Oncorhynchus mykiss — Steelhead

By Susan McDougall

If salmon species were to be judged for their complex personalities, Steelhead would, hands down, win the prize. Like a young human undergoing adolescent life change, Steelhead may at times give the impression of a calm, settled fish, while beneath this deceptive appearance a turmoil, manifested in a tendency towards unpredictability, occasionally erupts. A young, growing steelhead might stay home a year, or perhaps two. Yet one day, perhaps for no explicable reason at all, the small fish, in apparent unity with others, embarks on a journey downstream. But lacking a clear destination the juvenile might just keep swimming, far from its place of birth. Meanwhile, less driven cousins and siblings seek the shelter of home, sometimes poking their noses into salty waters, other times remaining in the fresh.

Returning home can also be problematic for the wayward young Steelhead. It might wait a year or two, maturing in the beneficent oceanic life, but ultimately it submits to an unavoidable call. Moving from salt water back to fresh water, it seeks a mate, as youngsters are inevitably inclined to do. No longer the silvery color of its juvenile days, the wandering, brilliant red adult enters the waters of its birth, where it seeks those who also were travelers. Nevertheless, rest is elusive, and after answering the call that form and function has placed upon it, and with a swish of its great tail, the older Steelhead returns to the sea. Staying home can wait another year.

Although the origin of the common name is obscure, the designation of the Steelhead as one of the "hooked snout" species — an *Oncorhynchus* — means this fish is closely related to the other five salmon species that live in the Strait. And, as with its relatives, the Steelhead's species name, *mykiss*, hints at the wide range of what is described, in reference to its lifestyle, as the most complex salmon of all. *Mykiss* is a Russian vernacular word, but the scientific name goes beyond a single word: the Steelhead is one of those few fish species that is divided into several subspecies. This acknowledges the various habitats and ranges occupied by *Oncorhynchus mykiss,* an adaptability that has produced a fish varying not only in color and size, but in its preference for salt or freshwater. Some call the Steelhead a "trout" rather than a salmon, in part because that freshwater form goes by a well-known name — the Rainbow Trout.

Yet, regardless of the common name, the Steelhead is an *Oncorhynchus*, a member of the Salmonidae family, a species of freshwater birth and saltwater maturity. And like its close relatives, this is a fish that for thousands of years provided sustenance to humans who made their homes along the saltwater coasts and the great western rivers alike.

Elongated and fusiform in shape, the adult Steelhead has a large head, a jaw that extends a bit beyond the posterior eye margin, small teeth (at least until spawning season), large scales, and, in its sea -run form a metallic blue to bluish-green hue on top with silvery sides and white tones below. There are small black dots on the body as well as on the dorsal and caudal fins. The maximum length is 45 inches (114 cm) with a weight of 37.9 pounds, but such large fish are uncommon; more often the weight is less than 10 pounds and the length approximately 2 feet (61 cm). During spawning season, the male develops the characteristic hooked upper jaw and large teeth, and a pink-to-red color along the sides; the rest of the body is dark green.

Historically, the natural range of the Steelhead stretched across the northern Pacific from Japan, Kamchatka, and the Bering Sea to the coastal waters of the Baja Peninsula, Mexico: today the species is absent south of San Luis Obispo County in central California. Spawning populations thrived in big and small rivers alike; the Columbia River and Snake River supported runs, and on the northern Olympic Peninsula Steelhead were also plentiful in the Elwha River, the Dungeness, the Hoko, and several coastal rivers as well as streams throughout the Strait.

Oncorhynchus mykiss — Steelhead

With its distinct two forms — the sea-run Steelhead and the freshwater Rainbow — *Oncorhynchus mykiss* is widely spread, but it is also known for its atypical spawning behavior. Unlike the truly anadromous salmon, which die after spawning, Steelhead is an iteroparous species, meaning that both males and females sometimes survive spawning, returning downriver, where they are known as "kelts," mature fish once again seeking nourishment in the sea. Although this behavior is uncommon in their native range, introduced Steelhead, such as those in the Great Lakes, are often repeat spawners.

This unusual behavior can increase the lifetime of an adult Steelhead to eight years; typically, a kelt does not return in consecutive years. In a river or lake, spawning adults sometimes interbreed with native rainbow trout, and at least one study indicates this tendency, where present, contributes to

Steelhead – *Oncorhynchus mykiss*

genetic diversity of the local population. Offspring from such mixes sometimes take up the iteroparous lifestyle, while others spend their lives in their freshwater birthplace.

Although spawning occurs in spring, there are two distinct "runs" — the winter run composed of mature fish that spawn the following spring, and the summer run, composed of immature fish, which, while continuing to grow may spend up to a year in the river or stream before spawning.

Adding to the complexity of Steelhead behavior, juveniles also exhibit a variable life history. The juvenile fish most often remain in their natal stream for two winters, reaching a smolt stage before embarking on their journey to saltwater in April or May. Occasionally, the developing young move downriver after a single season. Further complicating the picture, juvenile males, if they stay in their

natal stream, sometimes mature and breed with resident trout. Conversely, resident (Rainbow) males may fertilize the eggs of returning Steelhead females.

Sometimes highly migratory, Steelhead have been caught at nearly a thousand miles (1,600 km) offshore within a few months of their seaward journey, and many move northward as far as the Aleutians or west to Russian waters. Not all undertake such journeys, however, and studies indicate that juveniles from the same spawning grounds can exhibit different lifestyles in their saltwater residency. This variability may be reflected in return times, as Steelhead may remain in saltwater for only a year, or sometimes three or four. It has been observed that northern Steelhead populations are more likely to remain at sea for multiple seasons.

Clearly, studying Steelhead population dynamics can be challenging.

Juvenile freshwater Steelhead feed on aquatic insects, amphipods, and fish eggs. As adults the diet expands to include crustaceans, squid, and fish. In turn, seabirds find the young quite tasty, while larger predators such as lampreys and dogfish, as well as seals and whales, consume the mature fish.

Steelhead are closely related to the Cutthroat Trout (*Oncorhynchus clarkii*) and to an Asian species, the Cherry Salmon (*Oncorhynchus masou*). Their lineage has been traced to a Miocene species that lived approximately five million years ago named *Oncorhynchus lacustris*, in reference to its freshwater habitat in an ancient lake, then located in southwest Idaho. Such an occurrence may imply a freshwater origin for Steelhead and other salmon as well, although the topic is debated. What is known indicates that in the past as the oceans cooled and became more productive, Steelhead and other salmon species began their long tenure in the great Northwest rivers that emptied into the sea. There they would mature in the bountiful saltwater, returning to their birthplace to spawn and die.

Feeding the People

Like blood cells coursing through arteries and veins, creating and defining the life of the organism, so, too, did the salmon populate the rivers and streams of the Pacific Northwest landscape, enriching it for countless other species. While the contributions to so many systems would only slowly yield to research, the presence of this great pulse of life was through the eons utilized and appreciated by those who depended upon it. Without salmon, many human cultures could not have developed their rich complexities; the great fish were the staff of life for so very many.

Early European and American explorers quickly recognized the importance of salmon to indigenous diets: Lewis and Clark observed both the local fishing efforts as well as the preservation of countless fish for sustenance: the expedition benefitted from trade for these magnificent fish, enriching their own provisions that had been depleted by months spent traversing the continent. Indigenous people honored the fish with ceremony and art; everywhere along the many waterways the salmon played an integral part of life.

Steelhead was particularly important to the people who lived near the rivers that flow from the western Olympic mountains into the north Pacific. These included the coastal Quinault, the Queets, the Quileute, and the Hoh. Along the western Strait coastline, Steelhead runs in the Elwha, the Dungeness, and the Hoko rivers, among other waterways, nourished the local tribes. Separate winter and summer Steelhead runs benefited the people as well. The Elwha in particular supported great runs of Steelhead and other salmon, and villages along the river provided homes for the tribes.

By the late nineteenth century, Steelhead provided a bountiful resource as settlers began an intense commercial and recreational harvest. On the Strait in the early 20th century, dams built on the Elwha had

reduced the species to a mere fraction of its former abundance. Although historically considered the richest of the salmonid returning populations, with blocked access Steelhead numbers plummeted. But it was not only the Elwha where runs were reduced; Steelhead would, a hundred years later, become a remnant species. Once numbered in the millions, the population was reduced to thousands.

Fishing the Steelhead — Commercial Bounty, Recreational Joy

Maturing from six-inch smolts weighing a few ounces to an average weight of 10 pounds, after a residency of one-to-four years, adult Steelhead return to their natal stream, in the past at numbers unimaginable today. At the beginning of the twentieth century in Puget Sound, estimates indicate that more than 900,000 spawning adults passed through, and along the Strait, where many Steelhead continued towards the Sound and more northerly waters as well, others turned right to thrash their way up rivers and narrow streams alike. It was a great time to enjoy the seemingly limitless bounty. In the early years of commercial fishing there was money to be made. And for the angler, sport to be had.

Today, estimates of wild (also referred to as "natural origin") Steelhead in Puget Sound are such a shadow of the past that it is difficult to fully grasp the change in just one hundred years. Fisheries count approximately 14,000 adult Steelhead in Puget Sound, while within the Strait the rivers supported severely reduced numbers. On the Dungeness, the building of a hatchery in 1902 greatly augmented the run, but these were captive fish, quite different in their life history and genetic robustness from the ancient populations that thrived in Pacific Northwest rivers. (Hatchery goals and concerns with augmenting Steelhead populations through artificial production will be discussed below.)

Prior to the mid-20th century, separating wild from hatchery fish was difficult, a gap particularly important in fisheries which caught both. Adipose fin clipping, a method to distinguish the two, was still years in the future. While this implementation would improve estimates of wild Steelhead and impact fishing regulations, the species continued in free fall, and *in 2016, all retention of wild Steelhead was prohibited.*

Throughout the heady years of unrestrained fishing, other impacts on Steelhead contributed to their decline. Habitat loss from riverside and upstream construction, runoff alterations, logging, stream course straightening, degradation of water quality, and many other human impacts were factors in the Steelhead loss. The wild fish were robust, but they were also quite specific in their requirements. Particularly for spawning.

It is interesting that although not considered the tastiest salmon, by the end of the nineteenth century Steelhead would nevertheless occupy an important role in cannery production. In part, the species would fill the vacancy left by the declining Chinook salmon. Canneries popped up like mushrooms, particularly along the Columbia River. Here, the river served as conduit for the millions of cans that were exported around the world. Frozen fish were also popular exports.

It was exploitation on a massive scale, and it couldn't last. This was before the time of significant record keeping, but if the fish were gone, so, too, was the industry. The last cannery along the Columbia River did not close until 1980, but as early as the 1920s the steady decline had begun. From its status as a regular family food item, salmon, including Steelhead, became more of a restaurant specialty, and in time recreational fishing began to equal the commercial take. Unfortunately, accurate and consistent records were not kept during this heyday of salmon fishing.

Meanwhile, along the coast and in the Strait, as with many other salmon populations, local Steelhead went into a free fall of their own, relentless with the specter of extinction hanging over many runs. Olympic coastal populations are estimated to have declined since 1950 by 55%, based on historical records. In the Elwha, of course, the species was essentially gone, possibly with the exception of the land-locked Rainbows in the manufactured lakes, and in the Dungeness the record was poor as well, reflecting both overfishing and loss of habitat throughout the Salish Sea, including the Strait.

Hatcheries – the "Answer" That Will Not Die

Today, fish hatcheries are under scrutiny for the role they are intended to play in the restoration of salmon. The stated primary goal is to ensure the survival of wild salmon populations, but throughout history their role has shifted to support the fishing industry and away from the less lucrative and fuzzier goal of maintaining historic wild fish runs. Eventually, the system of hatcheries in Washington would become the largest in the world, with approximately 200 million juvenile fish raised in more than 100 state, federal, and tribal facilities. It seems like an obvious answer. Yet the number of wild salmon continues to fall.

In the Strait, the Lower Elwha Klallam tribe built a hatchery on the Elwha River in 1975, hoping to restore salmon runs, primarily for fishing. To the east, the state of Washington constructed a hatchery as well; this one on the Dungeness River was built in 1902 on Canyon Creek and relocated in 1945 to the current site. Today, the Dungeness hatchery raises spring and winter Chinook and Coho, while near the mouth of the river, the Hurd Creek Hatchery raises Steelhead.

Yet with the hope of supporting the wild runs by taking pressure off them (even the most ardent advocate of hatchery-raised fish probably does not equate these fish with wild ones), in the early years, hatcheries must have seemed like the answer. And the exploitation of salmon, including the Steelhead, is evident from how quickly hatchery construction proceeded. The first was authorized in 1891 and built in 1895. From 1900-1945 alone, Steelhead production in the Dungeness hatchery numbered nearly two million. Such a high rate supported the best fishery in the state.

Fish-and-wildlife policy specifies the requirements for state-run hatcheries. However, a new guideline, C-3624, adopted in 2020, is believed by many to have weakened hatchery policy. Although this document states that the primary purpose of hatcheries is to ensure the continuance of wild salmon, including the Steelhead, "sustainable economic" benefits are also to be considered. WDFW must, as always, wear at least two hats.

That said, hatchery management and goals have changed over the many years of salmon exploitation throughout the region. And directives include consideration of habitat loss (and the possibilities for reversing and correcting the trend), tribal rights, and the preservation of listed mammals, such as the Southern Resident Orca (SRO) whale population are all important to salmon management in the 21st century.

With general guidelines specified in documents such as C-3624, it is acknowledged by regulatory agencies that hatcheries should also be managed on an individual basis: each embodies a different history with individual concerns and needs. Some are perhaps "state of the art," but it also must be acknowledged that programs and standards vary both in their modernity and effectiveness. Indeed, they are not all the same.

Listing the Steelhead – the Entire Strait

Along the Strait, the wild Steelhead that spawned in the cold rivers and streams have declined to fractions of their former abundance. The Salt Creek winter run has been reduced by at least 43%; the Hoko nearly as much. Dams on the Elwha River doomed the run there, and in the eastern Strait, the Steelhead that inhabited the small streams emptying into Sequim and Discovery Bays now hang on as remnant populations. Yet compared to the coast, the pressure was less, perhaps because of fewer numbers, or the impact of dams eliminating one of the largest populations.

Meanwhile, Steelhead runs in the large coastal rivers were until recent times deemed "healthy," but that status would be lost within a few years. And so in 2022, the depressed numbers were serious enough to provoke two conservation groups into action.

On August 1, 2022, Wild Fish Conservancy Northwest and The Conservation Angler organizations petitioned the Secretary of Commerce for the listing of the Olympic Peninsula Steelhead Distinct Population Segment (DPS) under the auspices of the Endangered Species Act as a threatened or endangered population. Both petitioners are nonprofit groups based in Washington state. The two also requested that "critical habitat" be designated. The letter notes that the National Marine Fisheries Service has jurisdiction over the request.

A ruling on the petition has not yet been made, but it is interesting that such a move came after years of reports covering the ups-and-downs of the formerly great runs of the western rivers of the Olympic Peninsula. The summary notes that the summer run is nearly extinct, and the winter-run is rapidly declining. All had been closed in the four great rivers that drain the western Olympics. The document also reveals that commercial fishing has continued despite sharp declines, and that in many streams and rivers hatchery fish have replaced wild Steelhead.

If this petition is approved, the Olympic Peninsula DPS will join a list of Steelhead Distinct Population Segments throughout the west. In fact, of the 15 DPS in the western states, 11 are Threatened or Endangered. Since the listings began in the 1990s, none have been removed from the designation.

At the present time (2023) the Puget Sound Steelhead is listed: this population includes Steelhead in the Strait west to Salt Creek. The Olympic Peninsula DPS includes those local populations as far west as the coast near Neah Bay. Thus, one outcome of listing the Olympic Peninsula DPS would be that the entire Strait of Juan de Fuca Steelhead population would be included in recovery plans, with the goal of delisting.

Listing the Steelhead — The Distinct Population Segments (DPS) Concept

It is perhaps easiest to understand the status of wild Steelhead throughout its historic range by considering the current EPA listing of the several Distinct Population Segments (DPS) and the background of the concept. The DPS approach is primarily a means to separate a species into groups, based upon their specific habitat, range, and breeding cycle. The concept dates to the enactment of the Magnuson-Stevens Fishery Conservation and Management Act, reauthorized in 2007, and its history reflects the attempts by agencies to grapple with how to define a particular group within a species. A species-wide regulatory inclusion was from the start too broad a definition for legislating and managing impact: population designations cut across boundaries that were too large. And it is a reality of species dynamics that some subset of the whole may be healthy, while others are seriously threatened.

Enacted in 1973, the Environmental Species Act (ESA) embodied the concept of variation within a species and the need to maintain biodiversity. Thus, the DPS was seen as a valuable tool for recognizing differences, those that would contribute to the species' health but require more protection and focusing of resources. Yet the concept was too vague to provide clear direction and in 1996 a new policy was developed to guide the designation of populations within a species. One of the most important aspects of this approach is that this smaller group is significant to the survival of the species. Additionally, genetic diversity within a defined population is considered important to preservation. The concept was also to be employed if this distinct group was vital to the ecosystem of which it was part.

A DPS may be recognized without listing it, and the size may be of importance to delisting. Scientific evidence for the definition of a particular DPS must be offered and significance to the species demonstrated.

Efforts to clarify the concept since the 1996 policy acceptance have been ongoing, with some calling for a revamping of the language that directs the specification of and listing of a DPS. While the definition is altered in response to efforts to fully understand what specific guidelines should be, including criteria for delisting, petitions continue to be submitted. One of these is the Olympic Peninsula Steelhead DPS.

Two Distinct Population Segments are represented in the Strait of Juan de Fuca Steelhead. One is the Puget Sound DPS, listed as Threatened under the Endangered Species Act in 2007. This DPS includes the entire Puget Sound basin and the Olympic Peninsula to Salt Creek. The Olympic Peninsula DPS, recently petitioned for listing, includes the Strait from Salt Creek to Neah Bay and south to Willapa Bay.

Since These two Distinct Population Segments encompass large territories, and so for the purpose of state regulations, as well as specific local considerations of species' dynamics, the DPS units are further divided into "populations." Additionally, state regulations are applied to defined areas; as an example, Sequim and Discovery Bay are part of Area 6, whereas the western Strait is included in Areas 4 and 5. Within these areas (and the rest of Washington state as well) stocks are defined by the Salmon and Steelhead Stock Inventory (SaSSI). In the document, a "stock" is a specific population in a lake, river, or stream which does not interbreed with any other spawning group. Thus, they are reproductively isolated, either by season, location, or biology.

In the Strait of Juan de Fuca, 14 Steelhead stocks are defined; this is from a total of 60 for Puget Sound. Statewide, there are 443 defined salmonid stocks, including Steelhead. Stocks are evaluated for their health. There are five categories – Healthy, Depressed, Critical, Unknown, and Extinct— these definitions have not changed since the original specification in 1992.

However, the methods for evaluating stock status *have* changed. Factors such as habitat, landscape use, stream conditions (woody debris, and other factors), and life history — all are considered and given an importance not previously acknowledged. However, definitions have changed, as for example, the use of "available habitat" has altered. Thus, in the past a stock may have been rated "healthy" when in fact the numbers were low.

In the 21st century, more data is available for assessing the status of Steelhead stocks. Documentation such as the "Steelhead at Risk Report" considers data to 2013 in evaluating Steelhead status throughout the state. However, given recent closures in Steelhead fisheries, it is worrisome that improvement is slow or stalled: the quest to list Olympic Peninsula Steelhead as threatened or endangered would seem to confirm this reality.

To List a DPS

The Environmental Species Act is specific about the criteria for listing and the definition of recovery as well. While the goal is delisting, the implications for what appears as a simple directive imply actions that can be complicated, expensive, and very long term. Knowledge of a specific DPS must be enhanced, threats new and historic identified, issues such as climate change studied, the goal of harvesting considered — the list is lengthy and just getting longer with additional knowledge and study. Any recommendations are made within the context of the involvement of many organizations, the realities of what has historically transpired for listed populations, the necessity of cooperation and public education, and more. Even succeeding in listing a DPS is a process with possible pitfalls and the necessity of thorough research. It is anything but automatic approval.

However, the criteria are straightforward enough, even if listing can be difficult to achieve. In particular, the Steelhead Recovery Plan for the Puget Sound DPS addresses five criteria that when addressed will hopefully lead to delisting. Those factors are (1) Viability Criteria — the DPS will have a negligible risk of extinction over a 100-year period, and (2) Listing Factor Criteria — the National Marine Fisheries Service (NMFS) will evaluate whether declines have been addressed and mitigated. More specifically the five listing factors from the ESA must be considered – (A) destruction of species' habitat or range, (B) overutilization (fishing, scientific, educational) (C) Disease or predation (D) inadequacy of regulatory mechanism, and (E) other factors that affect species' existence.

In a sense, these factors are an acknowledgement of what caused the decline of the species in question (in this case, all groups of Puget Sound steelhead), and require that those be adequately addressed. Ultimately, of course, the proof is in the numbers. Is the wild Steelhead of Puget Sound increasing?

Recovery — The Dream and the Plan

As required by the ESA for listing a marine fish Distinct Population Segment, the National Marine Fisheries Service created a recovery plan for Puget Sound Steelhead. It should be noted that such a plan once adopted is not regulatory but rather a compendium of observations and recommendations "action" items). The plan was published in 2019, although the Puget Sound Steelhead DPS had been listed in 2007. Eight years after this listing it was noted that the decline had not stopped or reversed.

The plan is a lengthy document (291 pages) that includes both generalities and specifics for Puget Sound Steelhead recovery. The strategies and actions are aimed at three population levels; these include the DPS, the Major Population Group (MPG,) and, at the smallest scale, the Demographically Independent Populations (DIP). The last is a population that is found in a particular lake or stream and does interbreed with other DIPs; an example is the Elwha River.

The goal of the plan is simplicity itself — delisting — but the emphasis is specific. The strategy for recovery is to increase "production habitats." In other words, restoration of rivers and streams, both within the waterway itself and along the banks as well. It is this necessity that is the overriding focus of the recovery plan.

With these ideals in mind, several strategies are specified. The plan acknowledges the steep decline (which has not stopped) of wild Steelhead populations and specifies recovery actions that have measurable criteria. Factors which have contributed to the decreasing numbers are itemized, and include impacts such as urbanization, dams, land use, and more. Of these 10 are noted as the most significant — these include biological impacts, such as the interactions between hatchery and wild fish, as well as climate change, timber management, and dams. Each is addressed in the plan with suggestions that sometimes embody lofty goals while at the same time offering specific recommendations. Cooperation between various agencies involved with Steelhead is called for, a list that includes at least 19 entities. Coordination with plans for other listed species, such as Puget Sound Chinook is also mentioned for its importance to over-all restoration.

Increased monitoring is acknowledged as important while potential costs are included in the plan as well. And the necessity of specific recovery actions is emphasized. It also states the importance of commitment and dedication of the many groups as well as individuals responsible for Steelhead recovery.

Elusive Recovery – The Maximum Sustained Harvest (MSH) Concept

The closures occur with monotonous regularity. In the first four months of 2022, Steelhead sport fishing was closed in several Olympic coast rivers. It wasn't the coast alone, as Steelhead fishing also ceased in other state rivers and streams. In 2023, more fishing opportunities were available, but Steelhead numbers were considered chronically low and less than predictions. closures were for hatchery Steelhead, in recognition of the impact of fishing on wild steelhead populations. In Olympic National Park, the rules were similar.

While intended to protect wild Steelhead, closures result in excess hatchery fish — those that are not caught because of the early ending of a fishing season — an outcome also considered problematic as it leaves unharvested fish, a result disliked by anglers and managers alike. Controversy accompanies fishing regulations, particularly closures, but the conclusion seems clear—the system is not working. Wild Steelhead remains at the brink.

In addition to the concerns over habitat degradation, interbreeding of wild and hatchery fish, climate change, and other factors, one notable failure is that wild Steelhead returns to their natal streams have been consistently less than predicted numbers. This lack of accuracy not only influences decisions about fishing closures but is indicative of the difficulty in forecasting fish population dynamics. Most worrisome is that the numbers continue to fall. The petition to list the Olympic Peninsula DPS includes a table which reveals the freefall in rivers along the Strait. The Hoko, the Pysht, the Clallam, West Twin River — all are in decline.

When considering the ongoing decrease in wild Steelhead numbers, and the impact of fishing regulations on this worrisome trend, it is important to consider how predicted "escapement" — meaning the number of fish that complete their life cycle by spawning in their natal stream — is determined. Each year the escapement goal of winter run Steelhead (Summer run are not monitored) is calculated. Unfortunately, disagreement as to how to estimate escapement goals has been an ongoing reality. Today, for unlisted populations the Washington Department of Fish and Wildlife (WDFW) relies on the Maximum Sustained Harvest (MSH) concept. As the name implies, the MSH uses an approach that aims to provide maximum harvests from a population while maintaining fish numbers at a specified level. Lack of data and a simplistic concept, or at least one without sufficient data to support it, may be among the factors contributing to the lack of success in consistently calculating escapement.

In 1985, a paper that detailed the MSH method provided details for wild Steelhead management. The approach embodied quantifying spawner-recruit (S/R) relationships, although admittedly data was sparse. To determine input values, the S/R numbers were standardized by potential juvenile parr production (PPP) as an input to mathematical models. This parameter is the number of parr counted by various methods, such as snorkeling, in a specific river site and then multiplied by the size of the surveyed area. This variable is used in the model, along with the spawner value for the specific stream, to compute the MSH. Since long term data for PPP is not available for many river systems, assumptions were made about the use of data from more complete surveys to those Steelhead populations lacking quantification. Data was acquired from several sources, and divided into two categories, tributaries and mainstems, with the acknowledgement that large rivers were difficult to sample; few of the available

methods such as trapping or electrofishing were considered adequate. Snorkeling, with training for distinguishing species, was most often employed. Only rivers that were "fully seeded," meaning supporting Steelhead at maximum production, were considered. Measurements such as habitat composition, gradient, and other parameters were taken at study sites. Tributary sites included data from several creeks that drain into the Strait.

Parr density dependence on discharge rate was noted (habitats were stratified by gradient); "avoidance" was also quantified as well as preference for habitats such as riffles. Data insufficiencies such as differences between various gradient "zones" necessitating assuming parr densities were similar between tributaries and mainstems. Application of a mathematical model provided estimates of spawners needed for a specific system. The model ultimately derives a linear multiplier to the potential parr production to calculate the number of spawners needed for a system. This multiplier was itself a median of two approaches; the number was calculated as .264 (26.5 spawners/1000 PPP), a parameter that could then be used to determine the escapement goal. Thus, in the end, the model depends on the potential parr production calculation, dependent on surveys, and the accuracy of the mathematical model. It is also noteworthy that different models gave varying results.

Yet, even with all the assumptions and estimates, the incorporation of available data as an input to the mathematical model was considered to provide sufficient accuracy for its use as a management tool with further research needs specified.

Nevertheless, in 2007 the Puget Sound Steelhead was listed as threatened, and in 2016, wild Steelhead fishing would be prohibited throughout the Salish Sea.

With listing, jurisdiction over the Puget Sound Steelhead was transferred from state management to the National Oceanic and Atmospheric Administration (NOAA). Today, permits for incidental taking of wild Steelhead must be made on an individual fishery basis, and such impact on wild Steelhead are based upon exploitation rate limits rather than the MSH calculation. Not all listed areas have been permitted. For those Steelhead not currently listed, such as the western Strait and coastal waters, management continues with the MSH approach.

One of the problems with any management method, and in particular the MSH concept which tends to keep numbers low, is that with a small population, inaccuracies in prediction can have a dramatic impact. Annual fluctuations in productivity, temperature, damage to wild populations at sea, survey efforts, mortality rates, and the presence and competition from hatchery fish, among others, contribute to uncertainty. And with numbers that are already depressed, it is possible that *a majority of wild Steelhead will be caught at least once*, although by regulation such fish must be released.

On the Strait - The Dungeness and the Elwha

Difficult to survey, in part because river runoff during spawning is high, making redd (the location of egg-laying) observation inaccurate, the Dungeness River mixes the wild and domesticated, with two hatcheries present, one of which (Hurd Creek) releases steelhead to the river. Habitat destruction from a variety of impacts such as agriculture, dikes, and removal of woody material on the river is endemic. Hope lies in large scale improvements such as widening the flood plain with dike removal near the mouth, and unprecedented construction of side channels in the river itself.

Oncorhynchus mykiss — Steelhead

Lack of data concerning the impact of hatchery releases complicates management of the river for protection of wild Steelhead, although it is estimated that in the past as many as 4,900 wild Steelhead spawned in the river and its tributaries. Today, a "critical threshold" for winter Steelhead is considered to be 125 fish. Recent numbers are approximately 400, a number considerably less than a recovery figure estimated from 1,200 to 4,100. Meanwhile, concerns over the genetic introgression of hatchery fish into the Dungeness wild stock continue, without clear resolution.

Smaller streams such as Snow Creek reveal the ups-and-downs of wild Steelhead, a reality that may reflect an unknown past of spawner fluctuations. In fact, oscillating numbers are to be expected from year to year in any wild or for that matter, hatchery population. In 2023, a count of 57 spawning Steelhead in Snow Creek gave encouragement for the status of the fish: as low as this number is, nevertheless it is the highest in over 20 years and slightly more than the annual average.

Meanwhile, on the Elwha River, where the removal of two dams has enabled the passage of salmon upstream for the first time in one hundred years, the number of returning Steelhead has increased, from a low of perhaps 100 wild fish to an encouraging count of approximately 2,400 spawning adults. The origin of these mature Steelhead is most likely mixed, with Rainbow Trout, the same species, already resident throughout the length of the river, contributing to the genetic mix of the present Steelhead population. It has also been confirmed that genetic diversity, determined from DNA sampling, in the Elwha has remained high.

While quantifying Steelhead numbers may always remain a challenge, it can be hoped that the plasticity of the magnificent Steelhead and its freshwater form, the Rainbow Trout, will contribute to its restoration in the Strait and the ocean beyond. The Elwha River provides such encouragement. Perhaps one day the imperiled status of this salmon will be consigned to memory while lessons learned in management of a limited resource, as all fish are, will not be forgotten.

Small, aquarium-sized net in hand, I looked down at the little fish in the holding tank on their natal stream, ready for counting, although of course they had no knowledge of why their downstream journey had been halted, however briefly. These were Coho smolts, seven-inch youngsters, a year old, embarking on a swim to the sea where they would hopefully grow fat and stout, only to return in a few years to their freshwater home. They milled about, confidently it seemed, given their temporary captive status. They seemed to know where they were going — their own personal destiny.

But they were not a uniform group. Among them a few darker, more spotted smolts, revealed their presence with a dash here-and-there, avoiding the little net, seeming content to remain where they were, or perhaps a little anxious. Different yet the same, these were Steelhead smolts, their presence noted with elevated human voices. They, and their cousins swimming seaward in other rivers, represented hope for a species historically in sharp decline, but now perhaps creeping away from extinction. Upstream, human endeavors had altered the course of the creek, in an attempt to improve the habitat for these youngsters, who in a few years would come home. It wasn't so much as just turning back the clock, but rather looking to the future.