

# Selective Fishing on the Columbia River

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Washington  
Department of  
**FISH &  
WILDLIFE**

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# Table of Contents

<b>Part 1: Selectivity Concepts</b> .....	<b>1</b>
<b>Target and non-target stocks</b> .....	<b>2</b>
<b>Managing bycatch through selective fishing</b> .....	<b>3</b>
a. Avoidance Strategies .....	<b>3</b>
b. Harm minimization Strategies .....	<b>4</b>
<b>Calculating Post-Release Mortalities</b> .....	<b>5</b>
<b>Evaluating selectivity</b> .....	<b>6</b>
Table 1: Selectivity concepts .....	<b>7</b>
<b>Part 2: Selectivity in Columbia River mainstem fall fisheries: A Case Study</b> .....	<b>8</b>
<b>Measuring Selectivity</b> .....	<b>8</b>
Table 2: Selectivity Calculations for fall Columbia River mainstem fisheries .....	<b>9</b>
<b>Management Toolbox</b> .....	<b>9</b>
Gear .....	<b>9</b>
Policy and regulations .....	<b>10</b>
<b>Selectivity and conservation</b> .....	<b>10</b>
<b>Part 3: Other Considerations</b> .....	<b>12</b>
<b>Columbia River fishery objectives</b> .....	<b>12</b>
Social and economic benefits .....	<b>12</b>
Operational goals .....	<b>12</b>

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# Part 1: Selectivity Concepts

## Target and non-target stocks

Commercial and recreational fisheries on the Columbia River target hatchery-origin salmon, certain healthy wild runs of salmon (both sectors) and hatchery-origin steelhead (recreational only), plus some additional non-salmonid species such as eulachon, white sturgeon, and shad.

Due to the complex life cycle of salmon and dynamic environmental conditions, the number of fish returning to the Columbia River varies from year to year. Managers conduct pre-season forecasts to determine how many fish are expected to return to the Columbia River. Based on these abundance estimates and the harvest guidelines (e.g., Endangered Species Act (ESA) impact limits, co-manager agreements, fishery policy), managers set fishing regulations for each specific fishery.

The Columbia River is home to many species of salmon and other marine life that live in or migrate through the Columbia River throughout the year. As a result, Columbia River fisheries are **mixed stock fisheries**, meaning that a mix of different **species** and **stocks**<sup>1</sup> are present during the same time of year and at the same geographic location. This poses a challenge for commercial and recreational fisheries: how to catch the healthy hatchery and wild fish (**target stocks**), while avoiding the other fish in the river (**non-target stocks**).

When fishers/anglers “catch and discard animals they do not want, cannot sell, or are not allowed to keep,” this creates what we call **bycatch**<sup>2</sup>. Bycatch is a broad term used in fisheries around the world and can include the incidental catch of fish, marine mammals, sea turtles and birds. In the Columbia River, bycatch is primarily of non-target fish stocks, including wild salmon and steelhead listed under the Endangered Species Act (ESA). **Non-target catch** is another term for bycatch, but generally refers to a more specific category of stocks that are anticipated to be handled (encountered) in the fishery (e.g., wild Chinook when targeting hatchery Chinook). When non-target fish are caught as

### “Species” and “Stocks”

**Species** refers to a formal taxonomy used to distinguish similar organisms that are genetically distinct, such as Chinook and coho salmon. A **stock** is an independent breeding population of the same species, which is distinct genetically and/or geographically.

In the Columbia River, species and stocks are organized into **management stocks** (also referred to as management stock units), that are mixtures of many independent breeding populations. Columbia River managers group salmon and steelhead into management stocks using non-breeding attributes such as run time and geographic distribution. These groupings enable managers to better achieve various conservation and allocation goals and respond to the biological and logistical challenges of managing Columbia River fisheries.

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<sup>1</sup> For simplicity, the term “stock” is used throughout this document to represent the distinct “management stocks” used in the Columbia River (see text box on this page).

<sup>2</sup> [NOAA Fisheries bycatch definition](#), NOAA Fisheries website, visited 9-9-22

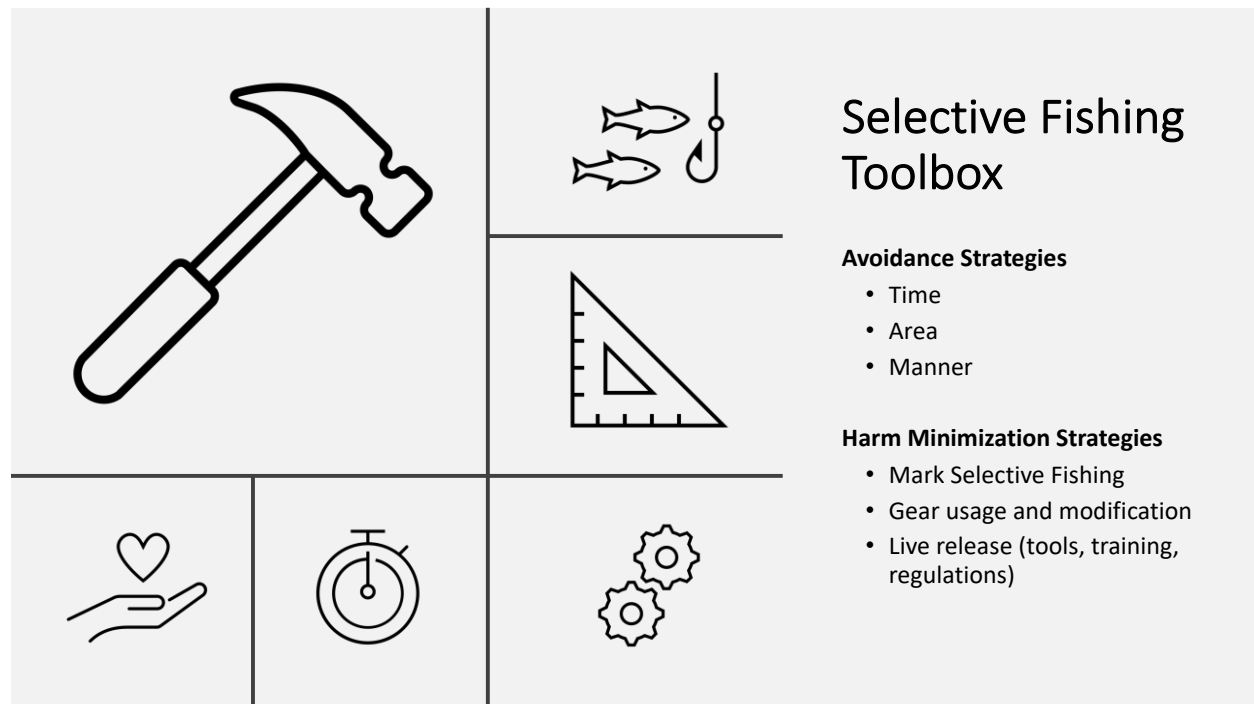


bycatch, they are generally required to be released but they may suffer injuries or mortality, depending on how they are caught and handled.

The term **target catch** generally refers to the fish that commercial and recreational fisheries are targeting or that are allowed to be retained. For example, the coho fishery typically encounters a substantial number of Chinook salmon. Fishers/anglers are allowed to retain the Chinook salmon they catch in the coho fishery even once the traditional Chinook-directed fishery has concluded for the season. Managers also use the term **directed fishery** to indicate the specific fish being targeted (e.g., coho salmon), and the terms **retained catch** or **allowed sale** when referring to the secondary fish that can be kept (e.g., Chinook salmon).

## Managing bycatch through selective fishing

Both fishers/anglers and managers want to avoid bycatch. While it's not realistic to completely eliminate bycatch in most fisheries, managers and fishers/anglers work to a) avoid encountering and handling non-target stocks, and/or b) release bycatch in the best condition possible when encountered. The extent to which a fishery can harvest target stocks, while avoiding and/or minimizing harm to non-target stocks is known as **selectivity**. The strategies of avoidance and releasing fish unharmed are often used in conjunction. Additionally, while avoidance and release strategies are built into fishing regulations, fishers/anglers often expand on these selectivity tools, using their experience and expertise to further refine these tools in response to current conditions.



### Selective Fishing Toolbox

**Avoidance Strategies**

- Time
- Area
- Manner

**Harm Minimization Strategies**

- Mark Selective Fishing
- Gear usage and modification
- Live release (tools, training, regulations)

### a. Avoidance Strategies

Managers at the Washington and Oregon Departments of Fish and Wildlife (WDFW, ODFW) use several tools to promote selective fisheries and to ensure that Columbia River fisheries remain within the allowable impact limits (i.e., mortality limits) for ESA-listed salmon and steelhead (see



text box on page 10). Columbia River fisheries are monitored and adaptively managed throughout each season using **time**, **area**, and **manner** restrictions to maximize benefits to commercial and recreational fisheries while minimizing impacts to non-target stocks.

- **Time:** Managers time fishery openings to the days or seasons when there are more of the fish that fishers/anglers are allowed to catch, and fewer of the fish that need to be avoided. For example, when fall tangle-net fisheries occur in the mainstem, they are timed to occur when the ratio of coho salmon (i.e., target stock) to steelhead (i.e., non-target stock) is favorable to reduce impacts on steelhead.
- **Area:** Managers provide fishing opportunity in areas where there is a lower likelihood of encountering the fish we want to avoid, or a higher ratio of target to non-target fish. For example, the commercial gillnet fishery was moved to zones 4 and 5 (further up the river) to target upriver bright Chinook and reduce the handle of lower river “tule” Chinook. Similarly, in 2019 and 2020, the spring mainstem recreational fishery was moved further down the river to avoid Cowlitz spring Chinook.<sup>3</sup>
- **Manner:** Managers specify the manner in which fishing can occur, including allowable fishing gear, and the fish that can and cannot be harvested. Regulations related to gear include the types of gear that are allowed to be used in different times and areas, as well as detailed gear specifications like minimum mesh sizes and maximum net soaking times for commercial fisheries. These gear regulations are designed to maximize harvest and/or fishing opportunity while minimizing interactions with, or mortality to, non-target fish.

#### **b. Harm minimization Strategies**

Complementary to the above avoidance strategies are management and handling strategies to release bycatch alive and minimize harm to the non-target fish that are encountered in commercial and recreational fisheries.

- **Mark-selective fishing** is where fishers/anglers are allowed to retain marked fish (i.e., fish with an identifiable external mark, such as a clipped adipose fin), but must release all unmarked fish. In Washington, nearly all fish produced at hatcheries are marked in this manner. This management strategy helps fishers/anglers easily distinguish between target and non-target fish and is most effective when the mark rate of the target fish is high and the release mortality of non-marked fish is low.
- Live release regulations are rules for recreational anglers intended to reduce non-target mortality, such as prohibiting non-target fish from being removed from the water.
- Live-release training for commercial fishers provides instruction on handling non-target fish. This training is required for all commercial fishers participating in Columbia River tangle-net fisheries.
- Gear usage or gear modification regulations can lower post-release mortality rates, such as the use of barbless hooks in mainstem Columbia River recreational fisheries.
- Recovery boxes allow bycatch to recover before being released. Recovery boxes are required in Columbia River commercial tangle-net fisheries.

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<sup>3</sup> [Map of commercial fishing areas](#), [Description of recreational fishing areas](#) WDFW website, visited 9-9-22



## Mark-Selective Fisheries

**Mark-selective fishing** is a management strategy used in several commercial and recreational fisheries in the Columbia River. In both recreational and commercial mark-selective fisheries, encounters with unmarked fish occur, but anglers are only allowed to retain marked fish and must release all unmarked fish. Therefore, mark-selective fisheries aren't inherently more "selective" than fisheries that employ avoidance strategies (e.g., time, area, manner) or other harm minimization strategies (e.g., gear modification and handling techniques). Mark-selective fisheries do not necessarily result in fewer mortalities to non-target and ESA listed stocks.

In the Columbia River, mark-selective fisheries are typically used to harvest marked hatchery-origin fish and release wild and ESA-listed stocks. For example, spring Chinook and coho salmon fisheries are currently mark-selective to target hatchery spring Chinook and coho and release wild spring Chinook and coho. Mark-selective fisheries are valuable because the presence of marking allows fishers/anglers to readily identify non-target stocks when encountered and release these fish alive. Therefore, mark-selective fisheries are most effective when the mark rate of the target fish is high, and the release mortality of the non-marked fish is low. Mark-selective fishing is sometimes used in conjunction with time, area and gear measures to maximize encounters with marked fish and minimize encounters with unmarked fish.

## Calculating Post-Release Mortalities

While the above avoidance and harm minimization strategies can be quite effective, non-target stocks are still caught as bycatch in all recreational and commercial Columbia River fisheries. To understand the implications of this interaction, it's important to look at the impact to individual non-target fish and to the non-target stock.

Fishery managers measure the extent to which an individual non-target fish is harmed using **individual post-release mortality rates**. These rates are derived from literature review, observation and scientific study, and are specific to the fishery (e.g., season and gear type), and the species of fish caught as bycatch. Post-release mortality rates indicate the probability of an individual non-target fish dying as a result of being caught incidentally in a fishery. If a non-target fish is caught but quickly released with minimal physical interaction, the probability of mortality is going to be lower. If a non-target fish is caught but injured or extensively handled, the probability of mortality is going to be higher. This estimate includes immediate and delayed mortality due to injuries sustained from being encountered and/or caught by the gear.

To understand the impact of a fishery on a non-target stock, it's important to look at **total post-release mortalities**, which is the product of the total number of non-target fish handled (i.e., caught and released) during the fishery and the individual post-release mortality rate.

**Total post-release mortalities** = (# of fish handled and released) x (post-release mortality rate)

As illustrated in Table 1, a fishery with a relatively low individual post-release mortality rate may have a higher level of total non-target mortalities due to the number of non-target fish handled. Conversely, a fishery with a high individual post-release mortality rate but a lower number of non-target fish handled, may have a lower total number of non-target mortalities. Therefore, both the





individual post-release mortality rate and the total number of non-target fish handled are equally important when calculating the total number of post-release mortalities in a fishery.

## Evaluating selectivity

To evaluate the selectivity of different fisheries, it's important to put the number of total post-release mortalities in context. Given that selectivity is a measure of how well a fishery can harvest target stocks while avoiding and/or minimizing harm to non-target stocks, **relative mortality** provides a valuable metric. Relative mortality relates the number of non-target mortalities to the overall catch in the fishery by calculating the number of fish harvested per non-target mortality. This reflects how selective a fishery is, and the effectiveness of the avoidance and harm minimization strategies used in the fishery.

The table on the following page (Table 1) outlines three hypothetical fisheries to demonstrate the relationship between the different selectivity concepts outlined in Part 1 of this document. The first row shows how many target and non-target fish were handled in Fishery A, B and C. This relates to the concept of avoidance – how well a fishery can catch target fish while avoiding non-target fish. While Fishery C catches more fish overall, a large portion of those are non-target fish. Fishery B catches fewer target fish but also fewer non-target fish. Fishery A catches the most target fish and has the least non-target catch. Row 2 shows the ratio of target catch to non-target catch (i.e., how many target fish are caught for each non-target fish handled)



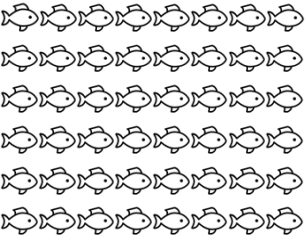

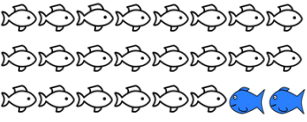

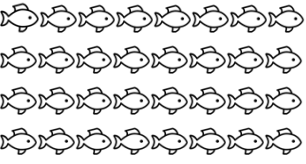
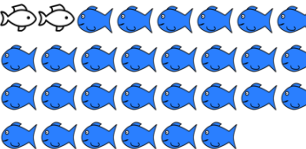





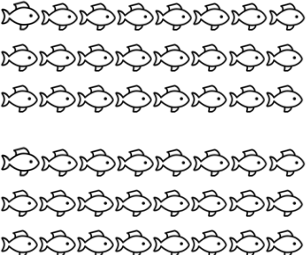

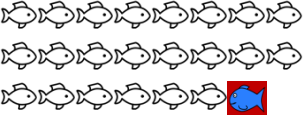

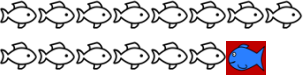

The third and fourth rows of the table show the individual post-release mortality rate and the total number of non-target mortalities for each fishery. This relates to the concept of releasing bycatch unharmed. Fishery A has the highest individual post-release mortality rate: 50% of the fish handled are not expected to survive. However, because few non-target fish are handled, total post-release mortality is low (one fish). Fishery B has a lower individual post-release mortality rate of 33% but a slightly higher number of non-target fish handled, which results in the same total number of total mortalities as Fishery A. Fishery C has the lowest individual post-release mortality rate of just 11%. However, given how many non-target fish are handled, the total number of mortalities is three times that of the other two fisheries.

The final two rows of the table compare relative mortality (i.e., the number of target fish harvested relative to the number of non-target mortalities). Fishery A, despite having the highest post-release mortality rate of the three fisheries, catches 48 target fish for every one non-target mortality. Fisheries B and C catch significantly fewer target fish (22 and 14, respectively) for every non-target mortality.

While relative mortality and selectivity are straightforward concepts, there are additional considerations that may be helpful when assessing the benefits and/or effectiveness of various fisheries. These are discussed in part 3 of this report.



**Table 1: Selectivity concepts**

Row		Fishery A	Fishery B	Fishery C
1	Number of fish handled  target  non-target	 	 	 
2	Ratio of target to non-target	24 : 1	7.3 : 1	1.5 : 1
3	Post-release mortality rate	50%	33%	11%
4	Total number of non-target fish mortalities	 (1)	 (1)	   (3)
5	Number of target fish harvested per non-target mortality	 	 	 
6	Ratio of harvest to non-target mortalities	48:1	22:1	14:1





# Part 2: Selectivity in Columbia River mainstem fall fisheries: A Case Study

## Measuring Selectivity

Applying the concepts described in Part 1 of this document to Columbia River fisheries allows us to explore how each fishery performs relative to selectivity. The following text and Table 2 describe relative mortality for fall commercial and recreational salmonid fisheries in the mainstem Columbia River.<sup>4</sup>

The Zone 4-5 mainstem commercial gillnet fishery has the most favorable ratio of target catch per non-target mortality: 123 target fish are harvested for every 1 non-target mortality. While this fishery has the highest individual post-release mortality rates (38.3 – 44.8%), it has the lowest number of total mortalities because only a small number of non-target fish are handled. The fishery utilizes a number of avoidance strategies (time, area, manner) to reduce overlap with non-target stocks. The Zone 4-5 fishery is organized into two distinct fall seasons (early and late) with a break in early to mid-September to allow a large portion of the steelhead run to pass. The fishery also utilizes different mesh sizes to target and avoid different socks. For example, the early Zone 4-5 fishery applies a 9-inch minimum mesh size restriction to target larger-sized Chinook returning to the river and reduce the handle of smaller-bodied fish like steelhead.

The mainstem fall recreational fishery has the lowest ratio of target catch per non-target mortality: 11 target fish harvested for every 1 non-target mortality. While the individual post-release mortality rates are low (10-19%), almost a third of the fish handled are non-target fish which results in a significant number of mortalities. The number of total mortalities for this fishery is also related to the scale of the fishery; the mainstem fall recreational fishery is the largest commercial or recreational fishery in the Columbia River. Several management avoidance and harm minimization strategies are used in this fishery to support selectivity, including sequential closures to avoid steelhead when run sizes are lower, as well as mark-selective regulations for coho. The fall mainstem recreational fishery for Chinook salmon is primarily a non-mark selective fishery due to low mark rates on hatchery fish.

One important thing to note for this case study is that not all fall mainstem fisheries have the same restrictions on what defines a target and non-target stock. Mainstem commercial fisheries are allowed to retain un-marked fall Chinook, but at times the mainstem recreational fishery may be not allow the retention of un-marked Chinook. This illustrates how management strategies can influence the target catch to non-target post-release mortality ratios detailed in the table below.

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<sup>4</sup> For fall fisheries that have operated in the most recent years, individual post-release mortality rates range from 10 – 45%. Mortality rates may be reviewed and updated as new information becomes available.



**Table 2: Selectivity Calculations for fall Columbia River mainstem fisheries<sup>5</sup>**

Sector	Mainstem Commercial			Mainstem Recreational		
<b>Fishery</b>	Zone 4-5 Gillnet (8-9.75")	Zone 1-3 Tangle net		Buoy 10 to Bonneville Dam		
<b>Season</b>	Fall	Fall		Fall		
<b>Species</b>	Steelhead	Steelhead	Coho	Chinook	Coho	Steelhead
<b>Per fish mortality rate</b>	38.3 or 44.8%	23.60%	23.60%	19%	19%	10%
<b>Data Years</b>	2016-2020	2013-15, 19-20		2016-2020		
<b>Mark Selective Fishery (Yes/No)</b>	No	Mixed		No	Yes	No
<b>Total Fish Handled</b>	27,096	9,420		72,702		
<b>Target Catch (# Fish Kept)</b>	26,303	7,790		49,448		
<b>Non-Target Catch (# Fish Released)</b>	793	1,629		23,255		
<b>Kept %</b>	97%	83%		68%		
<b>Released %</b>	3%	17%		32%		
<b>Total Post-Release Mortalities (# Fish)</b>	213	384		4348		
<b>Mortality Ratio (# of Target Fish per Non-Target Mortality)</b>	123:1	20:1		11:1		
<p>Salmonid handle Includes Chinook, coho, sockeye, steelhead, and chum; some minor handle in some fisheries may not be included.</p> <p>For commercial fisheries, data includes adults and jacks. Recreational is adults only.</p> <p>All commercial fisheries are required to release all steelhead.</p>						

## Management Toolbox

Managing Columbia River fisheries is both an art and a science. Managers consider the scientific inputs, co-manager agreements and harvest constraints, and adaptively manage fisheries in response to the conditions in the river and the goals of each fishery. As described in part 3, commercial and recreational fisheries have different values and needs. Managers work to balance the constraints of ESA mortality limits with opportunity and economics to get the “biggest bang for the buck” in each fishery.

### Gear

Managers need a toolbox of fishing gears and management strategies to effectively manage Columbia River fisheries. Different gears have different benefits and drawbacks for targeting and avoiding different fish stocks and in different areas and seasons. As a result, fishing gears are not

<sup>5</sup> This data was compiled and presented to the Fish and Wildlife Commission’s Special Joint-State Columbia River Salmon Fishery Policy Review Committee on July 28, 2021. Materials, including the [agenda](#), [staff presentation](#) are available on the WDFW website. Visited 9-9-22



necessarily substitutable, and no single gear will work in all areas, seasons and target fisheries. Managers benefit from the ability to use the most effective gear in each fishery to optimize for fishery goals and adapt to fishery conditions. For example, gillnets are the most effective gear in the Select Area commercial fishery given the high catch rates and the low proportion of non-target fish. Tangle nets were tested in Select Areas but were found to be much less effective given the lower catch rates and reduced efficiency, and there were no additional gains in terms of non-target mortalities.

### **Policy and regulations**

While the operational nature of commercial and recreational fisheries (e.g., gears, seasons, areas) plays a large role in selectivity, there are policy and regulatory factors that influence selectivity. The Washington Fish and Wildlife Commission's Columbia River Policy (C-3630) allocates the allowable ESA impacts between recreational and commercial fisheries. In general, recreational fisheries are allocated 70-80% of allowable mortality, with the remaining 20-30% allocated to commercial fisheries. Under this allocation, it is expected that recreational fisheries will have a higher number of total post-release mortalities.

The policy also directs managers to conduct "weak stock management" which means managing the fishery to the most constraining stock limit. As a result, fisheries that interact with the most constraining non-target stocks may have less opportunity than the fisheries that are limited by less constraining non-target stocks.

Whether a fishery is operated as a mark-selective fishery or not also influences the ratio of target to non-target catch. Mark-selective fisheries are only allowed to keep marked fish. Therefore, if the proportion of marked fish is low, fishers/anglers may end up handling a significant number of non-target fish in pursuit of the target marked fish. Specific regulations, such as daily bag limits in the recreational fishery may also influence selectivity. If bag limits are low, anglers may catch and release more fish (target and non-target) for each fish that they choose to keep.

### **Selectivity and conservation**

All commercial and recreational fisheries in the Columbia River have some level of encounter and mortality on non-target stocks. Limits on non-target mortality, particularly for ESA listed stocks, are a central benchmark in how Columbia River fisheries are managed. Managers operate and optimize fisheries within these biologically and legally acceptable total mortality constraints, using the tools described above (time, area, manner, avoidance and harm minimization), and public input gathered through the management process.

#### **Mortality for ESA-listed salmon and steelhead**

All Columbia River fisheries encounter species that are listed under the Endangered Species Act (ESA). These ESA-listed species are managed to very specific legal limits, known as impact rates. The allowable ESA impact rates for Columbia River fisheries are established in the *United States v. Oregon* Management Agreement forum, with NOAA Fisheries and U.S. Fish and Wildlife concurrence. The allowable limits for ESA-listed species establish a level of mortality that does not appreciably reduce the likelihood of survival and recovery of the ESA-listed species. Thus, the amount of mortality for ESA-listed species does not jeopardize the listed salmon and steelhead populations.



Because allowable ESA impacts are a ceiling for Columbia River fisheries, ESA impacts are monitored throughout the season and managers scale back fishing opportunity as impact limits are approached, and all fishing is halted if/once limits are reached. Managers have a solid track record of staying within the acceptable level of ESA mortality for all Columbia River fisheries. For the thirteen specific ESA-listed salmon and steelhead stocks in the Columbia River, jointly managed non-treaty (ODFW/WDFW) fisheries have only exceeded allowable ESA impacts for a single stock on four occasions over the most recent 12 years.

The way in which allowable mortalities are utilized and distributed across fisheries is a policy decision that does not impact the ESA protections provided by these limits. Reducing the total number of allowable mortalities for Columbia River non-treaty fisheries may provide some conservation benefit in the form of increased escapement (i.e., more ESA-listed fish returning to the spawning grounds). However, Washington state policies, and co-management agreements may allow for unused impacts to be utilized by other fisheries rather than allowing those impacts to go unused.

Because of the hatchery production in the Columbia River system, there is also an interplay between managing the number of ESA mortalities to remain within the established limits and using those impacts to harvest hatchery fish. The harvest of hatchery and healthy wild fish is important to achieving recreational and commercial fishery objectives, and to managing the number of fish that return to both hatcheries and spawning grounds.

Given the complex and dynamic nature of the Columbia River, managing non-target mortality in commercial and recreational fisheries is only one aspect of conservation. There are five important components to conserving and recovering endangered salmon and steelhead stocks. The first four are commonly referred to as the “**4 Hs**”.

- **Hatchery production** – managing the production and removal of hatchery fish
- **Habitat** – conserving and restoring wild salmon habitat
- **Hydroelectric power** – minimizing the impact of hydroelectric dams and other barriers to fish passage on wild salmon migration and survival
- **Harvest** – managing the impact of commercial and recreational fisheries on ESA listed species
- **Predation** – managing and accounting for the impacts of predation on wild salmon populations (e.g., sea lions, avian predators such as cormorants)

Given the successful track record of managing fisheries within ESA impact limits and the fact that impact limits have significantly decreased over the last few decades, further reductions in allowable mortalities in commercial and recreational fisheries is likely to have only marginal benefits compared to improvements in fish passage, hatchery operations, and habitat availability.



## Part 3: Other Considerations

While selectivity is an important guide for managers, there are other fishery objectives that guide fisheries management and provide valuable insight for interpreting relative selectivity. For example, the economic benefits of the number of target fish caught per non-target mortality may vary in commercial fisheries depending on the value of the target fish harvested (e.g., species, size, condition). In recreational fisheries, the economic benefits of the number of target fish caught per non-target mortality may be influenced by the number of angler trips, the timing of angler trips, and the species and size of the fish caught. These considerations can provide additional context for the benefits derived from target catch and non-target mortalities.

### Columbia River fishery objectives

Both commercial and recreational fisheries in the Columbia River provide significant value to the states of Oregon and Washington, and to local, state and regional economies. However, commercial and recreational fisheries provide this value in different ways and have different needs and objectives. Considering the objectives and benefits of each fishery provides additional context for interpreting relative mortality and selectivity.

#### Social and economic benefits

- Commercial fisheries are particularly important to local Columbia River communities and economies. Because Columbia River fisheries are part of a fisher's larger portfolio, these fisheries anchor revenue made from other fisheries to the Columbia River region. Commercial fisheries also provide an important public service, supplying Oregon and Washington residents with access to healthy, sustainable seafood, and supporting local seafood economies.
- Recreational fishing in the Columbia River supports many fishing-related businesses (e.g., guide and charter businesses, outfitters), and generates tourism-related revenue across the region (e.g., hotels, restaurants). Recreational fisheries also provide a benefit to Oregon and Washington residents, offering a direct opportunity to participate in Columbia River fisheries.

#### Operational goals

- Commercial fishing operations in the Columbia River are small businesses where fishers earn income from the direct sale of their catch. Therefore, the number of fish caught, the specific stock, and the time and expense of catching the fish all contribute to the economic value and economic viability of small fishing businesses. For example, the Zone 4-5 gillnet fishery is not the largest commercial fishery in terms of the number of fish harvested; however, it is the most economically important commercial fishery. While the season is typically only 4-12 days long, fishers can catch a large number of high-value fish during that time.
- Recreational fisheries value opportunity and the quality of the fishing experience. In general, recreational anglers value having more days to fish and the placement of fishing days (e.g., weekend and holiday openings). The fish stocks targeted, the number of fish that can be kept, and the size of the fish all contribute to the quality of the experience. For



example, the early fall recreational fishery provides high value angler trips given the proportion of desirable upriver bright fall Chinook in river.

