Oregon Chub in the Willamette River Basin

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Introduction

If you think of the world as a cake, the species of the world are the ingredients that make up the cake, and every single one of these ingredients is important for the survival and success of that cake. Therefore, forgetting even the smallest ingredient, such as the pinch of salt, could prove detrimental to the cake. Thus, even the loss of a small, olive-colored minnow in the Willamette River Basin, the Oregon chub, could prove a tragedy for our world.

The tragedy is not so much in the loss of the Oregon chub, but in what the chub represents. The endangered status of the Oregon chub, *Oregonichthys crameri*, proves to be a good indicator of the effects that human management and manipulation have had on the Willamette River and its inhabitant species. Although seemingly insignificant, the Oregon chub is the only fish within the Willamette River basin that has been federally listed as an endangered species, and sadly enough, its decline has been brought about almost entirely by human actions and manipulations of its habitat. The main reasons for its decline that I will be exploring are the introduction of non-native species, the changes in the flow of the river, and the chemicals and sediments found in the water.

History

The history of the Oregon chub is a sad tale of man's disastrous efforts to control nature to fit his own needs and thus damaging the habitat and threatening the existence of the other species around him.

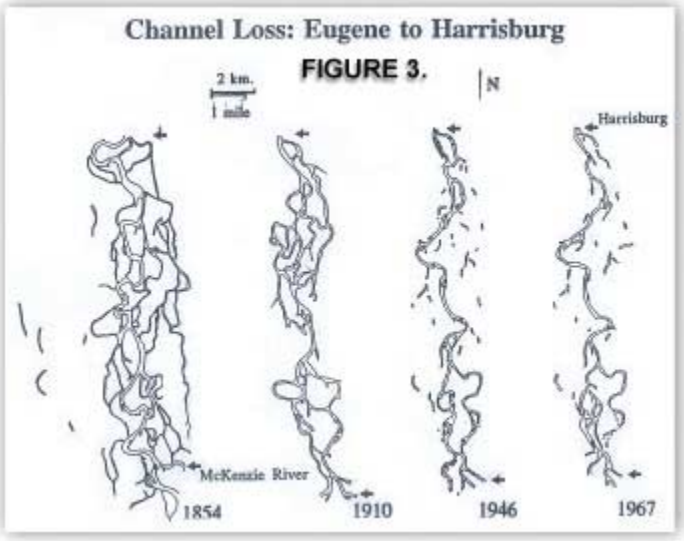
The Willamette River, the habitat in which the Oregon chub is found, is situated between the Cascade and Coast Mountain ranges in the northwestern portion of Oregon. It is the thirteenth largest river in the United States ("The Willamette River" 5). Historically the Willamette was a wild, braided river, measuring 187 miles on its main stem ("The Willamette River" 2). Cool wet winters and warm dry summers characterize the climate in the area with 70 to 80 percent of the rain accumulation from October to March (U.S. Army Corps of Engineers 1). These rains, historically, led to an average of 14 floods above the bank per decade from the years 1884 to 1969 (U.S. Corps of Engineers 1970). Each time these floods occurred, they created new side channels, oxbows, meanders, and overflow ponds. These off-channel areas with slow water flow, silty organic substrates, and an abundance of aquatic vegetation provided the perfect habitat for the Oregon chub, a species that was historically distributed widely throughout the Willamette Valley (Markle et al. 227-293). Historic maps and aerial photographs of the Willamette River basin show the area having a great web of channels and ponds with a wide range of vegetation types (Andrus et al. 2). Since the Oregon chub typically prefer habitats with dense vegetation cover for hiding and spawning, with an average depth of less than two meters and an average water temperature of no more than 61°F, the historical Willamette River Basin was an ideal habitat area for these small minnows (Oregon Fish and Wildlife Office 2).

Oregon's growing population in its three major cities (Portland, Eugene, and Corvallis) created an impetus to find new ways to use the water through navigation, the development of industrial and agricultural uses, and of course, hydropower. The Oregon chub's decline has been linked to the creation of dams along the Willamette River. The Oregon Fish and Wildlife Recovery plan of 1998 estimated that the severity of the Oregon chub's decline occurred between the years 1950 and 1960, and that happened to be the time when eight major flood-control/hydropower production dams were completed (12). By 1968, eleven major dams were constructed in the Willamette River Basin for the uses of flood control and hydropower production (Scheerer "Research Project" 20). The Oregon Department of Fish and Wildlife openly stated in their 1998 Recovery Report:

> The Oregon chub evolved in a dynamic network of slack water habitats in the floodplain of the Willamette River…Thus although the Oregon chub evolved as a fish of slow-moving streams and sloughs, near term persistence of the species will depend on its ability to survive and thrive in more isolated habitats (U.S. Fish and Wildlife 10).

Therefore, according to the opinion of the scientist, the dams changed the dynamics of the river so severely that the Oregon chub must evolve and adapt or die off as a species.

These wild, widely braided channels that supported local biodiversity transformed into largely one confined main channel (See Map, Benner 1)



Paul Scheerer of the Oregon Department of Fish and Wildlife stated, “In the past 150 years, the channel length of the Willamette River drainage has been drastically reduced by the construction of 13 major flood control dams” (“Implications” 1070). It was calculated that the area of channels and islands has been reduced to merely 20 percent of what it was in 1850 (Andrus et al. 7). In 1983, two Oregon State University scientists discovered that the Oregon chub populations along the Willamette River were declining and becoming rare (U.S. Fish and Wildlife 7). The construction of the flood control dams, in combination with large-scale removal of snags for navigation, channelization, revetments, and the drainage of the wetlands to increase the land available for river bottomland agriculture, decreased the diversity of the landscape of the river. The dams altered the flow rates of the river, which were historically low in the main stem during the summer and high with minor to major flooding and rechannelization in the winter. These alterations made what would have been 10-year flood events become 100-year flood events. The lack of floods further contributed to the decline of the species by not allowing for the creation of new habitats for the fish. They were then eventually listed as a federally endangered species in 1993 (U.S. Fish and Wildlife 7).

The most recent of these 100-year floods occurred in 1996 and redistributed non-native fish throughout the Willamette River. Because non-native fish are one of the largest threats to the Oregon chub population, according to studies, their populations declined substantially after the flood and have remained low since then (Scheerer “Chub Research” 7).

Therefore, the conditions of the Willamette River Basin pre- and post-damming are considerably different. Man has transformed a wild web of channels into a tame,

straight, single channel river. This transformation seemed advantageous for man and industry; however, it has proved to be injurious to the struggling Oregon chub population.

Oregon Chub Condition

The Oregon chub is a small minnow, about nine centimeters long, with white on the belly, silver sides, and an olive colored back. It is indigenous to the Willamette River basin. On November 17, 1993, the species was declared an endangered species. At that time there were only five known chub populations still in existence and the chub inhabited only a meager 2 percent of its historic range of the Willamette River (Russel 1). However, not all is hopeless for the Oregon chub. Their status has improved in recent years because of thriving introductions to new habitats and from the discovery of previously unidentified populations (Scheerer “Annual Report” 3).

According to the most recent annual progress report of the Oregon chub with data collected from September 17, 2003 to July 31, 2004, there are currently 30 locations of Oregon chub populations in the Willamette River basin, out of the 110 sites that were sampled. However, only 16 of these locations were naturally occurring populations of chub. These naturally occurring populations were found in the Middle Fork Willamette, the Santiam, the Coast Fork Willamette, and the Mid-Willamette drainages (Scheerer et al. 1). Although the total number of populations has increased, by 25 populations in three different sub-basins (Russel 2), the Oregon chub continue to be at risk since several populations declined in 2003 due to the drought that occurred in the area in 2001 (Scheerer et al. 1).

Recently, many steps have been taken in hopes to eventually downlist the species to "threatened," and ultimately delist the species altogether from the Endangered Species Act. In order to downlist a species from endangered to threatened, one must:

> Establish and manage ten populations of at least 500 adult fish. All populations must exhibit a stable or increasing trend for five years. At least three populations must be located in each of the three sub-basins (Middle Fork Willamette River, Santiam River, mainstream Willamette River and tributaries)(Scheerer et al. 1).

The studies conducted in 2003 showed that eight of the known populations met the criteria for downlisting the species. The criteria to delist the species entirely are "to establish 20 self-sustaining populations of at least 500 adult fish. All populations must exhibit a stable of increasing trend for seven years. At least four populations must be located in each of the three sub-basins" (Scheerer et al. 21).

Many environmental organizations and other groups have set up projects in order to help nurse the dwindling chub population back to health. In 1991, even before the Oregon chub was officially listed as an endangered species, the Oregon Chub Working Group was formed, including biologists, academics, land managers, and concerned people who worked toward conserving and restoring the chub's habitat and raising public awareness of the species decline (U.S. Fish and Wildlife 15). Then, in 1992 the "Conservation Agreement for Oregon Chub in the Willamette Valley, Oregon" was signed with the purpose of reversing the declining trend of the species (U.S. Fish and Wildlife 15). Then eventually more drastic measures were taken in 1998 and 2000 with the Oregon chub Recovery Plan and the Safe Harbor Agreement. These two plans, which are still in action today, are working toward introducing new populations of Oregon chub to new locations in order to finally downlist the species. However, despite the attempted

reintroduction of the species to new areas, the Oregon chub still remains at risk due to loss habitat and the unremitting threats caused by the abundance of non-native fishes, illegal water withdrawals, accelerated sedimentation due to logging activities, and potential chemical spills and pesticide applications.

Reasons For Decline

1. **Non-native species**

The introduction of non-native fish to the Willamette River commenced in the late 1800s; however, at that time there was no idea as to the amount of damage these non-native fish would eventually have on the native species of the area (Dimick and Merryfield). Non-native fish are currently considered to be the greatest current threat to the populations of Oregon chub. They also present one of the most difficult hurdles to the recovery plans of the Oregon chub.

Today in the Willamette River basin, 29 of the 60 species of fish are introduced and non-native to the area (Gregory et al. 44). The species discovered as being threats to the Oregon chub populations are largemouth bass (*Micropterus salmoides*), smallmouth bass (*Micropterus dolomieui*), crappie (*Pomoxis sp*.), bluegill (*Lepomis macrochirus*), and western mosquitofish (*Gambusia affinis*) (U.S. Fish and Wildlife 12-13). These species, unfortunately, prefer to inhabit areas with little or no water velocity and plentiful amounts of aquatic vegetation such as ponds and sloughs in the Willamette River drainage (U.S. Fish and Wildlife 13). Sadly enough, this is also the preferred habitat for the Oregon chub.

The Oregon chub is threatened not only by loss of habitat to these non-native fish, but also by the risk of predation. Bass, crappie and mosquitofish are in the families of

centrarchids and ictalurids, which are both known piscivores, thus they are documented as having a diet of mostly other fish (U.S. Fish and Wildlife 13). Therefore Oregon chub recovery efforts are immensely difficult because new habitats found to be hospitable for the Oregon chub are also ideal for these non-native predator species.

Data show that there is a direct relationship between the connectivity of habitat to the adjacent river or reservoir and the chance that non-native fish will invade a habitat (Scheerer "Chub Research" 9). Therefore, in order to ensure the safety of a population of Oregon chub, they must be isolated from the rest of the river. However, this presents another problem because the isolation of the populations does not allow for much genetic exchange between the populations and thus does not allow for much genetic variability between the fish. This can be an evolutionary problem because a species with low genetic variability is more easily wiped out than those with high variability.

In 2003-2004 scientists collected non-native fish from eight locations where Oregon chub were present, but of the locations where the populations of Oregon chub were abundant (more than 500 fish), only one site was also inhabited by non-native fish (Scheerer et al. 4). Therefore, scientists came to the conclusion that in order to accommodate larger populations of Oregon chub, it was necessary to remove the non-native fish from the habitat. An experiment was then conducted where scientists drained a pond where Oregon chub had existed. They then treated the pond with rotenone in order to poison the non-native fish that were also living there. The pond was refilled and the Oregon chub were planted back into the pond. However, non-native fish are much more resilient and resistant to chemicals because after 3 years, western mosquitofish were again abundant in the pond and the Oregon chub populations began again to decline

(Scheerer “Chub Research” 17). Therefore the persistence and resilience of the introduced fish is what makes them the largest threat to the Oregon chub’s existence. Scientists have yet to find a way to completely isolate the Oregon chub from non-native fish in order to keep them safe from predation.

2. Change in the flow of the river

The construction of 13 flood control/ hydropower dams along the Willamette River drastically changed the flow of the river, which in turn drastically affected the Oregon chub population. The first change in the flow of the river was the decreased frequency of peak flows. This low flow system does not allow for the river to recreate itself and create new off-channel features such as ponds, side channels, and alcoves each flood season (Andrus et al. 5). Thus the river has become straighter and less braided, with fewer possibilities for habitat for the Oregon chub.

The second change that occurred because of the dams along the Willamette was a change in seasonal flow rates that also changes the water temperatures, affecting the fish. Naturally, the Willamette had faster flows in the winter and slower flows in the summers. However, the agencies fill the reservoirs in the winter and spring, reducing downstream flooding, and increase the flow rates in the summer, augmenting the flows to a higher than natural rate during the dry season. Reports from U.S. Forest Service show, “The Oakridge slough is undergoing eutrophication rates, and reduced water velocity and disconnection from the active flood plan because the construction of the upstream dams has reduced flushing” (Buck 2), and therefore the water quality of the chub habitat is decreased. Also, due to stratification in the water in the reservoirs, there ends up being an increased water temperature in the winter and a decreased water temperature in the

summer. According to specialists, “Temperatures exceeding the upper lethal tolerance for Oregon chub would negatively affect survival rates. Temperatures below the threshold where spawning has been observed might limit production at that location” (Scheerer “Chub Research” 12). Therefore, this change affects the Oregon chub in that it reduces their spawning success (Taylor pers. comm.). Oregon chub spawn from the end of April through early August and require warmer water for spawning, from 60 to 82°F. Therefore, by altering water flows along the Willamette, the dams have also decreased spawning success among the Oregon chub.

The third way that the construction of the dams along the Willamette River has helped to threaten the Oregon chub is by water withdrawals. About 1.4 million acres of the Willamette River basin are used for crop production and approximately 25 percent of this land is irrigated (U.S. Army Corps of Engineers 9). Where does the water come from? The answer is the reservoirs and the Willamette River.

3. Chemicals

The three main ways that chemicals enter the Oregon chub habitats are logging, agricultural runoff, and accidental chemical spills. These chemicals enter the watershed and greatly affect the Oregon chub populations. The reason that these chemicals more easily affect the Oregon chub than its predators or competitors is because, according to scientists, “The native fish fauna are more sensitive to the impacts of pollution than introduced species” (S. Gregory et al. 44). Of the native species in the Willamette River basin, “Only 13 percent are considered tolerant to pollution,” whereas 69 percent of introduced fish in the Willamette River basin are classified as pollution tolerant (S. Gregory et al. 44).

Logging along the edges of the Willamette River has influenced water quality by increasing the rates of fine sediments from runoff (U.S. Army Corps of Engineers 8). The reduction in peak flows has reduced the energy available to transport this excess sediment. However, during summer, the unnaturally higher flow rate transports more sediment downstream than in summers before the dams were built. This system is now the opposite of what it was in the past, because of the change in flow seasons caused by the dams. Therefore, this affects the Oregon chub because it alters their habitat from what it originally had been in the past.

Agricultural runoff causes an excess of both nitrate and phosphate in the waters. Although these chemicals are not directly toxic to fish at the levels found, an investigation of the Oakridge sewage treatment plant stated that nitrate, "At concentrations below levels associated with toxicity to fish, can contribute to eutrophication and algal blooms when other nutrient factors are present" (Buck 5). Phosphorus was said to "correlate well with the eutrophication in the water bodies, as it is often the limiting nutrient" (Buck 8). Therefore, both of these waste products augment the eutrophication in the watershed and thus limit the Oregon chub habitat by increasing plant and algae growth and increasing the biological oxygen demand during the summer months.

The last way that chemicals enter the habitat of Oregon chub is by accidents. The Oregon chub are threatened by chemical spills from overturned trucks or rail tankers, overflow from chemical toilets in campgrounds, and misuse of pesticides or herbicides near the habitat area (U.S. Fish and Wildlife 14). However, in August 1996, a no-spray agreement with Oregon Department of Transportation was created in order to protect the

Oregon chub habitat in the Middle Fork Willamette River. The agreement bans the usage of herbicides near the Oregon chub sites. Therefore, it is not hopeless, precautions are being taken, and there are many more that we can take.

Recommendations for the future

Since the federal listing of the Oregon chub as an endangered species in 1993, many organizations and recovery plans have been drafted and attempted in order to revive the populations of the Oregon chub. The two most recent and feasible plans are the 1998 U.S. Fish and Wildlife Service (USFWS) Oregon chub recovery plan and the U.S. Fish and Wildlife Service Safe Harbor Agreement for the Oregon chub.

The Oregon chub Recovery Plan is a general recovery plan with the ultimate goal to eventually delist the Oregon chub from the Endangered Species list. The budget for this recovery plan is $1,732,000. Since 1998 the USFWS has been working to manage the existing Oregon chub locations, attempting to establish new populations, research the characteristics of suitable habitats, spawning areas, the effects of non-native predators, and their survival rates. The plan encourages understanding of the species and its status through public education throughout the area with the use of published articles, public meetings, and interpretive displays (U.S. Fish and Wildlife iv).

The Safe Harbor Agreement is an interesting gardener's approach to the Oregon chub situation. The plan attempts to promote private property owners to voluntarily provide their own property as a refugia for the natural populations. Then, according to the plan, if a naturally occurring population is threatened, the donor population, located on the private property land, will be transplanted in order to supplement the natural population (Russel 1). This is a unique and innovative plan; however, it relies a lot on

human management in order to save the population rather than allowing nature to do its own job. It makes man play the role of the gardener and caretaker of the earth.

Another recommendation that I have in order to aid the recovery of the Oregon chub is to look for opportunities to increase the width of the active channel. Only a small amount of the once numerous side channels, natural ponds and alcoves remain. We could breach dikes at certain spots along the river and construct new side channels through shallow mined areas. Or we could dig out the upstream end of the channels that are now plugged, thus allowing the river to divert into these reaches. Man would have to do these things to the river since our dams have diminished the peak flows of the river so much that the river can no longer accomplish this on its own.

On top of increasing the width of the active channel, we could also excavate new alcoves and side channels where they seem appropriate and where they would serve as adequate habitat for the Oregon chub. By intentionally excavating these normally naturally occurring features of the river, we could help channel complexity and habitat for our fish. In the past this technique was successful when an alcove was constructed near Corvallis by a gravel company site a few years ago. IPA Research scientists noted that the man-made alcove was immediately occupied by native fish (Andrus et al. 34).

My last suggestion is the reduce the threat of logging-related sedimentation by pursuing agreements with the U.S. Forest Service in order to discontinue logging in areas close to the Willamette River. These unsustainable logging practices allow for a lot of sediment to enter the waterways, thus affecting chub habitat. It would be ideal if we could, instead, establish large trees close to the river channels or off channel features. A durable restoration strategy could include converting reed canary grass and blackberries

into large native trees along the edges of the river. These native trees would be most appropriate where the river is slowly meandering into the bank.

Conclusion

At this point, the Oregon chub in the Willamette River basin are in bad shape. As of today they are still federally listed as an endangered species and have been for seven years. This is due to reduction of habitat, competition and predation by non-native species, the change in the flow of the river due to 13 flood-control dams along the Willamette River, and accidental spills of chemicals, pesticides, herbicides and sediments into the watershed. In an ideal world, we could use a remote control and rewind time back to before man had attempted to control this wild, fierce, braided, frequently flooded river. Rewinding back to before he turned it into something that he could control, manage, and use for his own benefit. We would rewind to before the time of dam construction, and well before the time of non-native fish introduction and massive logging. That way, the Oregon chub could have a pristine habitat that was naturally occurring along its banks, side channels and oxbows.

However, rewinding is not an option right now. So, the best we can do is manually create new habitats which the chub can use, and manually monitor these habitats to ensure that non-native fish do not invade these new habitats. In combination with these efforts, by educating and getting the whole community involved, eventually we may be able to delist this species from the Endangered Species list. Pretty soon people could be chanting “Save the Chub!” in the middle of Town Square rather than “Save the Whales.” In conclusion, the Oregon chub are a good indicator of the effects of

human actions and manipulations on natural habitats such as the Willamette River, and it is thus our job to clean up and repair the consequences of these actions.

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