Goose Lake Redband Trout

Existing Populations

Goose Lake basin is a closed interior basin that straddles the Oregon - California border. Named for the late Pleistocene Lake, Goose Lake experiences extreme fluctuations in lake level. Historically it has both overflowed into the Pit River (most recently in 1881) and completely dried (most recently in 1992). Goose Lake redband trout are thought to be an undescribed unique subspecies of redband trout (Moyle 1992). The Goose Lake SMU is comprised of 13 populations in the Oregon portion of the basin. Six other populations exist in California; New Pine, Cottonwood, Willow, Lassen, Davis, and Corral. Populations were identified based on Bowers et al. (1999), the Goose Lake Fishes Working Group (1995) and reviews by ODFW staff (Table 1). This review will only assess the status of the populations in the Oregon portion of the basin.

Table 1. Description, existence status, and life history of redband trout populations in the Goose Lake SMU.

Exist	Population	Description	Life History
Yes	Fall	Fall Creek.	Resident
Yes	Dry	Dry Creek & tributaries.	Resident / Migratory
Yes	Lower Drews	Drews Creek downstream of Drews Reservoir Dam.	Resident / Migratory
Yes	Upper Drews	Drews Creek & tributaries upstream of Drews Reservoir Dam including Quartz Creek.	Resident / Migratory
Yes	Antelope	Antelope Creek.	Resident / Migratory
Yes	Muddy	Tributaries upstream of Muddy Reservoir.	Resident / Migratory
Yes	Cottonwood	Cottonwood Creek & tributaries including Messman Cr.	Resident / Migratory
Yes	Thomas-Bauers Complex	Thomas, Bauers, Camp, Cox , Auger Creeks & tributaries.	Resident / Migratory
Yes	Deadman	Deadman Creek.	Resident / Migratory
Yes	Crane	Crane Creek.	Resident / Migratory
Yes	Cogswell	Cogswell Creek.	Resident / Migratory
Yes	Tandy	Tandy Creek.	Resident
Yes	Kelley	Kelley Creek & tributaries.	Resident / Migratory

Distribution

Analysis of the distribution criterion is based on 1:100,000 GIS hydrography of redband trout distribution (Flitcroft and Dambacher 2001). A population passes the distribution criterion if it satisfies two of three metrics – the current distribution must: 1) occupy >10% of the total stream distance in the populations basin, 2) total more than ten km (six miles), or 3) be connected to other populations. Populations that do not have a documented distribution are assumed to be less than 10 km and occupy less than 10% of their basin. Five populations pass the distribution criterion (Table 2).

Table 2. Distance of current distribution, total stream distance in each basin, percent of each basin occupied, and connectivity to other populations for redband trout populations in the Goose Lake SMU (based on Flitcroft and Dambacher 2001).

Population	Current (km)	Total Basin Distance (km)	% Occupied	Connected to Other Pops.	Pass / Fail
Fall	0.8	4.3	18.7	No	Fail
Dry	19.1	75.3	25.4	Yes	Pass
Lower Drews	--	133.8	--	Yes	Fail
Upper Drews	29.0	326.1	8.9	No	Fail
Antelope	--	68.7	--	Yes	Fail
Muddy	--	25.3	--	No	Fail
Cottonwood	26.1	138.5	18.8	No	Pass
Thomas-Bauers	134.4	578.6	23.2	Yes	Pass
Deadman	4.2	30.4	13.7	Yes	Pass
Crane	10.6	40.3	26.4	Yes	Pass
Cogswell	7.4	28.1	26.4	Yes	Pass
Tandy	--	7.4	--	No	Fail
Kelley	7.9	30.2	26.1	Yes	Pass

Even though redband trout are present in most of the major tributaries of Goose Lake, spawning and resident distribution is highly fragmented and limited to headwater and some mid-order reaches. Historically, all streams maintained hydrologic connection to Goose Lake and other streams. This connection provided opportunity for redband trout to express a migratory life history, mix among populations, and re-colonize unoccupied habitats. Currently, Cottonwood and Tandy creeks do not connect to Goose Lake and other populations due to irrigation diversions and water withdrawal. Upper Drews is isolated above an impassable dam on Drews Reservoir, Muddy is isolated above Muddy Reservoir, and the Fall Creek population is located above a barrier falls (W. Tinniswood, ODFW Klamath Fish District, pers. comm.). These isolated populations have no opportunity for genetic mixing with fish from other populations, increasing the risk of inbreeding effects when populations are small.

The documented distributions of four populations; Fall, Deadman, Cogswell, and Kelley creeks, are less than ten km. The distributions of four other populations are undocumented, and assumed to be less than ten km. The relatively short distance occupied by these populations puts them at greater risk of extinction due to stochastic events.

Upper Drews is the only population to occupy less than 10% of the total stream habitat in its basin. Although redband trout did not likely occupy all stream habitats in Upper Drews basin, the low occupancy rate serves as a red flag to identify populations in which distribution may be drastically constricted and warrants further investigation.

Abundance

Data describing the abundance of constituent populations of the Goose Lake SMU over the last 30 years are not available. Instead, mean density of a given population serves as a surrogate criterion. Mean density estimates are compared to density benchmarks for redband trout populations in eastern Oregon streams (Dambacher and Jones In press). A population passes the abundance criterion if the average density is classified as ‘moderate’ or ‘high’ in three of the previous five years. Populations with a ‘low’ rating for three of the last five years fail the criterion and are warranted for further investigation. When density estimates for the last five years are not available, the criterion is applied to only those years for which data are present.

Populations in Dry, Upper Drews, Cottonwood, Thomas-Bauers, and Crane creeks have high or moderate densities relative to similar populations in the Great Basin and eastern Oregon (Dambacher and Jones, In Press). These populations pass the abundance criterion (Table 3).

Table 3. Mean density, age 1+ fish/m^2 (number of samples), of redband trout populations sampled each year.

Population	1997[a]	1999	Assessment	Pass / Fail[b]
Fall	--	--	--	Fail
Dry	--	0.25 (3)	High	Pass
Lower Drews	--	--	--	Fail
Upper Drews	0.26	0.17 (4)	Moderate	Pass
Antelope	--	--	--	Fail
Muddy	--	--	--	Fail
Cottonwood	0.17	0.14 (5)	Moderate	Pass
Thomas-Bauers Complex	0.10	0.12 (14)	Moderate	Pass
Deadman	--	--	--	Pass
Crane	--	0.14 (2)	Moderate	Pass
Cogswell	--	--	--	Pass
Tandy	--	--	--	Fail
Kelley	--	0.0 (1)	Low	Pass

a- Data from Bowers et al. (1999) - number of sample sites not reported.
b- See below for justification.

For populations where measures of abundance are non-existent, densities of neighboring populations were applied with the following exceptions:

- Tandy and Muddy - Redband trout distribution in these populations was classified as 'absent - opinion' by local biologists (Flitcroft and Dambacher 2001). In 2001 ODFW documented the presence of redband trout in both streams. The abundance of native trout in these populations is likely extremely low. These populations fail the abundance criterion until abundance and density can be better assessed.

- Antelope – Until recently redband trout were not observed in Antelope Creek for a period of ten years. In 2003 ODFW biologists documented the presence of a redband trout (W. Tinniswood, ODFW Klamath District Office, pers. comm.). The abundance of this population is likely very low.

- Lower Drews - This population resides in habitat that is generally degraded with no access to headwater habitat. Stream flow is very low after the irrigation season due to closure of the headgate at Drews Reservoir Dam. Given current habitat conditions this population fails the abundance criterion until abundance can be better assessed.

Based on these metrics and available data, the population in Kelley Creek fails the abundance criterion; the 1999 surveys found zero redband trout at the only sample site on Kelley Creek. However, this sample site was not representative of the population; it was located in the lower reaches near the mouth in low quality habitat where the presence of redband trout is unlikely. Therefore this population was treated as not having data and densities from adjacent populations, Crane and Cottonwood (CA) were applied. The Kelley population passes the abundance criterion.

Using a probability sample design, ODFW conducted an SMU level population estimate of redband trout in 1999 in the Goose Lake basin (Dambacher et al. 2001). Population and density estimates were conducted at 35 randomly selected sample sites throughout the SMU (including six sites in California populations). Redband trout populations were estimated at 102,352 +/- 32% (95% CI) age 1+ individuals. Average density among the sites was 0.140 age 1+ fish/m^2.

Productivity

Data are not available to quantitatively assess productivity and the intrinsic potential of population increase for redband trout in the Goose Lake Redband Trout SMU. In the absence of these data a qualitative assessment of the productivity criterion is based on distribution and abundance, connectivity, life history, habitat quality, and presence of non-native species. A population that is widely distributed and exhibits high densities is assumed to have minimally rebounded from past drought cycles. Connectivity to a diversity of high quality habitats capable of supporting multiple life history types during extreme environmental conditions indicates a high potential for populations to rebound quickly given the opportunity. The expression of a migratory life history produces large, highly fecund adult individuals that further increase the intrinsic potential of productivity. Thus, a population passes the criterion if it: 1) is connected to habitat capable of supporting multiple life histories and/or serving as refuge during periods of environmental constraint, 2) expresses multiple life history strategies, 3) is widely distributed, and 4) relatively abundant. A population may also pass the criterion if data are available that indicate an increasing or stable trend in abundance. These qualities suggest populations are resilient and minimally able to rebound rapidly after periods of low abundance. This assessment, however, does not attempt to describe the degree to which populations may rebound. A population may pass the productivity criterion and not attain total abundance equivalent or greater than that prior to the previous low period. The presence of non-native species negatively effects productivity and may cause a population to fail the criterion if it is limited in other aspects. In many populations the intrinsic potential productivity is uncertain; these populations fail the criterion until productivity can be adequately assessed.

Although densities of redband trout in Goose Lake basin were higher than other populations, the average weight of age 1+ fish was significantly less than that of other Great Basin SMUs (Dambacher et al. 2001). Explanations of this relationship are not available, however it does suggest productivity in the Goose Lake SMU is lower than in other basins. Five populations pass the productivity criterion (Table 4). Only three of these populations retain connection to Goose Lake, providing both high potential productivity and population interchange.

Table 4. Factors influencing productivity of Goose Lake SMU redband trout populations.

Population	Factors	Pass/Fail
Fall	Extremely limited distribution; low abundance; no connection to habitat capable of support a migratory life history.	Fail
Dry	Adequate distribution; high abundance; connection to Goose Lake potentially supports a migratory life history in wet years.	Pass
Lower Drews	Undocumented but likely limited distribution and abundance; connection to Goose Lake provides opportunity to express a migratory life history; degraded habitat quality.	Fail
Upper Drews	Distribution adequate but only occupies 9% of the stream habitat; abundance moderate; Drews Reservoir capable of producing large migratory fish; habitat degraded.	Fail
Antelope	Undocumented but likely limited distribution and abundance; connection to Goose Lake provides opportunity to express a migratory life history.	Fail
Muddy	Undocumented but likely limited distribution and abundance; not connected to Goose Lake but expression of an adfluvial life history possible in Muddy Reservoir.	Fail
Cottonwood	Adequate distribution; moderate abundance; adfluvial life history expressed in Cottonwood Reservoir; brook trout present.	Pass
Thomas-Bauers Complex	Widely distributed throughout diverse habitats; connectivity to habitats capable of producing adfluvial and fluvial life history, but barriers to migration exist during some seasons and years; habitats in lower reaches degraded.	Pass
Deadman	Limited distribution and abundance; passage to and from Goose Lake is questionable.	Fail
Crane	Adequate distribution and abundance; connection to Goose Lake provides opportunity to express a migratory life history.	Pass
Cogswell	Limited distribution and low abundance; connection to Goose Lake provides opportunity to express a migratory life history.	Fail
Tandy	Limited distribution and low abundance; no connection to Goose Lake due to irrigation diversion dams.	Fail
Kelley	Limited distribution and low abundance; connection to Goose Lake provides opportunity to express a migratory life history.	Fail

Reproductive Independence

Data specific to reproductive independence do not exist for the Goose Lake Redband Trout SMU. Instead this review used current and historical stocking records to evaluate the current risk of hatchery origin rainbow trout to native redband trout. A population passes the criterion if hatchery origin rainbow trout are not currently stocked within the population, and if any available genetic analyses reveal minimal evidence of mixing between hatchery and wild species.

Planting of a coastal stock of rainbow trout in Goose Lake Basin began in 1925 and continued through 1961 when stocking hatchery fish in moving waters ceased. Drews, Cottonwood, Thomas-Bauers, Crane, Cogswell, and Kelley populations were stocked at least once. There is no record of stocking in Antelope, Muddy, Tandy, Deadman, Dry, and Fall creeks. Cottonwood Meadows Reservoir is the only water body currently receiving a coastal stock of hatchery rainbow trout. A study conducted in 1995 and 1996 suggests there is very little movement of hatchery fish from Cottonwood Meadows Reservoir downstream to Cottonwood Reservoir. Hatchery fish are not considered a threat to the Cottonwood population (Bowers et al. 1999).

Effects of stocking rainbow trout are not certain; however recently collected specimens from Thomas, Lassen (CA), and Davis (CA) creeks appeared to be influenced by interbreeding with hatchery fish (Behnke 1992). Because hatchery rainbow trout are not currently stocked in

waterbodies with redband trout, all populations pass this criterion until the effect of hatchery rainbow can be genetically assessed.

Hybridization

Non-native cutthroat trout are not present in the Goose Lake Basin and not a threat to redband trout. All populations pass the hybridization criterion.

Assessment Conclusions

The Goose Lake Redband Trout SMU is comprised of thirteen populations. Six populations exist in the California, but are not assessed in this review. Spawning and resident fish distribution is fragmented and limited to headwater and mid-order streams. Abundance of redband trout fluctuates with instream flows and habitat quality. Migratory redband trout are present when rearing conditions in Goose Lake are adequate, though irrigation activities and degraded habitat quality hinder movement between the lake and the spawning grounds. Eighty percent of the populations meet three of the six interim criteria, thereby classifying this SMU as 'at risk'. (Figure 1). Limited data sets and inferences from other information for populations in this SMU provide a qualified level of confidence in the assessment of the interim criteria.

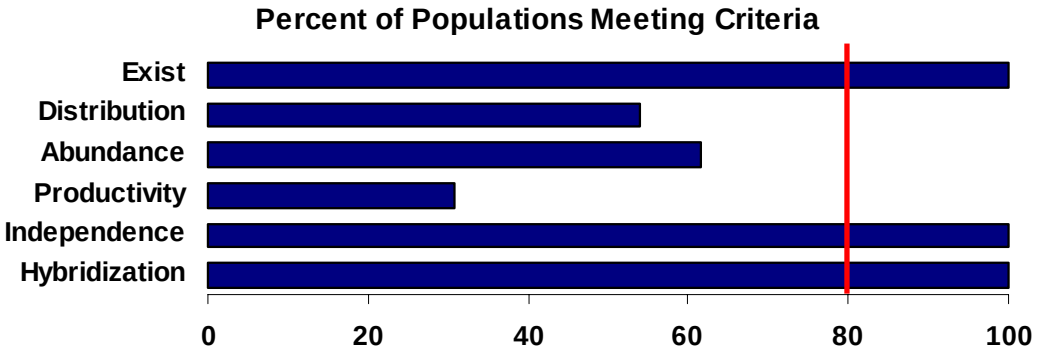

Figure 1. Assessment outcome for each of the six interim criteria with respect to the 80% threshold identified by the NFCP.