting ecosystem functioning. Another major concern is negative impacts on wild salmon from...
hatchery practices, primarily stemming from genetic and ecological issues (e.g., Naish et al. 2007). Managers are aware of these issues and are attempting to investigate and mitigate the problems. For example, the Hatchery Scientific Review Group (HSRG) has assessed individual populations and made hatchery-specific recommendations for improving practices and minimizing negative impacts on wild stocks, and some (but not all) recommendations are being implemented. There are no easy solutions given the desire to support fisheries with large numbers of hatchery salmon. Based on designation of these species as ‘exceptional’ and concerns that there can be serious negative impacts from hatchery supplementation in some areas, this factor was scored as a ‘High Concern.’

Rationale

Several scientific review groups have reviewed hatcheries and their impacts on West Coast salmon stocks (CHSRG 2012b)(HSRG 2014). They suggest that that management policies and strategies have not been completely effective in preventing negative hatchery impacts on the freshwater ecosystem. Examples of problems with hatchery programs are listed below:

- Hatchery broodstocks not representative of naturally spawning, locally adapted populations.
- Cross breeding of different run-types in the hatchery broodstock.
- Failure to include representative age-classes in the hatchery broodstock.
- Lack of protocols to prevent inbreeding.
- Releasing juveniles in locations away from the hatchery (such as the estuary) that increase stray rates.
- Excessive numbers of hatchery-origin fish in natural spawning areas.
- Lack of formal health policy for hatchery operations.
- Inadequate monitoring and evaluation programs.

Klamath River, Gillnet, Drift–Chinook

High Concern

Salmon are considered a species of exceptional importance because they are a keystone species in freshwater systems, providing an annual pulse of marine-derived nutrients and food for predators (Helfield and Naiman 2006). Research on ecosystem and food web impacts of salmon harvest is being conducted, although fishery management does not have explicit policies for protecting ecosystem functioning. However, a large concern is negative impacts on ecosystems from hatchery practices. For example, productivity of wild salmon may decrease as the numbers of hatchery-produced juveniles in the system increase (Buhle et al. 2009). The California Hatchery Scientific Review Group (CHSRG) has made hatchery-specific recommendations for improving practices and minimizing negative impacts on wild stocks, and some but not all recommendations are being implemented. The evidence of negative hatchery impacts result in ‘High Concern’ for this factor.

Rationale
The California Hatchery Scientific Review Group has conducted scientific reviews of Iron Gate and Trinity River hatcheries and their impacts on Klamath salmon stocks (CHSRG 2012c)(CHSRG 2012d). They suggest that management policies and strategies have been ineffective in preventing negative hatchery impacts on the freshwater ecosystem. Examples of problems with hatchery programs are listed below:

- Hatchery broodstocks not representative of naturally spawning, locally adapted populations.
- Cross breeding of different run-types in the hatchery broodstock.
- Failure to include representative age-classes in the hatchery broodstock.
- Lack of protocols to prevent inbreeding.
- Releasing juveniles in locations away from the hatchery (such as the estuary) that increase stray rates.
- Excessive numbers of hatchery-origin fish in natural spawning areas.
- Lack of formal health policy for hatchery operations.
- Inadequate monitoring and evaluation programs.

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**Puget Sound, Gillnet, Drift–Chinook**

**Puget Sound, Gillnet, Drift–Chum**

**Puget Sound, Gillnet, Drift–Coho**

**Puget Sound, Gillnet, Drift–Pink**

**Puget Sound, Gillnet, Drift–Sockeye**

**Puget Sound, Purse Seine–Chinook**

**Puget Sound, Purse Seine–Chum**

**Puget Sound, Purse Seine–Coho**

**Puget Sound, Purse Seine–Pink**

**Puget Sound, Purse Seine–Sockeye**

**High Concern**

Salmon are considered a species of exceptional importance because they are a keystone species in freshwater systems, providing an annual pulse of marine-derived nutrients and food for predators (Helfield and Naiman 2006). Research on ecosystem and food web impacts of salmon harvest is being conducted, although fishery management does not have explicit policies for protecting ecosystem functioning. However, a large concern is negative impacts on wild salmon from hatchery practices. The concern stems primarily from genetic and ecological issues (e.g., Naish et al. 2007). Co-managers are aware of these issues and they are attempting to investigate and mitigate the problems (WDFW & PSIT 2014) but there are no easy solutions given the desire to support fisheries with large numbers of
hatchery salmon. This factor is ranked as a ‘High Concern.’

**Rationale**

Several scientific review groups have reviewed hatcheries and their impacts on West Coast salmon stocks (CHSRG 2012b)(HSRG 2014). They suggest that that management policies and strategies have not been completely effective in preventing negative hatchery impacts on the freshwater ecosystem. Examples of problems with hatchery programs are listed below:

- Hatchery broodstocks not representative of naturally spawning, locally adapted populations.
- Cross breeding of different run-types in the hatchery broodstock.
- Failure to include representative age-classes in the hatchery broodstock.
- Lack of protocols to prevent in-breeding.
- Releasing juveniles in locations away from the hatchery (such as the estuary) that increase stray rates.
- Excessive numbers of hatchery-origin fish in natural spawning areas.
- Lack of formal health policy for hatchery operations.
- Inadequate monitoring and evaluation programs.

---

**Puget Sound, Trolling Lines**

**High Concern**

Salmon are considered a species of exceptional importance because they are a keystone species in freshwater systems, providing an annual pulse of marine-derived nutrients and food for predators (Helfield and Naiman 2006). Research on ecosystem and food web impacts of salmon harvest is being conducted, although fishery management does not have explicit policies for protecting ecosystem functioning. However, a large concern is negative impacts on wild salmon from hatchery practices. The concern stems primarily from genetic and ecological issues (e.g., Naish et al. 2007). Co-managers are aware of these issues and they are attempting to investigate and mitigate the problems (WDFW & PSIT 2014) but there are no easy solutions given the desire to support fisheries with large numbers of hatchery salmon. This factor is ranked as a ‘High Concern.’

**Rationale**

Several scientific review groups have reviewed hatcheries and their impacts on West Coast salmon stocks (CHSRG 2012b)(HSRG 2014). They suggest that that management policies and strategies have not been completely effective in preventing negative hatchery impacts on the freshwater ecosystem. Examples of problems with hatchery programs are listed below:

- Hatchery broodstocks not representative of naturally spawning, locally adapted populations.
- Cross breeding of different run-types in the hatchery broodstock.
- Failure to include representative age-classes in the hatchery broodstock.
- Lack of protocols to prevent inbreeding.
- Releasing juveniles in locations away from the hatchery (such as the estuary) that increase stray rates.
- Excessive numbers of hatchery-origin fish in natural spawning areas.
- Lack of formal health policy for hatchery operations.
- Inadequate monitoring and evaluation programs.

Puget Sound, Trolling Lines–Chinook
Puget Sound, Trolling Lines–Coho
Puget Sound, Trolling Lines–Pink

High Concern

Salmon are considered a species of exceptional importance because they are a keystone species in freshwater systems, providing an annual pulse of marine-derived nutrients and food for predators (Helfield and Naiman 2006). Research on ecosystem and food web impacts of salmon harvest is being conducted, although fishery management does not have explicit policies for protecting ecosystem functioning. However, a large concern is negative impacts on wild salmon from hatchery practices. The concern stems primarily from genetic and ecological issues (e.g., Naish et al. 2007). Co-managers are aware of these issues and they are attempting to investigate and mitigate the problems (WDFW & PSIT 2014) but there are no easy solutions given the desire to support fisheries with large numbers of hatchery salmon. This factor is ranked as a ‘High Concern.’

Rationale
Several scientific review groups have reviewed hatcheries and their impacts on West Coast salmon stocks (CHSRG 2012b)(HSRG 2014). They suggest that that management policies and strategies have not been completely effective in preventing negative hatchery impacts on the freshwater ecosystem. Examples of problems with hatchery programs are listed below:

- Hatchery broodstocks not representative of naturally spawning, locally adapted populations.
- Cross breeding of different run-types in the hatchery broodstock.
- Failure to include representative age-classes in the hatchery broodstock.
- Lack of protocols to prevent in-breeding.
- Releasing juveniles in locations away from the hatchery (such as the estuary) that increase stray rates.
- Excessive numbers of hatchery-origin fish in natural spawning areas.
- Lack of formal health policy for hatchery operations.
- Inadequate monitoring and evaluation programs.
## Cape Falcon to Humbug Mt. North Pacific, Trolling Lines

### Moderate Concern

Salmon are considered a species of exceptional importance because they are a keystone species in freshwater systems, providing an annual pulse of marine-derived nutrients and food for predators (Helfield and Naiman 2006). Research on ecosystem and food web impacts of salmon harvest is being conducted, although fishery management does not have explicit policies for protecting ecosystem functioning. However, a large concern is negative impacts on wild salmon from hatchery practices. The concern stems primarily from genetic and ecological issues (e.g., Naish et al. 2007). Managers are aware of these issues, and the Hatchery Scientific Review Group (HSRG) has assessed individual populations and made hatchery-specific recommendations for improving practices and minimizing negative impacts on wild stocks.

On the Oregon coast, hatchery releases of coho salmon were scaled back extensively in the 1990s in an effort to protect wild populations (Buhle et al. 2009). This is a major step for mitigating negative impacts from hatchery supplementation on wild salmon ecosystems that has not been implemented in the other fisheries assessed in this report. Thus this factor was ranked as a ‘Moderate Concern.’

### Rationale

Several scientific review groups have reviewed hatcheries and their impacts on West Coast salmon stocks (CHSRG 2012b)(HSRG 2014). They suggest that that management policies and strategies have not been completely effective in preventing negative hatchery impacts on the freshwater ecosystem. Examples of problems with hatchery programs are listed below:

- Hatchery broodstocks not representative of naturally spawning, locally adapted populations.
- Cross breeding of different run-types in the hatchery broodstock.
- Failure to include representative age-classes in the hatchery broodstock.
- Lack of protocols to prevent inbreeding.
- Releasing juveniles in locations away from the hatchery (such as the estuary) that increase stray rates.
- Excessive numbers of hatchery-origin fish in natural spawning areas.
- Lack of formal health policy for hatchery operations.
- Inadequate monitoring and evaluation programs.

## Horse Mt. to U.S./Mexico Border North Pacific, Trolling Lines–Chinook

### High Concern
Salmon are considered a species of exceptional importance because they are a keystone species in freshwater systems, providing an annual pulse of marine-derived nutrients and food for predators (Helfield and Naiman 2006). Research on ecosystem and food web impacts of salmon harvest is being conducted, although fishery management does not have explicit policies for protecting ecosystem functioning. However, a large concern is negative impacts on ecosystems from hatchery practices. For example, productivity of wild salmon may decrease as the numbers of hatchery-produced juveniles in the system increase (Buhle et al. 2009). The California Hatchery Scientific Review Group (CHSRG) has made hatchery-specific recommendations for improving practices and minimizing negative impacts on wild stocks, but not all recommendations are being implemented. The evidence of negative hatchery impacts result in ‘High Concern’ for this factor.

**Rationale**
The CHSRG has conducted scientific reviews of Iron Gate and Trinity River hatcheries and their impacts on Klamath salmon stocks (CHSRG 2012c)(CHSRG 2012d). They suggest that management policies and strategies have been ineffective in preventing negative hatchery impacts on the freshwater ecosystem. Examples of problems with hatchery programs are listed below:

- Hatchery broodstocks not representative of naturally spawning, locally adapted populations.
- Cross breeding of different run-types in the hatchery broodstock.
- Failure to include representative age-classes in the hatchery broodstock.
- Lack of protocols to prevent inbreeding.
- Releasing juveniles in locations away from the hatchery (such as the estuary) that increase stray rates.
- Excessive numbers of hatchery-origin fish in natural spawning areas.
- Lack of formal health policy for hatchery operations.
- Inadequate monitoring and evaluation programs.

**North of Cape Falcon North Pacific, Trolling Lines–Chinook**

**North of Cape Falcon North Pacific, Trolling Lines–Coho**

**Washington North Pacific, Gillnet, Drift–Chinook**

**Washington North Pacific, Gillnet, Drift–Chum**

**Washington North Pacific, Gillnet, Drift–Coho**

**Washington North Pacific, Gillnet, Drift–Sockeye**

**High Concern**

Salmon are considered a species of exceptional importance because they are a keystone species in freshwater systems, providing an annual pulse of marine-derived nutrients and food for predators (Helfield and Naiman 2006). Research on ecosystem and food web impacts of salmon harvest is being
conducted, although fishery management does not have explicit policies for protecting ecosystem functioning. However, a large concern is negative impacts on wild salmon from hatchery practices. The concern stems primarily from genetic and ecological issues (e.g., Naish et al. 2007). Managers are aware of these issues and are attempting to investigate and mitigate the problems. For example, the Hatchery Scientific Review Group (HSRG) has assessed individual populations and made hatchery-specific recommendations for improving practices and minimizing negative impacts on wild stocks, and some (but not all) recommendations are being implemented. There are no easy solutions given the desire to support fisheries with large numbers of hatchery salmon. This factor is ranked as a ‘High Concern.’

Rationale
Several scientific review groups have reviewed hatcheries and their impacts on West Coast salmon stocks (CHSRG 2012b)(HSRG 2014). They suggest that that management policies and strategies have not been completely effective in preventing negative hatchery impacts on the freshwater ecosystem. Examples of problems with hatchery programs are listed below:

- Hatchery broodstocks not representative of naturally spawning, locally adapted populations.
- Cross breeding of different run-types in the hatchery broodstock.
- Failure to include representative age-classes in the hatchery broodstock.
- Lack of protocols to prevent inbreeding.
- Releasing juveniles in locations away from the hatchery (such as the estuary) that increase stray rates.
- Excessive numbers of hatchery-origin fish in natural spawning areas.
- Lack of formal health policy for hatchery operations.
- Inadequate monitoring and evaluation programs.
Acknowledgements

Scientific review does not constitute an endorsement of the Seafood Watch® program, or its seafood recommendations, on the part of the reviewing scientists. Seafood Watch® is solely responsible for the conclusions reached in this report.

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Seafood Watch® would also like to thank the following individuals for data, comment, and/or discussion: Larry Gilbertson, Kirt Hughes, Ronald Roler, Rich Lincoln, Julie Bednarski, Charmane Ashbrook, Neala Kendall, Mike Haggerty, Stephanie Martin, Laurie Biagini, David Wiedenfeld, and Martin Huang.
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Appendix A

CHINOOK SALMON: Minor Stocks

Factor 2.1 - Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

Puget Sound, Trolling Lines–Chinook

Medium

The FishBase vulnerability score for Chinook salmon is 68, which corresponds to high inherent vulnerability. However, productivity susceptibility analysis (PSA) suggests moderate vulnerability based on attributes including age at maturity, maximum size, reproductive strategy, and trophic level (see Table 2 for estimates used). We rated inherent vulnerability as 'Medium.'

Rationale
The FishBase score is based on life history traits and ecological characteristics including maximum length, age at first maturity, and geographic range (Cheung et al. 2005). Data used for the productivity susceptibility analysis were obtained from Fishbase.org and are shown in Table 2.

Factor 2.2 - Abundance

Scoring Guidelines (same as Factor 1.2 above)

Puget Sound, Trolling Lines–Chinook

Very High Concern

The Puget Sound troll fishery occurs in the Strait of Juan de Fuca. It is a relatively small fishery that targets Chinook and coho, many of which are headed to places other than Puget Sound, including the Columbia River (CDFO/NMFS/WDFW 1988)(PFMC 2014a)(PSC 2012)(PSC 2013c). Puget Sound ESA-listed Chinook are scored under Criterion 1 in the troll fishery because they likely represent more than 5% of the overall catch of Chinook salmon given that many hatchery stocks are ESA-listed. Genetic data indicate that Columbia River Chinook are a dominant stock taken in this troll fishery although most of these Chinook are not ESA listed (CDFO/NMFS/WDFW 1988). Given the high presence of Columbia River Chinook, we assumed some ESA-listed Chinook from the Columbia River, such as Snake River fall Chinook and Lower Columbia River natural tule Chinook (NOAA 2014a), may be taken in the troll fishery. Therefore, the conservation concern regarding abundance is ‘Very High.’

Rationale
ESA-listed species that might be incidentally captured in Puget Sound salmon fisheries in addition to Puget Sound Chinook include Puget Sound steelhead, Hood Canal summer chum, Ozette Lake sockeye salmon, southern DPS of green sturgeon, bocaccio, canary rockfish, yelloweye rockfish, and marbled murrelet (NMFS 2014)(US FWS 2014). The conservation concern for all of these species is very high, but the susceptibility of the species to salmon trolling is negligible.

Factor 2.3 - Fishing Mortality

*Scoring Guidelines (same as Factor 1.3 above)*

**Puget Sound, Trolling Lines–Chinook**

*High Concern*

The Puget Sound troll fishery is limited to the Strait of Juan de Fuca, and harvests are moderate to small. For example, in 2010, only 2,910 Chinook were harvested (WDFW & PSTIT 2013). In recent years, annual harvests ranged from 400 to over 20,600 in the winter fishery, and from 100 to 4,500 in the spring/summer fishery. Limited genetic data indicate Columbia River and Puget Sound Chinook salmon are the primary stocks taken in this fishery, which occurs over multiple seasons. Given that many Chinook returning to Puget Sound (including some hatchery stocks) and the Columbia River are ESA-listed, we assume a portion of the troll catch is on ESA Chinook, though we are not aware of specific estimates. Cumulative harvest rates on these ESA salmon in the fisheries is high, e.g., 56% for brood years 2002 to 2006 (Table 3)(Ford et al. 2011)(PSIT/WDFW 2013). Trends in catch versus predicted catch have been relatively constant (flat) over the past 6 years, indicating catch is meeting pre season expectations. Long-term annual catch statistics for this fishery were not readily available in reports. However, there is no attempt to reduce mortality on natural fish by live-releasing unmarked salmon even though many Puget Sound populations are not meeting escapement goals for natural-origin fish. Although the NMFS Biological Opinion on the Pacific Salmon Treaty fisheries concludes that the fisheries are achieving recovery exploitation rates and that fisheries would not cause jeopardy to the Puget Sound Chinook ESU, the fisheries are still having a negative impact (NMFS 2008). Therefore, given high harvest rates on an ESA-listed stock and no attempt to live-release ESA salmon, fishing mortality is judged to have a ‘High Concern.’

**Rationale**
Table 3: Median exploitation rates on 22 Puget Sound Chinook salmon populations (ESA listed) in fisheries outside Puget Sound, inside Puget Sound, and all fisheries combined.

<table>
<thead>
<tr>
<th>BY</th>
<th>Mix Mat Fishery pop range</th>
<th>pop median</th>
<th>Mature Fishery pop range</th>
<th>pop median</th>
<th>Total AEQ E pop range</th>
</tr>
</thead>
<tbody>
<tr>
<td>1982-1986</td>
<td>0.36-0.72</td>
<td>0.58</td>
<td>0.02-0.39</td>
<td>0.15</td>
<td>0.44-0.9</td>
</tr>
<tr>
<td>1987-1991</td>
<td>0.29-0.65</td>
<td>0.55</td>
<td>0.01-0.29</td>
<td>0.10</td>
<td>0.39-0.84</td>
</tr>
<tr>
<td>1992-1996</td>
<td>0.22-0.56</td>
<td>0.38</td>
<td>0-0.32</td>
<td>0.04</td>
<td>0.23-0.8</td>
</tr>
<tr>
<td>1997-2001</td>
<td>0.29-0.53</td>
<td>0.45</td>
<td>0.01-0.35</td>
<td>0.09</td>
<td>0.31-0.73</td>
</tr>
<tr>
<td>2002-2006</td>
<td>0.09-0.63</td>
<td>0.42</td>
<td>0.02-0.33</td>
<td>0.16</td>
<td>0.12-0.72</td>
</tr>
<tr>
<td>Trend</td>
<td>-0.12 - +0.02</td>
<td>-0.04</td>
<td>-0.03 - +0.01</td>
<td>-0.01</td>
<td>-0.15 - +0.0</td>
</tr>
</tbody>
</table>

Table 3: Median exploitation rates on 22 Puget Sound Chinook salmon populations (ESA listed) in fisheries outside Puget Sound, inside Puget Sound, and all fisheries combined.

CHUM SALMON

Factor 2.1 - Inherent Vulnerability

*Scoring Guidelines (same as Factor 1.1 above)*

Puget Sound, Trolling Lines

Medium

The FishBase vulnerability score for chum salmon is 49, making inherent vulnerability ‘Medium.’ The FishBase score is based on life history traits and ecological characteristics including maximum length, age at first maturity, and geographic range (Cheung et al. 2005). Chum salmon have medium vulnerability because although they are a relatively large salmon, they have the widest natural geographic distribution of all Pacific salmon species.

Factor 2.2 - Abundance

*Scoring Guidelines (same as Factor 1.2 above)*

Puget Sound, Trolling Lines

Very Low Concern
suggest we delete this—essentially none taken

Factor 2.3 - Fishing Mortality

*Scoring Guidelines (same as Factor 1.3 above)*

<table>
<thead>
<tr>
<th>Puget Sound, Trolling Lines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Low Concern</td>
</tr>
</tbody>
</table>

Very few chum are taken in the troll fishery.

**CHUM SALMON: Minor Stocks**

Factor 2.1 - Inherent Vulnerability

*Scoring Guidelines (same as Factor 1.1 above)*

<table>
<thead>
<tr>
<th>Columbia River, Gillnet, Drift–Chinook</th>
</tr>
</thead>
<tbody>
<tr>
<td>Columbia River, Gillnet, Drift–Coho</td>
</tr>
<tr>
<td>Puget Sound, Gillnet, Drift–Chinook</td>
</tr>
<tr>
<td>Puget Sound, Purse seine–Chinook</td>
</tr>
<tr>
<td>Puget Sound, Trolling Lines–Chinook</td>
</tr>
</tbody>
</table>

Medium

The FishBase vulnerability score for chum salmon is 49, making inherent vulnerability ‘Medium.’ The FishBase score is based on life history traits and ecological characteristics including maximum length, age at first maturity, and geographic range (Cheung et al. 2005). Chum salmon have medium vulnerability because although they are a relatively large salmon, they have the widest natural geographic distribution of all Pacific salmon species.

Factor 2.2 - Abundance

*Scoring Guidelines (same as Factor 1.2 above)*
Columbia River, Gillnet, Drift–Chinook

**Very High Concern**

Columbia River chinook salmon are listed as a threatened stock under the Endangered Species Act. Thus concern regarding population status is Very High.

**Rationale**

Most chinook salmon production occurs in the Grays River in Washington, smaller tributaries downstream from Bonneville Dam, and some specific locations within the mainstream Columbia River (Joint Columbia River Management Staff 2014a). Returns are primarily from natural production, but there are four hatchery enhancement programs that contribute to the chinook population. Chinook salmon return to the lower Columbia River from early October through mid-December, so bycatch likely occurs only during late fall and winter fisheries. Historically, chinook salmon abundance has been monitored as number of fish per mile, but the reporting metric was switched to spawner estimates starting in 2013.

Puget Sound, Gillnet, Drift–Chinook

Puget Sound, Purse Seine–Chinook

Puget Sound, Trolling Lines–Chinook

**Very High Concern**

Hood Canal summer chinook salmon have undergone a significant decline in abundance, leading to being listed as threatened species under the Endangered Species Act. This ESU includes summer chinook in the Strait of Juan de Fuca. Hood Canal summer chinook have increased from less than 1,000 spawners in the early 1990s to 10,000 to 60,000 in the early 2000s, and to 7,000 to 30,000 during 2009 to 2012 (WDFW 2014b). Abundance has improved, in part, from conservation hatchery efforts, i.e., hatchery propagation specifically designed to improve summer chinook status rather than to provide some harvest (WDFW 2013)(WDFW 2014b)(WDFW and Point No Point Treaty Tribes 2000). The abundance of Hood Canal summer chinook is judged to have a ‘Very High’ conservation concern it remains listed as threatened under ESA.

**Factor 2.3 - Fishing Mortality**

*Scoring Guidelines (same as Factor 1.3 above)*

Columbia River, Gillnet, Drift–Chinook
### Columbia River, Gillnet, Drift–Coho

**Low Concern**

Columbia River chum are listed as threatened under the Endangered Species Act. Columbia River non-treaty commercial fisheries are limited to a 5% harvest rate on this stock, and in 2013 the exploitation rate was 1.9% (Joint Columbia River Management Staff 2014a). Treaty commercial fisheries do not impact this stock, and the 2008 NMFS Biological Opinion suggested that overall harvest of Columbia River chum is negligible (NMFS 2008). Available escapement data suggest that chum escapements have been low but somewhat cyclical, peaking in 2002-2004 and again in 2011-2012 (Joint Columbia River Management Staff 2014a). Conservation concern was rated low because fishing mortality is probably at a sustainable level, and the stock appears stable.

**Rationale**

Chum salmon return to the lower Columbia River from early October through mid-December, so bycatch likely occurs only during late fall and winter fisheries. Reported catches suggest that almost no chum are caught in fall fisheries, when coho and the majority of Chinook are harvested (Joint Columbia River Management Staff 2014a).

### Puget Sound, Gillnet, Drift–Chinook

**Low Concern**

The fisheries management goal for ESA-listed summer chum in Puget Sound is to keep fishing mortality to less than 10%. During 2003 to 2012, fishing mortality of Hood Canal summer chum averaged 9% per year whereas fishing mortality of Strait of Juan de Fuca summer chum was less than 1% (WDFW 2013)(WDFW 2014b). As noted previously, abundance of summer chum has increased over time. Based on improved abundance and low harvest rates on summer chum, fishing mortality is judged to have a ‘Low’ conservation concern.

### Puget Sound, Purse Seine–Chinook

**Low Concern**

The fisheries management goal for ESA-listed summer chum in Puget Sound is to keep fishing mortality to less than 10%. During 2003 to 2012, fishing mortality of Hood Canal summer chum averaged 9% per year whereas fishing mortality of Strait of Juan de Fuca summer chum was less than 1% (WDFW 2013)(WDFW 2014b). As noted previously, abundance of summer chum has increased over time. Based on improved abundance and low harvest rates on summer chum, fishing mortality is judged to have a low conservation concern.
Puget Sound, Trolling Lines–Chinook

Low Concern

The fisheries management goal for ESA-listed summer chum in Puget Sound is to keep fishing mortality to less than 10%. During 2003 to 2012, fishing mortality of Hood Canal summer chum averaged 9% per year whereas fishing mortality of Strait of Juan de Fuca summer chum was less than 1% (WDFW 2013)(WDFW 2014b). As noted previously, abundance of summer chum has increased over time. Based on improved abundance and low harvest rates on summer chum, fishing mortality is judged to have a ‘Low’ conservation concern.

PINK SALMON

Factor 2.1 - Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

Puget Sound, Gillnet, Drift–Chinook
Puget Sound, Purse Seine–Chinook
Puget Sound, Trolling Lines–Chinook

Medium

The FishBase vulnerability score for pink salmon is 37, making inherent vulnerability ‘Medium.’ The FishBase score is based on life history traits and ecological characteristics including maximum length, age at first maturity, and geographic range (Cheung et al. 2005). Pink salmon have medium to low vulnerability because this species matures quickly and has a relatively small body size. They have homogenous life history characteristics and are widely distributed.

Factor 2.2 - Abundance

Scoring Guidelines (same as Factor 1.2 above)

Puget Sound, Gillnet, Drift–Chinook
Puget Sound, Purse Seine–Chinook
Puget Sound, Trolling Lines–Chinook

Very Low Concern

Pink salmon return to Puget Sound primarily in odd-numbered years owing to their two-year life cycle. They are the most abundant salmon species in Puget Sound with annual abundances up to 10 million salmon in recent years (PFMC 2014a). Hatchery pink salmon production is very small, typically less than 1% of the total. Spawning escapement goals have been established for most but not all the areas. The goals have been met or exceeded 75% of the past fifteen years. Given the high abundance (Fig. 23) and lack of hatchery fish on the spawning grounds, the abundance of Puget Sound pink salmon is judged to have a ‘Very Low’ conservation concern.

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

Puget Sound, Gillnet, Drift–Chinook
Puget Sound, Purse seine–Chinook
Puget Sound, Trolling Lines–Chinook

Very Low Concern

Pink salmon are the most abundant salmon species in Puget Sound with annual abundances up to 10 million salmon in recent years (PFMC 2014a). Hatchery pink salmon production is very small, typically less than 1% of the total. Abundance has been increasing during the past 10 or more years. Given the high abundance and lack of hatchery fish on the spawning grounds, fishing mortality of Puget Sound pink salmon is judged to have a ‘Very Low’ conservation concern.

SOCKEYE SALMON: ESA LISTED

Factor 2.1 - Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

Columbia River, Gillnet, Drift–Chinook
Columbia River, Gillnet, Drift–Sockeye
Puget Sound, Gillnet, Drift–Chinook
Puget Sound, Purse seine–Chinook
Puget Sound, Trolling Lines–Chinook

**Low**

The FishBase vulnerability score for sockeye salmon is 32, making inherent vulnerability low. The FishBase score is based on life history traits and ecological characteristics including maximum length, age at first maturity, and geographic range (Cheung et al. 2005). Sockeye salmon have ‘Low’ vulnerability because they have high diversity in life history traits.

## Factor 2.2 - Abundance

*Scoring Guidelines (same as Factor 1.2 above)*

<table>
<thead>
<tr>
<th>Columbia River, Gillnet, Drift–Chinook</th>
</tr>
</thead>
<tbody>
<tr>
<td>Columbia River, Gillnet, Drift–Sockeye</td>
</tr>
</tbody>
</table>

**Very High Concern**

The Snake River sockeye stock is extremely depleted and is listed as endangered under the Endangered Species Act (NOAA 2014a). Because this stock is ESA-listed, conservation concern was rated ‘Very High.’

**Rationale**  
Production of Snake River sockeye is maintained through a captive brood program, and most returning adults are progeny of this program. The Snake River stock was federally listed as endangered in November 1991.

<table>
<thead>
<tr>
<th>Puget Sound, Gillnet, Drift–Chinook</th>
</tr>
</thead>
<tbody>
<tr>
<td>Puget Sound, Purse Seine–Chinook</td>
</tr>
<tr>
<td>Puget Sound, Trolling Lines–Chinook</td>
</tr>
</tbody>
</table>

**Very High Concern**

Fraser sockeye salmon is the primary stock targeted by the Puget Sound sockeye fishery. Fraser sockeye salmon consists of many populations but it is managed according to four migration timing groups; spawning escapements are monitored on about 18 populations. Although the major stocks have been relatively abundant (Fraser River Panel 2012), some smaller stocks have been depressed (CSAS 2013). For example, the Cultus population was classified as endangered by COSEWIC (Committee on the Status of Endangered Wildlife in Canada), leading to actions to reduce harvest rates to some extent.
Cultus sockeye abundance and other small Fraser populations are judged to have a Very High conservation concern regarding abundance. Very few, if any, Ozette Lake sockeye (listed under the Endangered Species Act as threatened) are likely to be captured by this fishery.

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

| Columbia River, Gillnet, Drift–Chinook |
| Columbia River, Gillnet, Drift–Sockeye |

Low Concern

Snake River sockeye are an ESA-listed stock caught in this fishery. To help protect Snake River sockeye, tribal commercial fisheries are limited to harvesting 5%–7% of the run, with the allowable harvest rate depending on sockeye run size, and non-tribal commercial fisheries are limited to harvesting 1% of the run (Joint Columbia River Management Staff 2014b). The 1% harvest allowance for non-tribal commercial fisheries is essentially incidental catch; there is no targeted non-tribal commercial fishery on Snake River sockeye. Abundances are monitored at Lower Granite Dam and appear to have increased since 2008, presumably due in part to hatchery supplementation. Because fishing mortality is probably at a sustainable level, conservation concern was rated ‘Low Concern.’

Rationale
Adult returns are monitored at Lower Granite Dam on the lower Snake River, and data suggest that abundances have been relatively high since 2008 (Fig. 31)(NMFS 2011d).
Puget Sound, Gillnet, Drift–Chinook

Puget Sound, Purse Seine–Chinook

**Moderate Concern**

Cultus Lake sockeye and other small, depressed sockeye populations are harvested along with the more abundant Fraser sockeye populations in the Puget Sound sockeye fishery. These populations have declined even though total spawning escapement of sockeye salmon to the Fraser River has increased over the past 20 years (Connors et al. 2010)(CSAS 2013). Management is attempting to balance the need to conserve these populations while also allowing harvest of the abundant populations. Accordingly, the maximum allowable exploitation rate for Cultus Lake Sockeye is “the greater of a) the low abundance exploitation rate identified for Late Run Sockeye, or b) the exploitation rate that is consistent with continued rebuilding of the population based on inseason information on returns and potential numbers of effective spawners” (DFO 2013a)(Fraser River Panel 2012). Management has taken some action to reduce harvests on Cultus sockeye, and fishing mortality is judged to have a moderate conservation concern. Very few, if any, Ozette Lake sockeye (ESA Threatened) are likely to be captured by this fishery.

Puget Sound, Trolling Lines–Chinook
**Very Low Concern**

Very few weak stock and ESA-listed sockeye are taken in the troll fishery, which is directed at coho and Chinook.

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**STEELHEAD: ESA LISTED**

**Factor 2.1 - Inherent Vulnerability**

*Scoring Guidelines (same as Factor 1.1 above)*

- Columbia River, Gillnet, Drift–Chinook
- Columbia River, Gillnet, Drift–Coho
- Puget Sound, Gillnet, Drift–Chinook
- Puget Sound, Gillnet, Drift–Coho
- Puget Sound, Purse Seine–Chinook
- Puget Sound, Purse Seine–Coho
- Puget Sound, Trolling Lines–Chinook
- Puget Sound, Trolling Lines–Coho

**Medium**

The FishBase vulnerability score for steelhead salmon is 36, making inherent vulnerability moderate. The FishBase score is based on life history traits and ecological characteristics including maximum length, age at first maturity, and geographic range (Cheung et al. 2005).

---

**Factor 2.2 - Abundance**

*Scoring Guidelines (same as Factor 1.2 above)*

- Columbia River, Gillnet, Drift–Chinook
- Columbia River, Gillnet, Drift–Coho

**Very High Concern**
There are five steelhead evolutionarily significant units (ESUs) associated with the Columbia River that are listed under the Endangered Species Act: Upper Columbia River, Middle Columbia River, lower Columbia River, Upper Willamette River, and Snake River basin steelhead. All five ESUs are listed as threatened, and thus conservation concern regarding population status is ‘Very High.’ The status of these ESUs was last reviewed in 2011, and signs of recovery were not reported.

| Puget Sound, Gillnet, Drift–Chinook |
| Puget Sound, Gillnet, Drift–Coho |
| Puget Sound, Purse Seine–Chinook |
| Puget Sound, Purse Seine–Coho |
| Puget Sound, Trolling Lines–Chinook |
| Puget Sound, Trolling Lines–Coho |

**Very High Concern**

From 1985 to 2009, Puget Sound winter-run steelhead abundance has shown a widespread declining trend over much of the Distinct Population Segment (DPS). During 2005-2009 abundance was low throughout the DPS; seven of 15 monitored populations had geometric mean annual abundances of less than 250 steelhead and only three populations had geometric means that exceeded 500 steelhead (Ford et al. 2011). Puget Sound steelhead, which are incidentally captured in Puget Sound salmon fisheries, were listed as threatened under the Endangered Species Act in May 2007. Therefore, the conservation concern was rated ‘Very High.’

**Rationale**

ESA-listed species that might be incidentally captured in Puget Sound salmon fisheries in addition to Puget Sound Chinook and steelhead include Hood Canal summer chum, Ozette Lake sockeye salmon, southern DPS of green sturgeon, bocaccio, canary rockfish, yelloweye rockfish, and marbled murrelet (NMFS 2014)(US FWS 2014). The conservation concern for all of these species is ‘Very High,’ but the susceptibility of the species to salmon fishing is relatively low.

**Factor 2.3 - Fishing Mortality**

*Scoring Guidelines (same as Factor 1.3 above)*

| Columbia River, Gillnet, Drift–Chinook |
| Columbia River, Gillnet, Drift–Coho |
Low Concern

There are 5 Columbia River steelhead evolutionarily significant units (ESUs) listed under the Endangered Species Act: Upper Columbia River, Middle Columbia River, Lower Columbia River, Upper Willamette River, and Snake River basin steelhead. These ESUs include both winter and summer run steelhead. Wild (unmarked) steelhead are released in non-Indian fisheries conducted during the winter season, because all winter-run steelhead are listed under the ESA (Joint Columbia River Management Staff 2014b). The fishery impact rate limit on winter steelhead is 2% per year. There are also minimum net mesh size restrictions to reduce incidental capture of steelhead, and incidental mortality is estimated (Joint Columbia River Management Staff 2014b). However, some tribal fisheries may retain wild steelhead, and steelhead may be caught in commercial fisheries for spring Chinook.

Abundance estimates, which are categorized by run type, suggest that wild steelhead numbers in the Columbia River are stable. The abundance of wild winter steelhead was high from 2001 to 2004 and has since been stable at a lower level (Fig. 32)(Joint Columbia River Management Staff 2014b). Escapement estimates for wild summer steelhead appear cyclical, with abundances peaking in 2001 and 2009 (Fig. 33)(Joint Columbia River Management Staff 2014b). Because fishing mortality is probably at a sustainable level, and population trends are stable, conservation concern was rated 'Low Concern.'

Rationale

Figure 32: Estimated returns of wild Columbia River winter steelhead over time. Data from Table 11 in the 2014 Joint Columbia River Management Staff Report (Joint Columbia River Management Staff 2014b).
There are two basic run-types of steelhead, winter- and summer-run. Upper Columbia River and Snake River steelhead are generally classified as summer-run. Middle Columbia River steelhead are predominantly summer-run, but winter-run fish are found in two tributaries (Klickitat River and Fifteenmile Creek). The Lower Columbia River and Upper Willamette River steelhead ESUs include both summer and winter-run fish.
Rationale
Puget Sound steelhead are impacted in terminal tribal gillnet fisheries and in recreational fisheries (Ford et al. 2011). Steelhead fisheries are directed at hatchery stocks, but some harvest of natural-origin steelhead occurs as incidental to hatchery directed fisheries. Winter-run hatchery steelhead production is primarily of Chambers Creek (southern Puget Sound) stock which has been selected for earlier run timing than natural stocks to minimize fishery interactions. Hatchery production of summer steelhead is primarily of Skamania River (a lower Columbia River tributary) stock which has been selected for earlier spawn timing than natural summer steelhead, to minimize interactions on the spawning grounds. In recreational fisheries, retention of wild steelhead is prohibited, so all harvest impacts occur as the result of release mortality and non-compliance. In tribal net fisheries, most fishery impacts occur in fisheries directed at salmon and hatchery steelhead. Most Puget Sound streams have insufficient catch and escapement data to calculate exploitation rates for natural steelhead. Populations with sufficient data include the Skagit, Green, Nisqually, Puyallup, and Snohomish rivers. Exploitation rates differ widely among the different rivers, but all have declined since the 1970s and 1980s. Exploitation rates on natural steelhead in recent years have been stable and generally less than 5%. In Hood Canal fisheries, the harvest rate on steelhead averaged less than 2.6% during 2002-2012 (Point No Point Tribes 2013).

Puget Sound, Purse Seine–Chinook
Puget Sound, Purse Seine–Coho
Puget Sound, Trolling Lines–Chinook
Puget Sound, Trolling Lines–Coho

Very Low Concern
Puget Sound steelhead are impacted in terminal tribal gillnet fisheries and in recreational fisheries (Ford et al. 2011) but relatively few steelhead are taken in the purse seine fisheries (non-treaty fisheries cannot sell steelhead). Information on the gillnet fishery is provided for reference. In tribal gillnet fisheries, most fishery impacts occur in fisheries directed at salmon and hatchery steelhead. Gillnet exploitation rates on natural steelhead in recent years have been stable and generally less than 5% in Puget Sound. This includes tribal fisheries that target hatchery steelhead. In Hood Canal fisheries, the gillnet harvest rate on steelhead averaged less than 2.6% during 2002-2012 (Point No Point Tribes 2013). The conservation concern related to purse seine and troll fishing mortality on steelhead during fisheries targeting salmon is judged to be very low because it is probable that fishing mortality is sufficiently low to allow the population to maintain itself or rebuild once other issues such as habitat are addressed.