# Creating a Sanctuary for Wild Steelhead Trout Through Hatchery Operations*

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**ABSTRACT**— The Deschutes River basin in north-central Oregon supports a wild population of threatened summer steelhead (*Oncorhynchus mykiss*). The basin has seen large increases in the number of out-of-basin stray hatchery steelhead in recent years. Since 1987, hatchery strays have accounted for over 50% of the total steelhead returns to the Warm Springs River, a major tributary of the Deschutes River. While the large numbers of stray hatchery steelhead have contributed to making the Deschutes River one of Oregon's premier summer steelhead fishing streams, the impact of hatchery strays on the wild steelhead population is a concern for fishery managers. Warm Springs National Fish Hatchery, located on the Warm Springs River, is cooperatively managed with the Confederated Tribes of the Warm Springs Reservation of Oregon to produce spring Chinook salmon (*O. tshawytscha*) for harvest while protecting the indigenous fish populations in the river. To preserve the genetic integrity of wild steelhead populations, the hatchery is operated to allow only wild, unmarked steelhead upriver into the major steelhead spawning areas. The management and operation of the hatchery since its inception has created the only wild steelhead sanctuary in the Deschutes River basin.

## INTRODUCTION

Fishery managers often use hatcheries as a tool for enhancement, mitigation, or supplementation of depleted fisheries resources. Hatchery programs, however, are often criticized for their effect on wild fish populations. In many instances this negative criticism is warranted and hatchery programs can result in undesired ecological consequences to wild fish populations (Marnell 1986; White et al. 1995; Northwest Power Planning Council 1999). For salmon and steelhead hatchery programs in the Pacific Northwest, recent independent reviews have suggested management changes and reform measures to reduce the negative impacts of hatchery programs on wild fish populations (Hatchery Scientific Review Group 2000; Williams et al. 2003). In particular, the effect of naturally spawning hatchery fish on wild populations is receiving increased attention. In this paper, we look at the effect of stray, out-of-basin hatchery fish in the Deschutes River and how the unique management and operation of a hatchery facility has created a sanctuary for wild summer steelhead trout (anadromous form of *Oncorhynchus mykiss*).

## SITE DESCRIPTION

The Deschutes River originates on the east slope of the Cascade mountain range, flows north through central Oregon, and enters the Columbia River at river kilometer (rkm) 330. Summer steelhead historically were found in the main-stem of the Deschutes River up to rkm 214. The development of the Pelton/Round Butte hydroelectric project, a series of three dams completed between 1958 and 1964, limited the natural production of anadromous salmonids to the main-stem Deschutes River and tributaries below Pelton Dam at rkm 166 (Oregon Department of Fish and Wildlife (ODFW) 1997). Steelhead in the Deschutes River basin are part of the mid-

*Published as part of the proceedings of the Wild Trout VIII Symposium, September 2004, Yellowstone National Park

Columbia River Evolutionary Significant Unit that was listed as a threatened species by NOAA-Fisheries in 1999.

The Warm Springs River is the major westside tributary of the lower Deschutes River. The river flows entirely within the Warm Springs Indian Reservation and enters the Deschutes River at rkm 135. Warm Springs National Fish Hatchery (NFH) is located at rkm 16 of the Warm Springs River (Figure 1). A barrier dam, located adjacent to the hatchery blocks all upstream migrating fish and diverts them into a fish ladder. Depending on hatchery operational needs, fish can pass upstream through the fish ladder or be diverted to hatchery holding ponds. Approximately 111 rkm of stream habitat is accessible to anadromous salmonids above the hatchery barrier dam (Cates 1992).

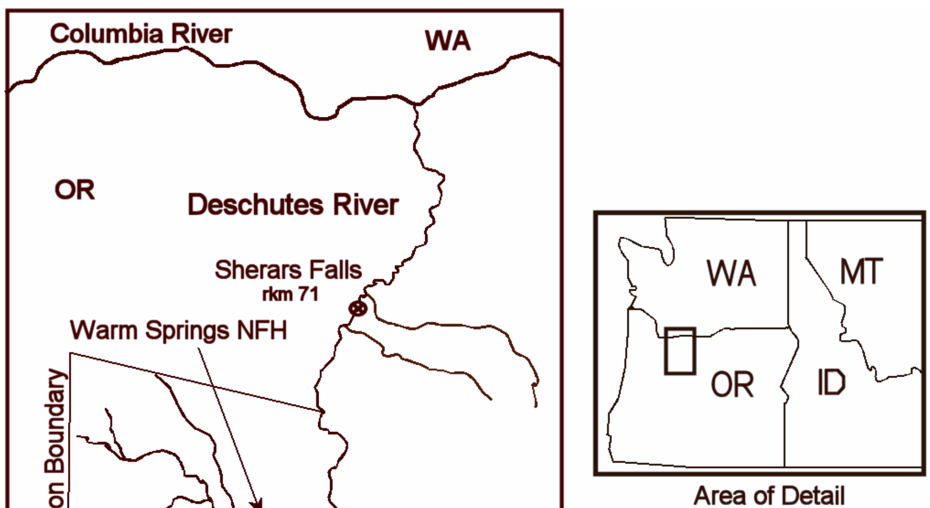


**Figure 1. Map of the lower Deschutes River basin**

## HISTORY AND OPERATION OF THE HATCHERY

Warm Springs NFH was authorized by Congress in 1966 in response to a request from the Confederated Tribes of the Warm Springs Reservation of Oregon (Tribes) to establish a hatchery on Reservation land. The original purpose of the hatchery was to increase harvest opportunities of spring Chinook salmon (*O. tshawytscha*), summer steelhead, and trout (resident form of *O. mykiss*) in the Deschutes River and Reservation waters (Cates 1992). The hatchery, managed by the U. S. Fish and Wildlife Service in cooperation with the Tribes, became fully operational in 1978. The steelhead program was terminated in 1981 due to disease problems in the hatchery and the physical limitations of rearing 2-year-old smolts. Shifting priorities for the co-managers has resulted in the curtailment of resident trout production. Currently, the focus of the hatchery is on providing spring Chinook salmon for harvest in Tribal and sport fisheries in the Deschutes River. Olson et al. (1995) provide a detailed review of the spring Chinook salmon program.

Since the inception of the hatchery, federal, tribal, and state governments have worked together to develop a hatchery operational plan that minimizes the effects of hatchery operations on wild fish populations. In developing and updating the operational plan, the co-managers recognized the importance of wild steelhead populations in the Warm Springs River. When the hatchery steelhead program ended in 1981, a decision was made to try to limit the effect of hatchery steelhead on the wild fish populations in the Warm Springs River. Since any hatchery steelhead entering the Warm Springs River are straying from their hatchery release location, the operational plan was updated in 1984 to specifically exclude these strays from the spawning grounds upstream of the hatchery. During the steelhead spawning migration in the Warm Springs River, generally between February and May, all fish passing upstream through the fish ladder are diverted into holding ponds at the hatchery. Hatchery personnel hand sort the fish and pass wild, unmarked steelhead upstream of the fish ladder while hatchery steelhead, identified by marks applied at a hatchery prior to juvenile release, are removed from the stream and distributed to the to the Tribes for food. Prior to distribution to the Tribes, hatchery steelhead are checked for the presence of a coded-wire tag in the snout to determine their hatchery of origin. Coded-wire tags are small (<1.5 mm) identification tags that are implanted into juvenile hatchery steelhead prior to release and used to evaluate hatchery programs.

## Steelhead in the Deschutes River Basin

Juvenile summer steelhead in the Deschutes River basin spend between one and four years rearing in freshwater before smolting and migrating downstream to the ocean (Northwest Power and Conservation Council 2004). After spending one to two years in the ocean, steelhead migrate back to freshwater and enter the Deschutes River as early as June and continue to enter the system throughout the summer and fall. Returning adults over-winter in the main-stem Deschutes River before moving onto the spawning grounds in the following spring. Based on limited spawning ground surveys in the main-stem and tributaries, main-stem spawning is believed to account for between 30% and 60% of the natural production in the basin (ODFW 1997). Spawning in eastside tributaries and lower sections of the main-stem generally occurs between January and April. Spawning in westside tributaries, such as the Warm Springs River, can begin as early as February, with peak spawning usually occurring in mid-April and continuing into May (Olson et al. 1995). Round Butte Hatchery, located at the hydroelectric project, is the only hatchery in the Deschutes River basin that currently produces summer steelhead. The hatchery, operated by the state of Oregon as part of a mitigation program for the hydroelectric project, annually releases around 160,000 summer steelhead smolts into the Deschutes River.

Reliable estimates of the number of adult steelhead entering the mouth of the Deschutes River are unavailable. A fish trap operated by ODFW, located at Sherars Falls on the Deschutes River (rkm 71), is used to sample steelhead as they pass upstream. Since the fish trap captures only a portion of the steelhead passing upstream, a Peterson mark-recapture method, with fish recaptured at Pelton Dam and Warms Springs NFH, is used to estimate the total steelhead population. Fish are classified as either wild, Round Butte Hatchery, or stray (out-of-basin) hatchery steelhead based on fin marks. Sherars Falls steelhead numbers in this paper are derived from unpublished ODFW-Mid Columbia Fish District mark-recapture estimates.

The average number of wild and Round Butte Hatchery steelhead passing the falls between 1979 and 2002 was 5,030 (SD=2,769) and 4,959 (SD=2,571) adults, respectively. Large numbers of stray hatchery steelhead began passing the falls in the early 1980's, with an even more pronounced increase in numbers beginning in 1995 (Figure 2). Between 1995 and 2002, stray steelhead accounted for an average of 62% (SD=10%) of the total number of adult steelhead passing upstream of Sherars Falls. A large number of wild and hatchery steelhead migrating to other streams in the Columbia River basin enter the lower sections of the Deschutes River for a period of time before exiting back out to the main-stem Columbia River and continuing their migration to their natal streams for spawning (ODFW 1997). Based on recoveries of tags applied to stray hatchery fish and a radio-telemetry study, an estimated 50% of the stray hatchery steelhead passing upstream of Sherars Falls eventually exit the Deschutes River (Rod French, ODFW, personal communication). Since the origin of wild fish cannot be determined without genetic analyses, the number of stray wild fish that migrate up and down the river is unknown.

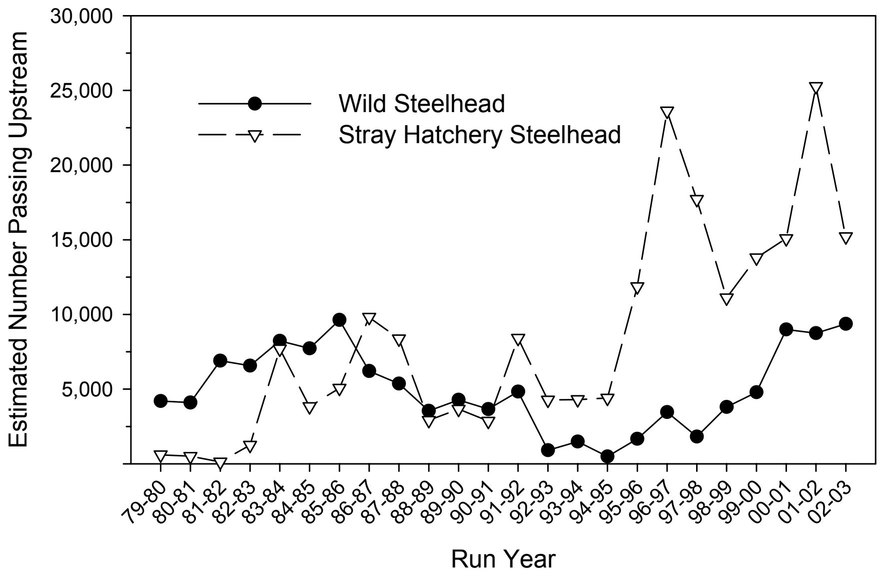


**Figure 2. Peterson mark-recapture estimates of the number of steelhead passing upstream of Sherars Falls (ODFW unpublished data). Round Butte Hatchery fish are not included in this figure.**

While 50% of the stray hatchery steelhead may eventually leave the basin prior to the spawning period, the large overall number of strays in recent years means that in many years the number remaining can equal or exceed the number of wild steelhead in the basin. The reasons for the large number of stray steelhead migrating up and remaining in the Deschutes River are unknown. Fish transportation operations, in which a proportion of juvenile smolts are artificially transported around main-stem Columbia and Snake river dams, may influence the straying rate of returning adults (Olson et al. 1995; Quinn 1997).

Some of the stray hatchery steelhead that remain in the Deschutes River move onto the wild steelhead spawning grounds. Based on spawning surveys conducted by ODFW on Buckhollow and Bakeoven creeks, major eastside tributaries that enter the Deschutes River at rkm 68 and 84 respectively, hatchery steelhead accounted for a yearly average of 42% (SD=25%) of the total number of steelhead on the spawning grounds between 1991 and 2003 (ODFW unpublished data). Shitike Creek, a westside tributary entering the Deschutes River at rkm 155 just downriver of Pelton Dam, also has stray hatchery fish moving onto the spawning grounds. Between 2001 and 2003, out-of-basin stray hatchery steelhead have accounted for an average of 28% (SD=7%) of the adult steelhead trapped at a weir located near the mouth of the creek (Confederated Tribes of the Warm Springs Reservation of Oregon, unpublished data).

## Warm Springs River

The only tributary in the Deschutes River basin where stray hatchery steelhead are actively excluded from the wild steelhead population is the Warm Springs River. If strays were not excluded, the steelhead population in the Warm Springs River would have been heavily influenced by hatchery steelhead in recent years. The number of stray hatchery steelhead trapped and removed at the barrier dam at Warm Springs NFH increased substantially in 1987 (Figure 3). Between 1980 and 1986, stray hatchery steelhead accounted for a yearly average of 13% (SD=5%) of the total steelhead in the Warm Springs River. Between 1987 and 2003, an average of 51% (SD=10%) of the yearly steelhead run was composed of stray hatchery steelhead. The timing of upstream migration differed between wild and stray hatchery steelhead. The median day of migration to the barrier dam for stray hatchery steelhead was 14 days (SD=7 days) earlier than for wild steelhead.

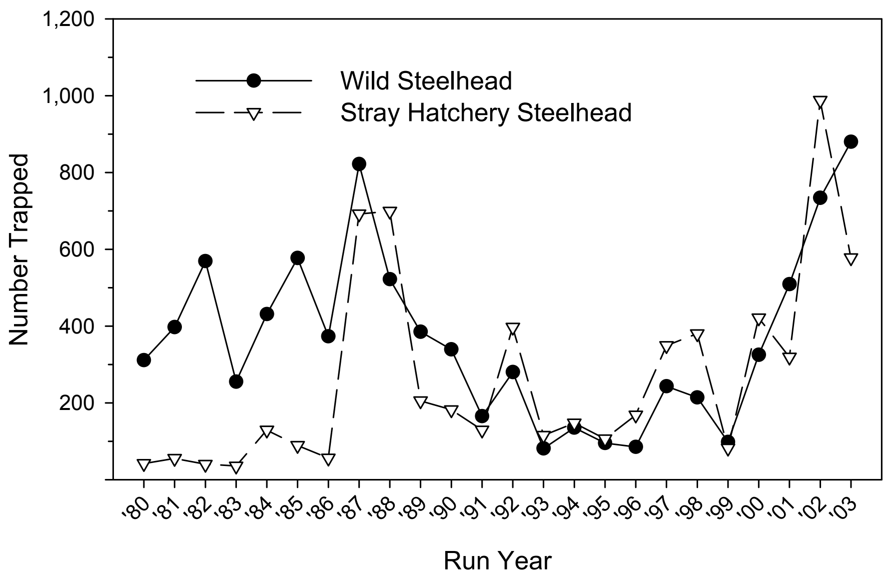


**Figure 3. Number of steelhead trapped at the barrier dam at Warm Springs NFH (rkm 16).**

Currently, the only way to determine the origin of stray hatchery steelhead in the Warm Springs River is to rely on the recovery of coded-wire tags. Analysis of stray steelhead is complicated by the fact that most hatcheries in the Columbia River basin do not coded-wire tag all of their juvenile steelhead releases. For example, in 2003 over 10 million juvenile steelhead were released from hatcheries in the Columbia River basin above Bonneville Dam (rkm 235). Of this total, only around 10% were coded-wire tagged (RMIS Database). To determine the straying rate of fish released from hatcheries that coded-wire tag at least a proportion of their juvenile steelhead releases, an expanded recovery number is estimated. The expanded recovery number is calculated based on the ratio of the number of coded-wire tagged fish released from each hatchery to the total number of fish released from that hatchery.

Between 1987 and 2002, expanded coded-wire tag estimates could account for 37% of the stray hatchery steelhead in the Warm Springs River. Of the strays that could be accounted for, most came from hatcheries or release locations in the Grande Ronde, Imnaha, Wallowa and other rivers in the Snake River basin (Figure 4). These rivers are over 450 rkm upriver from the confluence of the Deschutes and Columbia rivers. Since the origin of over 60% of the strays cannot be accounted for based on expanded coded-wire tag recoveries, a complete analysis of the straying phenomenon in the Warm Springs and Deschutes rivers cannot be completed. Strays from hatcheries that do not coded-wire tag any of their releases may be a source of a large number of strays trapped at Warm Springs NFH. In addition, although most hatchery steelhead are externally marked with an adipose fin-clip, making them easily recognizable to hatchery staff who are sorting fish, some fish are released without an adipose fin-clip as part of restoration efforts in the Upper Columbia and Snake rivers. For example, over 2 million non-adipose clipped juvenile steelhead were released from hatcheries in the Snake River basin in 2003 (U.S. Fish and Wildlife Service, unpublished data). If fish have no easily recognizable external marks and they do stray into the Warm Springs River they could be misidentified by hatchery staff as wild fish and be passed upstream into the spawning grounds.

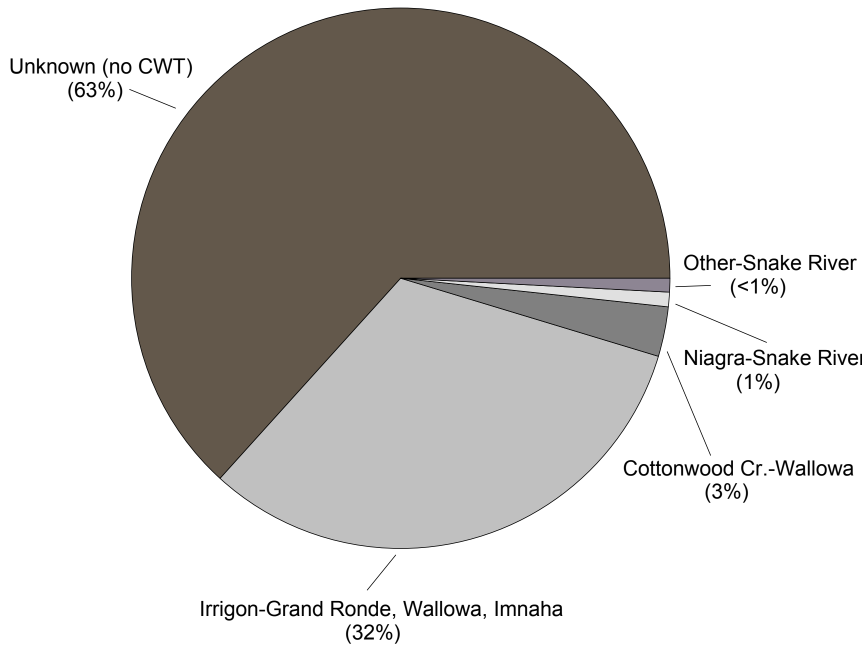


**Figure 4. Origin of stray hatchery steelhead (n=4,910) at Warm Springs NFH 1987-2002 based on expanded coded-wire tag recoveries. Hatchery and release river are listed.**

## IMPACT OF STRAY STEELHEAD

The Deschutes River is a popular summer steelhead fishing stream for sport and tribal fisheries (ODFW 1997). A large portion of the sport fishery for steelhead occurs from the mouth of the river up to Sherars Falls and a tribal dipnet fishery is primarily focused on the area just below the falls. In 1979, in an effort to protect wild steelhead populations, sport harvest of summer steelhead was limited to hatchery fish. Sport anglers are allowed to keep adipose clipped hatchery steelhead, regardless of the hatchery of origin. The tribal dipnet fishery is regulated by the Tribes and harvest of a limited number of wild summer steelhead is allowed during years when wild steelhead populations are abundant. While Round Butte Hatchery produces steelhead specifically for harvest in the Deschutes River, stray out-of-basin hatchery steelhead make up a large component of the sport harvest. Based on a statistical creel survey, between 1987 and 1995 a yearly average of 1,907 (SD=590) hatchery steelhead were harvested in the sport fishery below Sherars Falls. During this time, stray hatchery steelhead accounted for an average of 83% (SD=7%) of the total sport harvest (ODFW 1997).

While stray hatchery steelhead are an important and valuable component of the Deschutes River sport fishery, the potential impact of the strays on the wild steelhead population is a major concern for fishery managers (Northwest Power and Conservation Council 2004). Fish straying from one basin to another have the potential to introduce diseases that are not endemic to the receiving basin. *Myxobolus cerebralis*, the causative agent of whirling disease in salmonids, has been shown to infect juvenile hatchery steelhead held at acclimation sites in the Wallowa and Imnaha rivers in the Snake River basin (Sollid et al. 2004). While whirling disease does not appear to be established in the Deschutes River basin, the presence of *M. cerebralis* has been detected in adult stray hatchery steelhead sampled at Warm Springs NFH since 1987. In 2003, 81 stray hatchery steelhead collected at Warm Springs NFH were tested and 15 were found to be infected with *M. cerebralis* (U.S. Fish and Wildlife Service, Lower Columbia River Fish Health Lab, unpublished data). All of the infected adults in 2003 were released as juveniles from acclimation sites in the Wallowa River. While the adults do not exhibit clinical signs of the disease, if they die in the stream they could potentially release myxospores into the water column. The removal of stray hatchery steelhead from the Warm Springs River reduces the likelihood of whirling disease or other non-endemic diseases being introduced into the drainage. Given the large number of strays that are in the Deschutes River, the potential for introduction of non-endemic diseases to areas downstream of Pelton Dam on the Deschutes River and downstream of Warm Spring National Fish Hatchery on the Warm Springs River is a concern and needs to be evaluated.

The impact of stray hatchery steelhead on the genetic integrity and productivity of wild steelhead populations in the Deschutes River is not known. Chilcote (2003) used data from the Deschutes River steelhead population as part of his analysis of mixed spawning populations of wild and hatchery steelhead. In that analysis he found a reduced level of productivity in populations that had a higher proportion of hatchery fish on the spawning grounds. Other studies have also described reduced productivity in mixed hatchery and wild steelhead populations (Chilcote et al. 1986; McLean et al. 2003). The actual mechanisms for the reduced productivity are not known, but the incorporation of genetic material from out-of-basin fish into the Deschutes River stock may reduce the ability of the wild stock to respond to environmental extremes (Northwest Power and Conservation Council 2004). Wild steelhead are locally adapted to the environmental conditions in the Deschutes River. Steelhead reared in hatcheries in the Snake River basin do not have these local adaptations and therefore may have reduced reproductive success when spawning in the Deschutes River. If hybridization between wild and stray hatchery steelhead occurs, introduction of non-locally adapted traits may reduce the overall reproductive success of the wild population. For example, the difference in timing of migration to the barrier dam on the Warm Springs River may indicate a difference in spawn timing between wild and stray hatchery steelhead. In areas of the Deschutes River basin where wild and stray hatchery steelhead are intermingled, some level of hybridization has likely occurred. McLean et al. (2003) suggested that altered timing of reproduction resulting from hybridization of wild and hatchery stocks could lead to a reduction in productivity.

## Conclusion

The removal of stray hatchery steelhead from the Warm Springs River is an example of how the operation and management of a hatchery facility can play a role in the conservation of wild fish populations. The hatchery program has limited the potential mixing of wild and stray hatchery steelhead stocks and likely preserved the biological and genetic integrity of the wild steelhead population in the Warm Springs River. As such, the Warm Springs River may serve as a useful "control" stream for further investigations into the effects of stray hatchery steelhead on wild steelhead populations in the Deschutes River. We are currently developing plans to use mixed-stock genetic analyses to determine the origin of non-coded-wire tagged fish in the Warm Springs River, but the costs involved make it unlikely that this technique can be used on a basin-wide scale. A comprehensive marking and coded-wire tagging program for all hatcheries in the Columbia River basin will allow fishery managers to more effectively monitor and evaluate the straying problem in the Deschutes River.

## Acknowledgements

Policy and biological support staff from the Confederated Tribes of the Warm Springs Reservation of Oregon have been leaders for the conservation of wild fish in the Warm Springs River. We thank on-the-ground work by U. S. Fish and Wildlife Service staff from Warm Springs National Fish Hatchery, the Lower Columbia River Fish Health Lab, and the Columbia River Fisheries Program Office, as well as policy support from our Regional Office. Rod French of the Oregon Department of Fish and Wildlife provided helpful information on steelhead populations in the Deschutes River. Jen Stone of the U. S. Fish and Wildlife Service conducted an insightful review of this paper and Stephen Pastor provided information on hatchery returns to Warm Springs NFH .

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