Redband Trout: Resilience and Challenge in a Changing Landscape
Oregon Chapter, American Fisheries Society, 2007

Adaptive Management for Klamath Lake Redband Trout

RHINE T. MESSMER*[1] AND ROGER C. SMITH

Oregon Department of Fish and Wildlife, 1850 Miller Island Road West, Klamath Falls, Oregon 97603

Abstract.—The upper Klamath River basin trout fishery consistently produces redband trout *Oncorhynchus mykiss* that exceed 4.5 kg. It is among the finest trout fisheries in the United States. The redband trout of the upper Klamath River basin have evolved in harsh environmental conditions and may be uniquely adapted to the habitats found in Upper Klamath and Agency lakes. These redband trout also have developed behavioral and life history characteristics that enable them to inhabit the highly eutrophic waters of the Klamath Basin. The management of Klamath Lake redband trout has evolved from the early 1920s, when large numbers of hatchery trout were stocked to supplement consumptive recreational fisheries, to the 1990s, when natural production, habitat protection and enhancement, and conservative angling regulations were used to provide for trophy redband trout fisheries. This evolution in management resulted from evaluating hatchery trout stocking programs and collecting information on stock-specific disease resistance, life history, and genetics. In addition, changes were made in Oregon Department of Fish and Wildlife trout management policies that emphasized the importance of native fish. Fish managers should continue to collect new information critical for sound, biologically based management of redband trout, and to incorporate this information into management plans.

The native rainbow trout *Oncorhynchus mykiss* that inhabits Klamath Lake is considered a redband trout, and is sometimes listed as a subspecies *O. m. newberrii* (Behnke 1992). In addition to the lacustrine redband trout that migrates from Klamath Lake to the Williamson and other rivers, populations of redband trout are also found in small tributaries. Although little is known about their life history, Behnke (1992) suggested that the tributary populations might represent a resident stream form of redband trout.

Although Klamath Lake is usually mentioned as a single body of water, it consists of two lakes (Upper Klamath and Agency) connected by a 2.4-km waterway (Figure 1). The waters of Upper Klamath and Agency lakes are naturally eutrophic and produce an abundant supply of zooplankton, insects, and fish (Bond et al. 1968; Eilers et al. 2004). Klamath Lake redband trout grow to a large size because of ample food in the lakes. Their adfluvial life history allows them to take advantage of this abundant food by migrating from spawning streams to rear in the lakes. Because redband trout grow to become trophy-sized fish in just a few years, they are the most prized sport fish in the upper Klamath River basin. The largest redband trout recorded in the Klamath Lake fishery was caught in 1956, and measured 86.4 cm (34 in) and 11.3 kg (25 lb). One redband trout, found dead in a spawning tributary to the lakes, measured 94.0 cm (37 in) and would have been close to 13.6 kg (30 lb) prior to spawning. Thousands of anglers fish the waters of the upper Klamath River basin every year in search of trophy redband trout. Angling is open all year on the lakes, but the highest catch rates of redband trout occur in the spring to early summer and in the fall. The fishery on the Upper Klamath and Agency lakes is considered a mixed-stock fishery because the lakes are common rearing areas for multiple stocks of adfluvial redband trout. Fly anglers also pursue the trophy fish in tributary streams such as the Williamson, Sprague, and Wood rivers (Figure 1). These streams offer some of the best fly fishing in the United States and have been featured on national television and in magazine articles.

The upper Klamath River basin has a long history of fish management dating back to the early 1900s, when fishery managers first stocked hatchery trout into the waters of the basin. Many fish managers have since applied their craft in the basin with varying degrees of success. This paper will review the past management of the adfluvial stocks of redband trout in the upper Klamath River basin and will describe how changes came about in their management. Adfluvial populations of redband trout in the basin include populations in the Williamson River (lower and Kirk Springs reaches), Spring Creek, Wood River, and lower Sprague River (Figure 1) (Kostow 1995). Additional stock diversity may exist in redband trout populations in other tributaries of Klamath Lake, but the genetics and life histories of these populations have yet to be studied. Information on the biology and life history of redband trout stocks in the upper Klamath River basin also will be discussed as it relates to the management of this species. Much of the information presented in this paper is found in annual, monthly, and special reports of the Klamath Fish District, Oregon Department of Fish and Wildlife (ODFW) and in Klamath Basin Fish Management plans.

The Upper Klamath River Basin

Many unique fishes are found in the Klamath River basin because of its history of long periods of geological isolation. During the Pleistocene Epoch, the upper Klamath River basin was once dominated by a large pluvial lake called Lake Modoc. Lake Modoc covered an estimated 283,900 ha and stretched from what is now Tule Lake, California, to Fort Klamath, Oregon (Dicken 1980). Upper Klamath and

* Corresponding author: rhine.t.messmer@state.or.us

[1] Present address: Oregon Department of Fish and Wildlife, 3406 Cherry Avenue NE, Salem, Oregon 97303

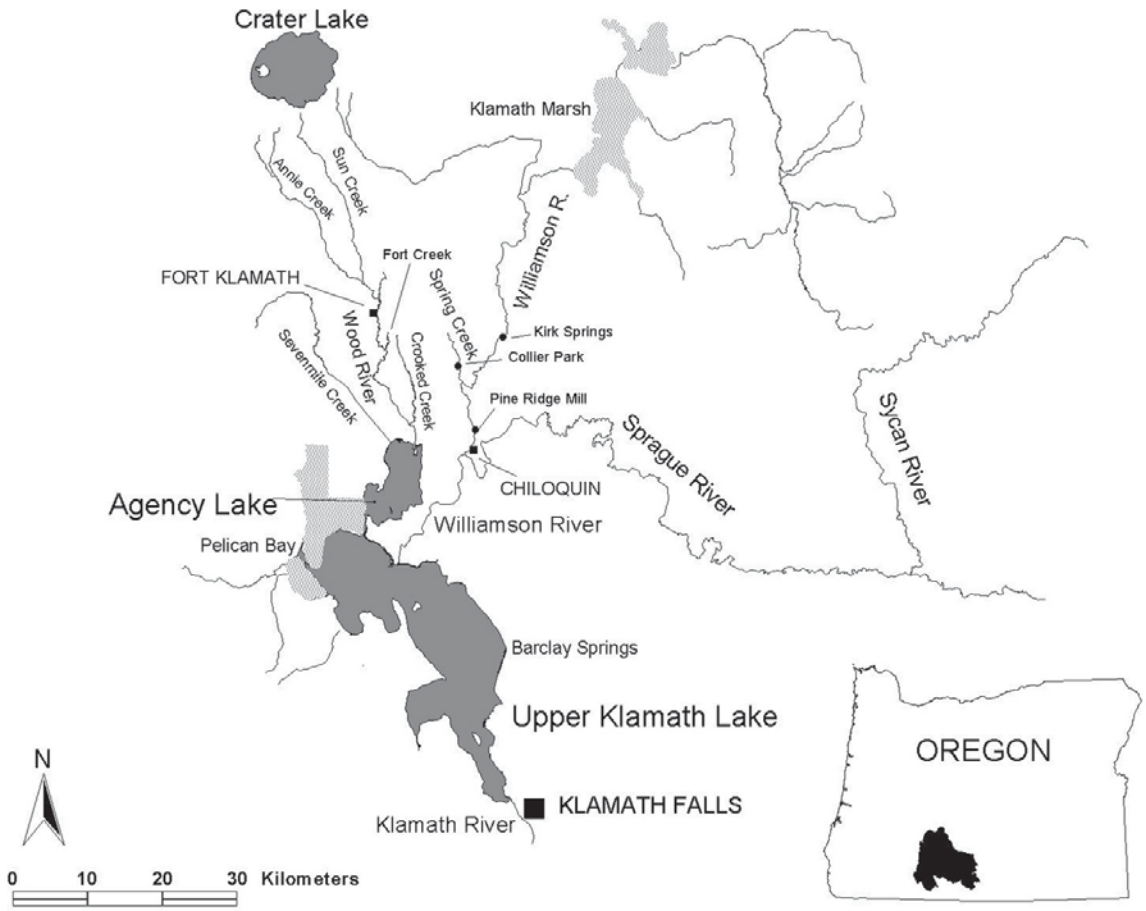

FIGURE 1.—Map of the Wood and Williamson River drainages in the upper Klamath River basin, Oregon. Light shaded areas represent hardstem bulrush–cattail marsh habitat.

Agency lakes are the largest remnants of this ancient lake and currently cover 32,900 and 3,500 ha, respectively, at maximum lake elevation of 1,263 m (USACE 1978). The level of the lake is regulated by Link River Dam, constructed in 1921 on a natural lava dam near the town of Klamath Falls. Both lakes, although large in surface area, are relatively shallow, with an average depth of about 2.5 m.

The watershed basin for the lakes encompasses an area of about 9,800 km^2. The major tributaries of Agency Lake are Sevenmile Creek, Wood River and its tributaries Fort and Crooked creeks (Figure 1), and numerous small springs along the west side of the lake. The Williamson River and its main tributary, the Sprague River, supply most of the inflow to Upper Klamath Lake. Smaller tributaries and springs also enter Upper Klamath Lake.

Although upper Klamath and Agency lakes are naturally eutrophic because of their shallow depths, deep sediments, and phosphorus-rich volcanic soils in the watershed, nutrient and sediment loading to the lakes have increased over the last century and have led to its current state as a hypereutrophic system (Eilers et al. 2004). Levels of phosphorus delivery to the lakes have increased from activities in the watershed such as logging, grazing, and irrigated agriculture (Miller and Tash 1967; Eilers et al. 2004). An additional source of phosphorus is from decomposition of soils in drained wetlands (Snyder and Morace 1997; Bradbury et al. 2004). Wind action can resuspend the fine lake sediments, further increasing the loading of phosphorus in the lakes (Bond et al. 1968; Laenen and LeTourneau 1996). Extensive blooms of *Aphanizomenon flos-aquae*, a blue-green alga, correspond to large seasonal increases in total phosphorus and adversely impact water quality and fisheries in the lakes. The dynamics of the algal bloom have resulted in extended periods of elevated pH, low dissolved oxygen, and toxic levels of ammonia (Bortleson and Fretwell 1993; Kann and Smith 1999; Perkins et al. 2000). These extended periods of poor water quality during summer months have caused chronic stress in fishes and resulted in fish kills (Scoppettone and Vinyard 1991; Kann and Smith 1999; Perkins et al. 2000).

Life History and Distribution of Adfluvial Redband Trout

The biology and life history of adfluvial redband trout in the upper Klamath River basin have not been extensively

investigated. We do have some knowledge of when and where adult redband trout spawn, but this information is limited to some of the larger spawning tributaries such as the Williamson and Wood rivers and Spring Creek. The adfluvial redband trout populations of the upper Klamath River basin utilize tributaries for adult holding and spawning, and for early juvenile rearing. Little information is known about juvenile life history of adfluvial redband trout. Juvenile redband trout are thought to spend up to 1 year rearing in tributaries before migrating to the lakes where they rear until maturity. Research has shown that redband trout first spawn generally at age 3 and, depending on the stock, may spawn in consecutive years up to age 8 (Borgerson 1991).

The major spawning tributaries for adfluvial redband trout in the upper Klamath River basin are the Williamson, lower Sprague, and Wood rivers and Spring Creek (Figure 1). The lower Williamson River below Klamath Marsh, and its main tributaries Spring Creek and the Sprague River, support the largest populations of redband trout in the upper Klamath River basin. The Kirk Springs area of the lower Williamson River (Figure 1), is one of two main redband trout spawning areas in the river; the other being the 3.2 km reach downstream of Spring Creek. Spring Creek, a major tributary of the lower Williamson River, has a flow of about 8.5 m^3/s (300 ft^3/s) of clear, cold water (4.4°C). Although Spring Creek is only 3.2 km long, it provides good spawning and rearing habitat, which has been improved with the addition of spawning gravel and large wood. The Wood River is a low gradient stream that flows 27 km from its spring source to Agency Lake. Redband trout spawn in the upper 3.2 km of the river.

Late summer fish kills that sometimes occur in Upper Klamath Lake usually involve large numbers of Lost River (*Deltistes luxatus*) and shortnose (*Chasmistes brevirostris*) suckers, and blue (*Gila coerulea*) and tui (*G. bicolor*) chubs, although some adult redband trout also have been found. Few juvenile redband trout are found during the fish kills, but moribund and dead juveniles are quickly lost to bird predation. In addition to direct mortality, long periods of poor water quality increase stress on fish and can have sublethal effects that reduce fitness (Perkins et al. 2000). Therefore effects on redband trout might be greater than that measured by counts of dead fish. Large fish kills were documented in 1995–1997, with 1997 being most severe for redband trout (Perkins et al. 2000). Redds counted in Spring Creek (Table 1) did not significantly change ($P = 0.87$) from 1991–1995 to 1996–2001, suggesting that fish kills in the lake did not have a direct effect on number of redband trout spawners. Periods of poor water quality that result in large fish kills of suckers and chubs may not cause high mortality of adult redband trout if the trout migrate out of Upper Klamath Lake early or move into cool-water refuges such as springs in Pelican Bay (Figure 1). Another possibility is that overlap in age classes of redband trout may buffer effects of mortality on the number of spawners, especially if conditions that lead to fish kills in the lake are infrequent.

Historical Management of Klamath Lake Redband Trout

The evolution of redband trout management in Klamath Lake and its tributaries has resulted largely from the collection of information by biologists who have worked in the upper Klamath River basin. This information has been used to develop new fish policies and plans that will guide the management of redband trout in the upper Klamath basin for years to come. In reviewing the historical management of Klamath Lake redband trout, it is important to remember the political and social atmosphere in which fishery biologists were working during their employment. Options for future management of native trout populations are often limited by the management decisions that were made during the past century and their consequences. Choosing the future direction of fish management will require an understanding of the historical changes that have shaped present-day trout populations (Buchanan et al. 1989).

Redband trout management in the upper Klamath River basin had its beginnings in the late 1920s, when hatchery

Table 1. Counts of redband trout redds in two sections of Spring Creek and in 5 km of the Williamson River below Spring Creek, 1974–2001. Redd counts were conducted at approximately 2-week intervals. Redd counts in Spring Creek started in November of the previous year. Redds were counted in the Williamson River in September after the river cleared of tannic runoff from Klamath Marsh.

	Spring Creek			
	Gabion	Collier		Williamson
Year	(near mouth)	Park	Total	River
1974				43
1975				99
1976	62	302	364	117
1977	36	294	330	170
1978	80	124	204	123
1979	49	230	279	61
1980	67	151	218	112
1981	86	180	266	105
1982	76	95	171	
1983	84	128	259	
1984	131	128	259	
1985	148	131	279	
1986	245	228	473	
1987	284	182	466	
1988	238	233	471	
1989	209	365	574	
1990	253	316	569	
1991	232	250	482	83
1992	274	326	600	161
1993	315	312	627	113
1994	328	354	682	146
1995	356	207	563	113
1996	292	276	568	171
1997	303	258	561	96
1998	346	394	740	
1999	366	147	513	
2000				153
2001	359	256	615	

trout were first stocked into Klamath Lake and its tributaries. The principal management activities for trout fisheries in Upper Klamath and Agency lakes from the late 1920s through the 1960s were the stocking of hatchery trout to provide recreational fisheries and the monitoring of fisheries with creel surveys. Stocking records of ODFW report large numbers of hatchery trout released into the lakes and tributaries from 1928 to 1963. The cumulative totals of hatchery trout stocked in the lakes during this period were 12 million rainbow trout and 400,000 brook trout *Salvelinus fontinalis*. Total numbers of hatchery trout stocked into tributaries were 4.8 million rainbow trout of various strains, 1.5 million brook trout, 280,000 steelhead *O. mykiss*, and 27,500 cutthroat trout *O. clarkii*.

The majority of hatchery trout stocked in the basin were released as unfed fry until 1960. One reason fish were released at this life stage was because high survival was assumed to occur in the highly productive lakes. Another reason larger fish were not released in the early years was that hatchery practices such as disease treatment and nutrition had not advanced to the point of successfully rearing larger fish. In the early 1960s, Arthur Gerlach (ODFW Klamath District fish biologist, 1957–1967) observed a decline in the numbers of trout taken in the sport fishery. Consequently, changes were made in the management of the lakes to increase the numbers and size of trout available to the recreational fishery. These changes included increasing the numbers of fingerling trout (5–10 cm) and swim-up fry released into the lakes. From 1961 to 1962, the numbers of hatchery trout released in the lakes increased for fingerlings (55,220 to 201,000) and for swim-up fry (539,500 to 2.3 million). Stocking times and locations also were modified to increase survival. Release times were changed from summer to winter to avoid releasing hatchery trout into marginal habitat caused by poor water quality. Location of release changed from general lake releases to releases into Barclay Springs, along the eastern shore of Upper Klamath Lake (Figure 1). The cool spring water in Barclay Springs provided better water quality than that in the lake, and it was believed that better water quality would provide excellent rearing conditions for fry releases and would increase survival. Angling regulations were adopted for the lakes that protected larger fish by limiting the daily bag limit to two trout $\geq$ 51 cm (20 inches).

Surveys of the important spawning tributaries also were conducted to determine what measures could be taken to increase natural reproduction. These surveys showed that small dams blocked most of the major spawning tributaries and that pumice sand covered the spawning areas. Surveys also revealed major losses of wetlands around the lakes, reduction of trout rearing habitat because of dredging in the lower sections of the Wood and Williamson rivers, and severe impacts to stream habitat in the upper watersheds of the basin because of poor forestry and agricultural practices.

Because of these findings, Gerlach concluded that the hatchery program for the Upper Klamath and Agency lakes was going to be important for the maintenance of the trout fishery. The increased stocking program also was seen as necessary to supplement any natural reproduction. A conclusion of the management program was that trout stocking should continue until such time that the natural production in the lakes could sustain the recreational trout fishery.

Managers noted some success following the increase in the numbers of hatchery trout stocked. In 1963, the proportion of small fish increased in the catch, but the total number of fish caught was low. The low catch was attributed to small numbers of anglers participating in the fishery. In 1964, managers observed that the numbers of trout taken by anglers in both lakes increased considerably, with the average size ranging from 36 to 46 cm. A group of 125,000 marked fingerlings were released in the lakes in 1963. Although the number of trout caught seemed correlated with increased numbers of stocked trout, few marked fish were caught in the fishery; none in 1963 and five in 1964, with an average length of 36 cm. It was becoming increasingly apparent that even though hatchery releases in the lakes had increased, the increase in trout production could not be attributed to increased levels of stocking.

Management in the 1970s continued to use hatchery releases as a strategy to supplement fish production and to increase the numbers of trout available in the recreational fishery. However, the trout stocking program was refined during this period. The fishery management plan called for annual stocking of 50,000–60,000 legal rainbow trout in streams and 550,000 fingerlings into Upper Klamath and Agency lakes. Concerns were frequently expressed that despite increases in hatchery releases, hatcheries were not keeping up with demand. Additional marking programs were initiated to evaluate the trout stocking program and to determine if changes in the hatchery stocking program were successful in increasing trout production.

Studies conducted in the early 1970s to evaluate success of trout stocking in Upper Klamath Lake concluded that a release of 310,000 fingerling trout in Upper Klamath Lake contributed < 0.4% to the trout fishery. These results added to the increasing evidence that rainbow trout stocked in the upper Klamath River basin did not survive to contribute to recreational fisheries. Fishery managers also recognized that because the stocks of rainbow trout released into waters of the basin were not indigenous, they did not exhibit survival and growth rates, or contribute to the fisheries as well as indigenous stocks of redband trout, which have adapted to the high summer pH and temperatures characteristic of waters in the upper Klamath River basin.

One of the early studies that helped shape management of the redband trout in the Williamson River was a 1972 study that evaluated the redband trout fishery in a 6.4-km section of the Williamson River south of the town of Chiloquin. The objectives of this study were to determine anglers' opinion of management of the fisheries and to document redband trout harvest in the river. The study, through its marking program, also provided information on redband trout

movement within the Williamson River and in Upper Klamath Lake. Findings from this study showed that the overall catch rate of redband trout in the lower Williamson River was 0.77 fish/angler and 0.29 fish/hr. Anglers considered a trophy fish to be ≥ 51 cm (20 inches), and wanted a quality rather than a consumptive fishery. As a result of this study, special angling regulations were enacted for portions of the lower Williamson River that included a bag limit of two fish > 30.5 cm (12 inches) and a gear restriction of lures and flies only. Additionally, stream rehabilitation projects were initiated in the Williamson River in 1974 to improve habitat for redband trout.

Shifts in management philosophy started to take place and were conveyed in a 1974 report by Wendell Stout (ODFW Klamath District fish biologist, 1967–1977) in which he stated: "Major emphasis in the Klamath Basin will be directed to the protection and enhancement of resident game fishes presently established." The management goals in 1974 for redband trout in the upper Klamath River basin were to (1) maintain the maximum healthy population of redband trout in all waters capable of trout production in the basin; (2) maintain and, where practical, enhance the present quality of angling experience in terms of productive angling for large fish in all waters providing this opportunity; (3) prevent any further loss or deterioration of redband trout habitat; (4) improve stream habitat; and (5) assure public access to all desirable fishing areas.

Problems in achieving these management goals were identified and actions were taken. Physical stream surveys were conducted in areas critical to natural production of redband trout to assess the location and extent of land use practices damaging fish habitat. These surveys were important for the identification of critical habitat for redband trout and physical factors limiting natural production. For example, lack of spawning and rearing areas were identified as limiting factors for populations of native redband trout in Spring Creek. In 1975, a gabion was placed across the mouth of Spring Creek and gravel was placed above it to provide spawning habitat. Wood was also added to the creek to provide juvenile rearing habitat. Adult redband trout were observed spawning in the introduced gravel within months of placement. Additional gravel was placed in the 1980s in Spring Creek at the gabion and upstream near Collier Park (Figure 1).

We compared counts of redds in years when surveys were conducted in Spring Creek and the Williamson River to assess use of placed gravel and potential shifts in spawning distribution. The average number of redds in Spring Creek significantly increased ($P < 0.01$) from 277 in 1976–1981 to 583 in 1991–1997 (Table 1). However, of the two survey sections in Spring Creek, the average number of redds in the gabion section increased almost five-fold ($P < 0.01$), from 63 to 300, while the average number of redds in the Collier Park section increased only about 30%, from 213 to 283 ($P = 0.08$). The lack of significant change in the upper section could have been a consequence of the introduced gravel moving downstream. Concern was raised that the increase in redds in Spring Creek could have resulted if redband trout that would have spawned in the main stem of the Williamson River below Spring Creek were now spawning in Spring Creek. Because of this concern, index counts in the Williamson River from Spring Creek to Pine Ridge Mill (Figure 1) were resumed in 1991 (after having been stopped in 1982). The average number of redband trout redds was not significantly different ($P = 0.98$) between 1976–1981 (115) and 1991–1997 (126) (Table 1). Redds were counted in the Williamson River in September, several months after redband trout spawned, because the river is discolored from tannic runoff out of Klamath Marsh until late summer. Therefore, counts of redds in any given year may include redds that were made and counted in the previous year, if the older redds remain visible because winter and spring flows were not high enough to move gravel. Although this bias may affect the exact number of redds in a given year, it is unlikely to affect comparisons between the two 6–7 year periods.

During the late 1970s and early 1980s, major changes were made in trout management in Oregon and in the upper Klamath River basin because of new ODFW management policies and plans, and the discovery of *Ceratomyxa shasta* in Klamath Lake (*see below*). Policies and management plans adopted by the Oregon Fish and Wildlife Commission (OFWC) included the Wild Fish Management Policy in 1978, and a statewide trout plan (ODFW 1987). These policies and plans guided fish management toward sustaining the diversity and abundance of native fish. Protection and enhancement of wild stocks was given first and highest consideration in fish management. The new policies and plans also provided guidance in addressing diversity in angling opportunities within the constraints of species biology, distribution, and abundance.

A new fish management plan for Upper Klamath and Agency lakes was adopted by the OFWC in 1981. This plan incorporated the newly developed ODFW Wild Fish Management Policy and called for management of the fisheries with wild trout only. No hatchery fish have been stocked in Upper Klamath and Agency lakes since 1979. In addition, stocking of all streams (except for Spring Creek) was discontinued after 1991, when the Wood River and Sevenmile Creek were last stocked.

The discovery of *C. shasta* in Upper Klamath Lake played a key role in determining the management of redband trout in the upper Klamath River basin. In 1979, *C. shasta* was determined to be the cause of death in 40 small rainbow trout in Upper Klamath Lake at Barclay Springs. This important discovery helped explain why hatchery trout survival was so poor in Klamath Lake. The majority of exotic rainbow trout stocked into Upper Klamath Lake were susceptible to and likely killed by *C. shasta*. As a result of detecting *C. shasta* in Upper Klamath Lake, stocking of rainbow trout in Upper Klamath and Agency lakes and all its tributaries (excluding Spring Creek) was terminated. The hatchery fish released into Spring Creek are a domesticated stock of coastal

rainbow trout and have very poor survival in the main stem of the Williamson River because they are susceptible to *C. shasta* that is present in the river. The hatchery rainbow trout stocked in Spring Creek provide a put-and-take fishery in summer, when numbers of wild redband trout are low. No hatchery rainbow trout were found in Spring Creek during studies when adults were trapped (Buchanan et al. 1990, 1991; Hemmingsen et al. 1992). Kirk Springs redband trout were used in the early 1990s to start a strain of hatchery redband trout. These fish were used in Spring Creek to replace the Cape Cod hatchery rainbow trout, but were difficult to catch. Some of these fish migrated to the Williamson River and Upper Klamath Lake and returned as adult spawners. For example, of the redband trout captured in Spring Creek in December 1992–May 1993, 267 were wild fish and 27 were hatchery fish (identified by adipose fin clips) that had been stocked in previous years (Hemmingsen and Buchanan 1993). This program was subsequently dropped because of the failure to meet the primary objective of a put-and-take fishery and because of potential negative impacts on wild redband trout. The stocking of hatchery rainbow trout (Cape Cod strain) was then reinstated.

Research studies were conducted by the Native Trout Project of the ODFW Fish Research Section in 1989–1994. These studies added information critical to the sound biological management of redband trout stocks in the upper Klamath River basin. Studies revealed that the redband trout of Upper Klamath Lake were unique in terms of life history characteristics, meristics, disease resistance, and allozyme variation. Studies on the resistance of redband trout to *C. shasta* within the upper basin found that the infective stage of *C. shasta* exists in the lower Williamson River and Upper Klamath Lake (Buchanan et al. 1989). Although *C. shasta* was not detected in Spring Creek, juvenile redband trout from the creek were resistant. However, these juvenile fish are progeny of adults that are exposed to *C. shasta* in the Williamson River and possibly in Upper Klamath Lake. *C. shasta* was absent from the Williamson River upstream of Klamath Marsh, and most of the juvenile redband trout from this area were susceptible when exposed to *C. shasta* (Buchanan et al. 1989).

Research findings also showed that redband trout in the upper Klamath River basin represent a unique and highly divergent evolutionary line (Buchanan et al. 1990), and that genetic differences existed between populations of redband trout in headwater streams and those associated with Upper Klamath Lake (Buchanan et al. 1994). A comparison between the life history characteristics of adult redband trout in Spring Creek and those at Kirk Springs showed significant differences in spawn timing and duration, and in the size of adult spawners (Buchanan et al. 1991; Hemmingsen et al. 1992; Hemmingsen and Buchanan 1993), although the two populations are genetically similar (Buchanan et al. 1994). In addition, tagging studies supported the hypothesis that redband trout populations from these two areas are reproductively isolated from each other, despite the absence of a physical barrier between the two spawning sites (Buchanan et al. 1991; Hemmingsen et al. 1992; Hemmingsen and Buchanan 1993). Redband trout from Spring Creek are genetically distinct from those in the Wood River, although fish from both populations are thought to spend some of their life in the Klamath Lake complex. Based on allele frequencies, Wood River redband trout grouped more closely with headwater groups than with other populations associated with Upper Klamath Lake, but they did share some similarities with the Upper Klamath Lake populations (Buchanan et al. 1994).

Future Management of Klamath Lake Redband Trout

The Klamath River Basin Fish Management Plan (ODFW 1997) was developed with information about past management of Klamath Lake redband trout, life history characteristics and biology of redband trout in the basin, and ODFW fish management policies. This plan was developed with the intent of optimizing recreational use of the fish resources in the upper Klamath River basin for present and future generations, while conserving the integrity of the native fish fauna. The principal consideration in developing this management plan was compliance with the ODFW Wild Fish Management Policy (ODFW 1992) and the statewide trout plan (ODFW 1987). These documents guide management toward sustaining diversity and abundance of the native trout in Oregon.

The guiding principles for redband trout management in Upper Klamath and Agency lakes, and all tributaries contributing redband trout production to the rearing populations in the lakes, include the following: (1) management of fish resources must consider potential ecological consequences; (2) maintenance or restoration of indigenous species is of foremost importance and is the guiding principle for this plan; and (3) no management direction proposed in the plan is expected to have significant detrimental effects on any indigenous species.

The key objectives of the plan are to maintain protection of genetic diversity, adaptiveness, and abundance of redband trout in the waters of the basin, and to provide for diverse angling opportunities by providing for consumptive and recreational fisheries on redband trout where they occur in these waters. Proposed management alternatives for Klamath Lake redband trout call for natural production and management for trophy fisheries.

Summary

Management of redband trout in the upper Klamath River basin has progressed from the early 1920s, an era when hatchery fish were released in attempts to increase fish production, to the 1990s, when the uniqueness of endemic stocks of redband trout and habitat protection and enhancement are paramount for producing trophy trout fisheries. This progression happened because fish managers incorporated the results of biological studies of redband trout to develop policies and management plans that recognized the importance

of native fishes and natural production. Although management goals and objectives have changed through time, the current management of Klamath Lake redband trout is designed to preserve these unique stocks of fish for the enjoyment of present and future generations of anglers and the general public.

References

Behnke, R.J. 1992. Native trout of western North American. American Fisheries Society Monograph 6, Bethesda, Maryland.

Bond, C.E., C.R. Hazel, and D. Vincent. 1968. Relations of nuisance algae to fishes in Upper Klamath Lake. Oregon State University, Terminal Progress Report, Publication WP-00625 prepared for U.S. Federal Water Pollution Control Administration, Corvallis, Oregon.

Borgerson, L.A. 1991. Scale analysis. Oregon Department of Fish and Wildlife, Fish Research Project F-144-R-2, Annual Progress Report, Portland.

Bortleson, G.C., and M.O. Fretwell. 1993. A review of possible causes of nutrient enrichment and decline of endangered sucker populations in Upper Klamath Lake, Oregon. U.S. Geological Survey, Water Resources Investigations Report 93-4087, Portland, Oregon.

Bradbury, J.P., S.M. Colman, and R.L. Reynolds. 2004. The history of recent limnological changes and human impact on Upper Klamath Lake, Oregon. Journal of Paleolimnology 31:151–165.

Buchanan, D.V., A.R. Hemmingsen, D.L. Bottom, R.A. French, and K.P. Currens. 1989. Native trout project. Oregon Department of Fish and Wildlife, Fish Research Project F-136-R, Annual Progress Report, Portland.

Buchanan, D.V., A.R. Hemmingsen, D.L. Bottom, P.J. Howell, R.A. French, and K.P. Currens. 1990. Native trout project. Oregon Department of Fish and Wildlife, Fish Research Project F-136-R, Annual Progress Report, Portland.

Buchanan, D.V., A.R. Hemmingsen, D.L. Bottom, P.J. Howell, R.A. French, and K.P. Currens. 1991. Native trout project. Oregon Department of Fish and Wildlife, Fish Research Project F-136-R, Annual Progress Report, Portland.

Buchanan, D.V., A.R. Hemmingsen, and K.P. Currens. 1994. Native trout project. Oregon Department of Fish and Wildlife, Fish Research Project F-136-R-7, Annual Progress Report, Portland.

Dicken, S.N. 1980. Pluvial Lake Modoc, Klamath County, Oregon, and Modoc and Siskiyou counties, California. Oregon Geology 42(11):179–187.

Eilers, J.M., J. Kann, J. Cornett, K. Moser, and A. St. Amand. 2004. Paleolimnological evidence of change in a shallow, hypereutrophic lake: Upper Klamath Lake, Oregon, USA. Hydrobiologica 520:7–18.

Hemmingsen, A.R., R.A. French, D.V. Buchanan, D.L. Bottom, and K.P. Currens. 1992. Native trout project. Oregon Department of Fish and Wildlife, Fish Research Project F-136-R, Annual Progress Report, Portland.

Hemmingsen, A.R., and D.V. Buchanan. 1993. Native trout project. Oregon Department of Fish and Wildlife, Fish Research Project F-136-R-6, Annual Progress Report, Portland.

Kann, J., and V.H. Smith. 1999. Estimating the probability of exceeding elevated pH values critical to fish populations in a hypereutrophic lake. Canadian Journal of Fisheries and Aquatic Sciences 56:2262–2270.

Kostow, K., editor. 1995. Biennial report on the status of wild fish in Oregon. Oregon Department of Fish and Wildlife, Portland.

Laenen, A., and A.P. LeTourneau. 1996. Upper Klamath Basin nutrient-loading study: estimate of wind-induced resuspension of bed sediment during periods of low lake elevation. U.S. Geological Survey, Open File Report 95-414, Portland, Oregon.

Miller, W.E., and J.C. Tash. 1967. Upper Klamath Lake studies, Oregon. Federal Water Pollution Control Administration, Pacific Northwest Laboratory, Water Pollution Control Series, Paper WP-20-8, Interim Report. Corvallis, Oregon.

ODFW (Oregon Department of Fish and Wildlife). 1987. Oregon's trout plan: a plan for the management of Oregon's trout. Oregon Department of Fish and Wildlife, Portland.

ODFW (Oregon Department of Fish and Wildlife). 1992. Wild fish management policy. Oregon Administrative Rule, 635-07-525 through 635-07-529, Portland.

ODFW (Oregon Department of Fish and Wildlife). 1997. Klamath River Basin fish management plan. Oregon Department of Fish and Wildlife, Portland.

Perkins, D.L., J. Kann, and G.G. Scoppettone. 2000. The role of poor water quality and fish kills in the decline of endangered Lost River and shortnose suckers in Upper Klamath Lake: Klamath Falls, Oregon. U.S. Geological Survey Final Report submitted to Bureau of Reclamation Klamath Falls Project Office, Contract 4-AA-29-12160.

Scoppettone, G.G., and G. Vinyard. 1991. Life history and management of four endangered lacustrine suckers. Pages 359–377 *in* W.L. Minckley and J.E. Deacon, editors. Battle against extinction: native fish management in the American West. University of Arizona Press, Tucson.

Snyder, D.T., and J.L. Morace. 1997. Nitrogen and phosphorus loading from drained wetlands adjacent to Upper Klamath and Agency lakes, Oregon. U. S. Geological Survey, Water Resources Investigations Report 97-4059, Portland, Oregon.

USACE (U.S. Army Corps of Engineers). 1978. Klamath River basin, Oregon. U.S. Army Corps of Engineers, Reconnaissance Report, San Francisco, California.