# Redband Trout

Redband trout are assessed using criteria similar to those designed for the anadromous salmon species. However, due to differences in ecology and life history and data limitations, metrics to assess the interim criteria are modified to more appropriately evaluate redband trout in the Oregon portion of the Great Basin. These modifications reflect the intent of each criterion and identify populations and SMUs at risk. Changes and substitutions are described below.

***Species Management Units and Populations***

Species Management Units for redband trout are defined as the major pluvial lake basins of the Great Basin. Redband trout within each lake basin are geographically isolated from populations in other SMUs and may be genetically distinct (Currens 1994, Behnke 1992). These basins coincide with ODFW management plans and the USFWS Status Review of Great Basin Redband Trout (2000). Populations identified in this status review were based on geography, movement and genetic data, Bowers et al. (1999), and reviews by ODFW staff.

***Existing Populations***

Assessment methods followed those outlined for anadromous salmon, and are based on whether a population is considered extinct or not at risk of extinction in the near future.

***Distribution***

Distribution of redband trout varies according to water year and annual fluctuation of instream flow. During drought years distribution constricts as streams dry and become uninhabitable. Trout re-colonize these streams during wet cycles, expanding the distribution. Where suitable habitat and water flow are available, redband trout are likely to be present.

The ability of a population to express multiple life history strategies is dependant on the extent of accessible high quality habitat. Access to a wide diversity of habitats including small streams suitable for spawning and large streams and lakes adequate for rearing large adults, provides a population with the opportunity to express a migratory life history. Populations that express both resident and migratory life histories have a greater ability to persist through drought years, (re)colonize new habitats, and mix with other populations.

The evaluation of the distribution criterion for anadromous species is based on either the current distribution or the accessible range as it compares to the historical. The historical distribution of redband trout is not well described and is difficult to determine given the hydrologic history of the Great Basin. In lieu of using the ratio of current to historical distribution, this review assesses each redband trout population based on the total stream distance it occupies, the percentage of the basin it occupies, and the degree to which it is isolated from other populations.

A small distribution will incorporate less diverse habitats and will not provide adequate refuge in the event of extreme environmental perturbation. In addition, populations with a limited distribution are less likely to sustain population abundance adequate to avoid the deleterious effects of inbreeding and genetic drift. A minimum distance of ten km is chosen as a cutoff to identify likely cases of extreme limitation. This cutoff is based on professional judgment of the minimum habitat below which managers should take note of population status. Dambacher and Jones (In Press) report average redband trout densities of 0.014 age 1+ fish/$m^2$. At these densities a population would require a minimum of ten km (assuming an average wetted-width of 2.5m (Dambacher and Jones In Press) to maintain a minimum abundance of 100 reproductive individuals. Similarly, a population that occupies less than 10% of the total stream distance within the population's watershed is considered reduced. We recognize the historic distribution

did not include all streams in the basin, but redband trout likely occupied a large portion of the wetted-stream distance in a watershed. The percentage of occupied stream distance for all Great Basin redband trout populations averages 16% (range 0 – 45%) (Flitcroft and Dambacher 2001) and the lowest quartile serves as the basis for this metric. This statistic serves as a red flag to identify populations in which distribution may be drastically constricted and warrants further investigation. Lastly, this review considers isolated populations at greater risk of extinction. Lack of regular and frequent connection between populations prevents genetic mixing, limits opportunities to express multiple life histories, increases risk of extinction due to stochastic events, and prevents recolonization in the event of extinction.

Thus, 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) regularly connect to other populations. In the absence of historical distribution data, we feel these measures are adequate to identify populations with a limited distribution and warrant further investigation.

It is important to note that many of the populations in the Great Basin redband trout SMUs are naturally isolated from other populations or large water bodies due to the drying of the pluvial lakes. A number of continuous high water years or even a change in climate may be required to reconnect these populations to others in an SMU.

The distribution criterion is assessed using a 1:100,000 GIS hydrography of redband trout distribution (Flitcroft and Dambacher 2001). The datalayer classifies stream reaches into six categories according to certainty of redband trout presence (Table 137). This review treats the 'presence – verified' (PV) and 'presence –opinion' (PO) categories as representative of current distribution. Populations are identified as isolated if reaches where redband trout are present are not connected to other populations by stream reaches classified as 'migratory corridors' (MC). The sum distance of all classifications represents the total stream distance within each population.

**Table 137. Classification of stream reaches according to certainty of redband trout presence. Bold = current distribution.**

| Classification | Definition |
|---|---|
| **PV** | Presence – verified |
| **PO** | Presence – opinion |
| MC | Migratory Corridor |
| AV | Absence – verified |
| AO | Absence – opinion |
| UN | Unknown |

This method provides a conservative evaluation of distribution. First, analyses were conducted using the 1:100,000 hydrography. Smaller tributary streams, where redband trout may be present during particularly wet cycles, are not included at this scale, potentially underestimating the extent of current distribution. Second, the total stream distance does not reflect habitable distance or historical distribution; each is less than total stream distance.

### *Abundance*

Data describing the absolute abundance of redband trout populations over the last 30 years do not exist, therefore minimum thresholds for each population cannot be calculated as they are for salmon and steelhead. 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) (Table 138). The benchmarks were developed using the interquartile values of density from pre-1998 samples in Crooked River and Catlow Valley Basin streams. 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.

**Table 138. Density benchmarks for age 1+ redband trout in eastern Oregon (Dambacher and Jones In Press).**

| Abundance Rating | Fish/ $m^2$ |
|---|---|
| Low | $\leq 0.059$ |
| Moderate | 0.06 - 0.19 |
| High | $\geq 0.20$ |

Mean density estimates are intended to be an approximate indicator of abundance. Density within a population varies widely and fluctuates with water year and habitat condition. Water years 1998 and 1999 were particularly wet with above average precipitation and snowpack. Conversely, 1994 and 2003 were extremely dry years. Fluctuations in precipitation between years were considered when evaluating abundance and trends of redband trout. Low densities may be attributed to a dry year, however low densities during a wet cycle are a cause for concern.

All density estimates included in the assessment were made using depletion-removal methods (Zippen 1958). At a minimum, sample sites were block-netted and a two-pass removal procedure was followed with backpack electrofisher and a 50% reduction criterion between passes for 1+ redband trout. Not all sample sites were randomly selected, therefore density estimates may not be representative of the population. In all cases, mean estimates are an average of individual density estimates and are not extrapolated to total stream area.

***Productivity***

Data are not available to quantitatively assess productivity as designed for salmon and steelhead. To provide a general assessment of potential productivity, this review considers current distribution and abundance, regular (1-5 yrs.) connectivity within and between populations, life history strategies, habitat quality, and the presence of non-native species or hatchery fish of the same species. In the absence of quantitative data, this assessment of the productivity criterion is purely qualitative and based on conjecture and professional judgment.

A population's intrinsic productivity, the capacity to rebound quickly after a period of environmental constraint (e.g., drought, habitat degradation), depends on its ability to increase in abundance, re-colonize historical habitat, and exploit new habitats. A population that maintains multiple life history strategies during periods of environmental constraint has a greater potential for locating and re-colonizing habitats quickly. Large, migratory adult fish are highly fecund, further increasing the potential productivity. In addition, habitat quality and quantity also influences the intrinsic productivity of a population. Extensive high quality habitat buffers extreme environmental conditions. Populations with adequate and well-distributed refuge habitat can respond quickly to improving environmental conditions, increasing the probability that distribution and abundance will rebound quickly. Populations that persist in low quality

habitat may also likely rebound in improving environmental conditions, but may not re-colonize historic habitat, or attain high levels of abundance.

A population that is widely distributed and exhibits high densities is assumed to have minimally rebounded from past drought or disturbance events. Connectivity to high quality refuge habitats capable of supporting multiple life history types during periods of extreme environmental conditions enables populations to rebound quickly. 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) maintains multiple life history strategies, 3) is widely distributed, and, 4) relatively abundant. A population may also pass the criterion if data 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, hatchery fish, or significant habitat degradation may negatively affect productivity and cause a population to fail the criterion. In many populations the intrinsic potential productivity is uncertain; these populations fail the criterion until productivity can be adequately assessed.

We acknowledge that including measures of distribution and abundance may be redundant with other criteria, however given the lack of adequate data pertaining to this criterion, these data present the best surrogate. In light of this, the assessment of the productivity criterion gives greater weight to life history, habitat quality, and presence of non-native species.

***Reproductive Independence***

Data specific to reproductive independence and the potential influence of hatchery fish do not exist for many populations of Great Basin redband trout. This review uses current and historical stocking records to evaluate current risk of hatchery origin rainbow trout to populations of native redband trout. Populations where hatchery rainbow trout are currently stocked fail the reproductive independence criterion. In most cases the effect of interbreeding between wild redband trout and hatchery rainbow trout are uncertain. In some instances genetic and meristic studies describe the degree of introgression between stocks in specific locales. In these cases, a population passes the criterion if analyses show introgression is minimal.

***Hybridization***

A population is considered to pass the hybridization criterion if redband trout x cutthroat trout hybrids are rare (hybridized individuals comprise <5% of the population) or non-existent. We recognize the challenges associated with field identification of hybridized individuals and the potential for error. Estimates provided in this review represent the minimum number of hybrids present. For many populations the degree of hybridization is not quantified, but professional judgment and the frequency of hybrids encountered during sampling indicates the degree of hybridization in each population. In cases where information specific to hybridization is not available, a population fails the hybridization criterion if non-native cutthroat trout are documented as sympatric with native redband trout.

# Malheur Lakes Redband Trout

### *Existing Populations*

The Malheur Lakes basin is the largest of the Oregon desert basins and contains the most diverse and greatest amount of trout habitat (Behnke 1992). Malheur and Harney lakes are remnants of pluvial Lake Malheur, which dried approximately 8,000 years ago. Three major stream systems flow into Harney and Malheur lakes. The Silvies River, in the north, drains into Malheur Lake from the forested Blue Mountains. The Donner und Blitzen River, in the south, drains the sagebrush dominated communities of the Steens Mountain. The Silver Creek system originates at lower elevations on Snow Mountain and drains into the highly alkaline Harney Lake. The upland and mountain reaches are typically cold, swift streams with rocky bottoms, and the lower reaches are slow and warm in summer with sandy and muddy substrates (Bisson and Bond 1971).

The Malheur Lakes Redband Trout SMU is comprised of ten populations (Table 1). One exists in each of the three major stream systems, Silver, Silvies, and Blitzen. Six small populations exist in isolated creeks that dissipate onto the valley floor in the northeast and southeast regions of the basin. Rattlesnake, Cow, Coffeepot, Prater and Poison creeks drain King Mountain and Riddle Creek drains the North Steens Mountain. McCoy Creek contains a small population that has a one way connection to the Donner und Blitzen River. Populations are identified based on Bowers et al. (1999) and review by ODFW staff biologists.

**Table 1. Description, existence status, and life history of redband trout populations in the Malheur Lakes SMU.**

| Exist | Population | Description | Life History |
|---|---|---|---|
| Yes | Silver | Silver Creek Basin. | Resident |
| Yes | Silvies | Silvies River Basin. | Resident |
| Yes | Poison | Poison Creek and tributaries. | Resident |
| Yes | Prater | Prater Creek. | Resident |
| Yes | Coffeepot | Coffeepot Creek. | Resident |
| Yes | Rattlesnake | Rattlesnake Creek. | Resident |
| Yes | Cow | Cow Creek. | Resident |
| Yes | Riddle | Riddle and Smyth Creeks and tributaries. | Resident |
| Yes | McCoy | McCoy, Cucamonga, and Kiger creeks plus tributaries. | Resident |
| Yes | Blitzen | Donner und Blitzen River and tributaries, Mud and Bridge creeks. | 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.

Redband trout in the Malheur Lakes Basin are widely distributed in small and medium size streams. Many of the mainstem habitats are not within the year around distribution of redband trout (Dambacher et al. 2001). Movement of fish between populations is severely limited by

warm water temperatures, barriers, and low flow conditions particularly in the summer. Redband trout in eight of the ten populations do not have access to other populations (Table 2) and, as a result, are considered to be at a greater risk of extinction due to stochastic events and lack of genetic mixing. During low water years fish in Silvies River are unable to access Malheur Lake and other populations due to diversion dams and periodic drying of stream sections due to irrigation withdrawal (Bowers et al. 1999). The Silver population is isolated by the dam at Moon Reservoir (Bowers et al. 1999). Populations in Poison, Prater, Coffeepot, Rattlesnake, Cow and Riddle creeks are naturally isolated from other populations. These streams are not connected to other systems and dissipate onto the valley floor. An unusually long wet cycle or change in climate may be necessary to reestablish connectivity between these populations.

The McCoy population is isolated from the Blitzen population by an impassable culvert (Bowers et al. 1999). Redband trout from the McCoy population can move into and mix with the Blitzen population, but cannot return to natal spawning grounds in McCoy or Kiger creeks.

Detailed distribution data are not available for redband trout in Coffeepot and Prater creeks, however very limited and sporadic sampling indicates distribution is limited (ODFW, Aquatic Inventory Project, unpublished data; ODFW, Hines field office, unpublished data). These populations are considered to occupy less than ten km of stream distance until actual distribution can be quantified. Given these streams are naturally isolated and distribution is undetermined, both populations fail the distribution criterion (Table 2).

**Table 2. Distance of current distribution, total stream distance in each basin, percent of each basin occupied, and presence of migratory corridors for redband trout populations in the Malheur Lakes SMU (Flitcroft and Dambacher 2001).**

| Population | Current (km) | Total Basin Distance (km) | % Occupied | Connected to Other Pops. | Pass/Fail |
|---|---|---|---|---|---|
| Silver | 222.4 | 619.5 | 35.9 | No | Pass |
| Silvies | 546.8 | 2630.0 | 20.8 | Yes | Pass |
| Poison | 30.7 | 213.2 | 14.4 | No | Pass |
| Prater | -- | 63.2 | -- | No | Fail |
| Coffeepot | -- | 27.2 | -- | No | Fail |
| Rattlesnake | 16.6 | 57.2 | 29.1 | No | Pass |
| Cow | 17.7 | 133.7 | 13.2 | No | Pass |
| Riddle | 73.0 | 465.2 | 15.7 | No | Pass |
| McCoy | 174.1 | 649.0 | 23.7 | No | Pass |
| Blitzen | 255.6 | 1078.2 | 17.8 | Yes | Pass |

### *Abundance*

Data describing the abundance of constituent populations of the Malheur Lakes Redband Trout SMU do not exist. 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 average density is classified as 'moderate' or 'high' in three of the previous five years. Populations with a 'low' rating fail the criterion and are warranted for further investigation. When density estimates for the last five years are not available, the criterion was applied to those years for which data are present. Of the ten populations, Prater and Cow populations fail the abundance criterion (Table 3).

**Table 3. Mean density, age 1+ fish/m$^2$ (number of samples), of redband trout populations each year sampled and predominant assessment (Dambacher and Jones In press).**

| Population | 1998 | 1999 | 2000 | 2001 | 2003 | Assessment | Pass/Fail |
|---|---|---|---|---|---|---|---|
| Silver | 0.243 (41) | 0.169 (5) | -- | -- | 0.084 (38) | Moderate | Pass |
| Silvies | -- | 0.294 (46) | 0.347 (41) | 0.445 (24) | -- | High | Pass |
| Poison | -- | 1.037 (3) | -- | -- | -- | High | Pass |
| Prater | -- | -- | -- | -- | -- | -- | Fail |
| Coffeepot | -- | -- | -- | -- | -- | -- | Pass |
| Rattlesnake | 0.387 (2) | -- | -- | 0.710 (2) | 0.202 (2) | High | Pass |
| Cow | -- | -- | -- | -- | -- | -- | Fail |
| Riddle | -- | 0.435 (2) | -- | -- | -- | High | Pass |
| McCoy | -- | 0.186 (6) | -- | -- | -- | Moderate | Pass |
| Blitzen | 0.097 (9) | 0.112 (3) | -- | -- | -- | Moderate | Pass |

*No data were collected in 2002.*
*Data collected by ODFW and USFS.*

Density measures are not available for Prater, Cow and Coffeepot populations. A 1994 survey targeting Malheur mottled sculpin in Prater and Cow creeks did not find redband trout (ODFW, Aquatic Inventory Project, unpublished data). Other anecdotal observations indicate redband trout abundance in these streams is depressed (T. Walters, ODFW Hines field office, pers. comm..). Based on these few observations both populations fail the abundance criterion until abundance can be assessed (Table 148).

Sampling of redband trout in Coffeepot Creek was conducted in 2001 (ODFW, Hines field office, unpublished data), but efforts failed to produce a density estimate. However, the number and size distribution of fish captured were similar to that of nearby sample sites in Poison and Rattlesnake creeks. Based on these similarities we assume density and abundance in Coffeepot Creek reflects that of Poison and Rattlesnake, and therefore the Coffeepot population passes the abundance criterion. Further field investigation is necessary to better assess status of this population.

Using a probability sample design, ODFW conducted an SMU level population estimate of redband trout in 1999 in the Malheur Lakes basin (Dambacher et al. 1999). Population and density estimates were conducted at 30 randomly selected, spatially balanced sample sites throughout the SMU. Redband trout were estimated at 414,551 +/- 43% (95% CI) age 1+ individuals. The large confidence interval suggests a wide range of fish densities were sampled and reflects the variable status among populations in the SMU. Overall mean density (0.156 age fish/m$^2$) is moderate relative to densities through out eastern Oregon, though half of the Malheur Lake populations exhibited high densities. These estimates were made during high water years and are expected to fluctuate with habitat quality and instream flows.

### *Productivity*

Data are not available to quantitatively assess productivity and the intrinsic potential population increase for redband trout in the Malheur Lakes 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 or disturbance events. Connectivity to high quality refuge habitats capable of supporting multiple life history types during periods of extreme environmental conditions enables populations to rebound quickly. 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 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, hatchery fish, or significant habitat degradation may negatively affect productivity and cause a population to fail the criterion. In many populations the intrinsic potential productivity is uncertain; these populations fail the criterion until productivity can be adequately assessed. Only the Blitzen population exhibits a migratory life history and passes the productivity criterion (Table 4).

**Table 4. Factors influencing productivity of the Malheur Lakes SMU redband trout populations.**

| Population | Factors | Pass/Fail |
|---|---|---|
| Silver | Widely distributed and moderately abundant; migratory life history appears to be absent -- movement to and from Moon Reservoir has not been documented; poor habitat conditions in portions of the basin (Bowers et al. 1999); presence of non-native species. | Fail |
| Silvies | Widely distributed; moderately abundant; migratory life history not documented and connection to Malheur Lake is assumed not possible due to impassable irrigation diversions (Bowers et al. 1999); although large fish have been observed in this population the fluvial component is not considered large enough to significantly enhance productivity; mainstem habitats inhospitable during summer months (Bowers et al. 1999); presence of non-native species. | Fail |
| Poison | Exhibits high density; small to moderate distribution; resident life history; although large fish have been observed in this population the migratory component is not considered large enough to significantly enhance productivity. | Fail |
| Prater | Abundance and distribution not documented but assumed to be extremely limited; not connected to other populations and habitats capable of producing large migratory individuals. | Fail |
| Coffeepot | Limited distribution; undocumented abundance; no connection to habitats capable of producing large migratory individuals. | Fail |
| Rattlesnake | Exhibits high density; small to moderate distribution; resident life history; although large fish have been observed in this population the fluvial component is not considered large enough to significantly enhance productivity. | Fail |
| Cow | Small distribution; abundance undocumented; not connected to other populations and habitats capable of producing large migratory individuals. | Fail |
| Riddle | Moderate distribution and abundance; not connected to other populations or habitats capable of supporting a migratory life history. | Fail |
| McCoy | Adequate distribution and abundance; isolated from the Blitzen River by an impassable culvert; a few unconfirmed anecdotal reports of large fluvial individuals have been reported in this population but the fluvial component is not considered large enough to significantly enhance productivity | Fail |
| Blitzen | Wide distribution among diverse habitats; moderate densities; migratory life history with connection to Malheur Lake and large rivers; potential mixing with the McCoy population. | Pass |

Large migratory fish are only captured regularly from the Donner und Blitzen population where they have periodic access to Malheur Lake and regular connection to the lower river (USFWS, Malheur National Wildlife Refuge, unpublished data). Movement in the lower reaches of the Donner und Blitzen populations is hindered by irrigation weirs, dams and poor water quality; however the Malheur National Wildlife Refuge has recently placed ladders on dams to help facilitate passage. The regular expression of a migratory life history ensures large fish return to

the natal spawning grounds. These large individuals are highly fecund and contribute significantly to productivity of the population.

***Reproductive Independence***

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

Extensive planting of a non-native rainbow stock occurred historically throughout the Malheur Lakes basin. However, planting of hatchery rainbow in rivers and streams has been discontinued. The stocking program ceased in 1973 in the Silver, 1992 in the Blitzen, and 1993 in the Silvies basins. Water bodies currently planted with a coastal rainbow stock are Krumbo Reservoir, Fish Lake and BLM stock ponds in the Blitzen River Basin, Yellowjacket Lake in the Silvies River, and Delinament Lake, and Moon and Chickahominy reservoirs in the Silver Creek basin. Few fish are thought to be able to escape from these water bodies.

Evidence of introgression of wild redband trout with hatchery rainbow trout (coastal lineage) in populations of the Malheur Lakes SMU appears to be minimal. Genetic studies have occurred in streams of the Blitzen, McCoy, and Silvies populations. No strong evidence of introgression appears in the Blitzen population, specifically in Bridge and Mud creeks (Currens et al. 1990a). The contribution of hatchery rainbow trout was found to be approximately 0.6% in McCoy Creek and 4.9% in Kiger Creek (Phelps et al. 1996). Moderate levels of introgression with hatchery fish was noted in genetic studies in Emigrant and Nicol creeks (Williams and Shiozawa 1992) and on the mainstem Silvies near historical stocking sites (Hosford and Prybil 1991). Rainbow trout in Krumbo Reservoir are considered as most likely derived from Oak Springs hatchery stock (Currens et al. 1990b), however fish are thought to be unable to escape from this water body and do not mix with native wild populations.

Because hatchery fish are no longer stocked into moving waters in the SMU and only minimal evidence of introgression exists, all populations pass the reproductive independence criterion.

***Hybridization***

Cutthroat trout are not present in the Malheur Lakes SMU and therefore are not a threat to redband trout populations. All populations pass the hybridization criterion.

***Assessment Conclusions***

The Malheur Lakes Redband Trout SMU is comprised of ten populations in the closed interior basin of Harney and Malheur lakes. Historically, all streams were interconnected and fish could move to the lakes and among populations. Currently, populations are isolated by natural and manmade barriers. Only the Blitzen population is known to express a migratory life history. Redband trout in the SMU are widely distributed in small and medium sized streams and moderately abundant during high water years. The SMU meets five of the six interim criteria and is classified as 'potentially at risk' (Figure 32). 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.

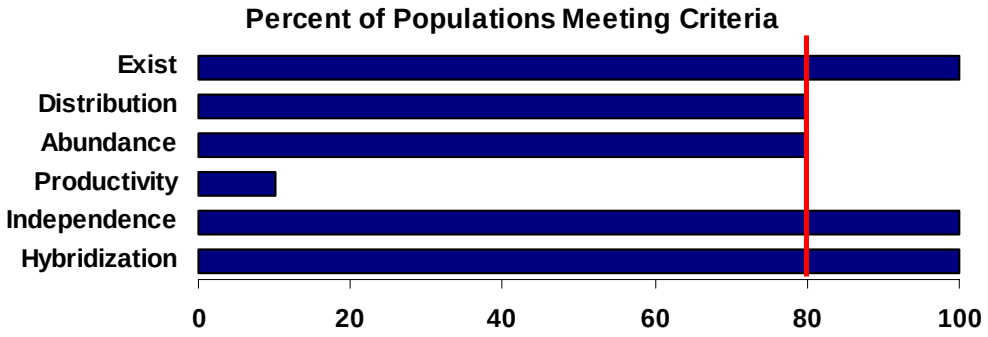


**Figure 32. Assessment outcome for each of the six interim criteria with respect to the 80% threshold identified by the NFCP.**

# Catlow Valley Redband Trout

### *Existing Populations*

The Catlow Valley Redband Trout SMU is comprised of five populations (Table 1). Three exist in Home, Threemile, and Skull creeks, located on the east side of the valley. These populations drain the Catlow Rim on the west side of South Steens Mountain. Two populations exist on Hart Mountain on the west side of Catlow Valley in Rock and Guano creeks. Rock Creek flows north into the valley and Guano Creek flows south off Hart Mountain and eventually north through Catlow Slough to Catlow Valley. All streams historically flowed into pluvial Lake Catlow before it dried 10,000 years ago.

**Table 1. Description, existence status, and life history of redband trout populations in the Catlow Valley SMU.**

| Exist | Population | Description | Life history |
|---|---|---|---|
| Yes | Home | Home Creek and tributaries. | Resident |
| Yes | Threemile | Threemile Creek. | Resident |
| Yes | Skull | Skull Creek and tributaries. | Resident |
| Yes | Rock | Rock Creek and tributaries. | Resident/migratory |
| Yes | Guano | Guano Creek. | Resident |

This review identifies Guano as an existing redband trout population. Some controversy exists over whether redband trout are native to the system. Mention of native trout in historical documents does not specify species (OSGC 1957), however the biogeography and zoological history of Catlow Valley suggest redband trout may be the original and native trout species. Tui chub were documented in Guano Creek as well as the other streams in Catlow Valley where redband trout are also present (Williams and Bond 1981, Hubbs and Miller 1948). This review considers redband trout to be the native salmonid species in Guano Creek until genetic studies and other research can clarify the zoological history of the creek. Currently, Lahontan cutthroat trout and cutthroat x redband trout hybrids occupy Guano Creek and the presence of redband trout is uncertain. Limited population surveys occurred in 1992 and 1995, the later targeting Tui chub (ODFW, Aquatic Inventory Project, unpublished data). Neither survey documented redband trout. If redband trout are present in the basin the distribution and abundance are severely limited. The population will not be considered extinct until a thorough and appropriate survey is conducted.

### *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. Guano, Threemile, and Skull populations did not meet any of the three metrics and failed the distribution criterion (Table 2). Rock and Home populations occupy greater than ten km of habitat and 10% of the stream distance within their respective basins and pass the criterion.

**Table 2. Distance of current distribution, total stream distance in each basin, percent of each basin occupied, and presence of migratory corridors for redband trout populations in the Catlow Valley SMU (Flitcroft and Dambacher 2001).**

| Population | Current (km) | Total Basin Distance (km) | % Occupied | Connected to Other Pops. | Pass/Fail |
|---|---|---|---|---|---|
| Home | 37.1 | 81.0 | 45.8 | No | Pass |
| Threemile | 3.5 | 38.6 | 9.0 | No | Fail |
| Skull | 3.5 | 90.6 | 3.8 | No | Fail |
| Rock | 24.7 | 183.4 | 13.5 | No | Pass |
| Guano | 0.0 | 209.6 | 0.0 | No | Fail |

Even though redband trout are present in most perennial streams in Catlow Valley, the distribution is highly fragmented (Table 2). Connection does not exist between any populations, which prevents genetic mixing, limits opportunities to express a migratory life history, and increases risk of extinction from stochastic events. Rock and Guano creeks have been isolated from other populations since the drying of pluvial Lake Catlow 10,000 years ago. Due to this extended isolation, redband trout in Rock Creek are thought to be genetically unique (Bowers et al. 1999). In recent history, Catlow Marsh (Garrison Lake) was drained for agricultural purposes isolating Skull, Threemile, and Home creeks. Reconnection to Garrison Lake and other populations may require consecutive high water years or a change in climate.

Access to lakes and larger water bodies where a migratory life history may be expressed is available only during high water years in Rock Creek, Threemile Creek, and Skull Creek. Redband trout in Rock Creek have periodic access to Rock Creek Reservoir; however their ability to return to spawning grounds is uncertain (Bowers et al. 1999). Redband trout in Threemile Creek have access to Threemile Reservoir when water quality and flow are adequate. In 1998 a fish screen was installed on Threemile Creek and Threemile Reservoir was reconstructed to ensure access to the reservoir during high water years. In 1999 passage was provided from Skull Creek Reservoir, high in the watershed, to the upper reaches of Skull Creek.

Distribution of redband trout in Guano Creek is undetermined. Redband trout were not detected during surveys in 1992 (six sites) and 1995 (five sites) (ODFW, Aquatic Inventory Project, unpublished data). Stream reaches of Guano Creek were classified as absent – based on opinion by local biologists (Flitcroft and Dambacher 2001). However, anecdotal information suggests native redband trout are present in Guano Creek, and if so, then distribution is likely limited and highly fragmented.

### *Abundance*

Data describing the abundance of constituent populations of the Catlow Valley Redband Trout SMU do not exist. 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 average density is classified as 'moderate' or 'high' in three of the previous five years. Populations with a 'low' rating 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. Guano and Skull populations fail the abundance criterion (Table 3).

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

| Population | 1995 | 1997 | 1999 | Assessment | Pass/Fail |
|---|---|---|---|---|---|
| Home | | | 0.10 (16) | Moderate | Pass |
| Threemile | 0.05(23) | | 0.21 (3) | High | Pass |
| Skull | 0.0 (19) | 0.12 (3)* | 0.04 (1) | Low | Fail |
| Rock | | | 0.78 (13) | High | Pass |
| Guano | | | | -- | Fail |

** Extrapolated from presence/absence techniques (Dambacher and Jones In Press).*
*Data collected by ODFW.*

Redband trout density and abundance in Threemile Creek has decreased significantly within the past 30 years. During the mid-1970s the stream population was estimated to be 1,700 age 1+ redband trout, with densities as high as 1.5 fish/m$^2$. The number of fish estimated in Threemile Reservoir was 890 age 1+ individuals (Kunkel 1976). In 1995, the population in Threemile Creek was estimated to total 265 age 1+ fish (+/- 41%, 95% CI) (Dambacher and Jones In Press). No redband trout were found in the reservoir and no migratory fish were observed. Basinwide surveys in 1999 found an average density of 0.21 age 1+ fish/m$^2$ (n = 3) in Threemile Creek. The Threemile population passes the abundance criterion, based on the relatively high densities observed within a very limited distribution during the 1999 survey (Table 3). However, this survey was conducted during high water years, and given current habitat conditions the Threemile Creek population is expected to decrease significantly during drought cycles.

Abundance of redband trout in Skull Creek is extremely low (Table 3). Repeated sampling efforts have detected few individuals; zero in 1995 (n = 19), 16 in 1997 (n = 3), and three in 1999 (n = 1). The population was estimated at 250 - 500 individuals in a two mile reach in 1997 (Dambacher and Jones In Press). Because abundance and densities are consistently low, even during high water years, Skull Creek fails the abundance criterion.

Similarly, the density and abundance of redband trout in Guano Creek is thought to be perilously low. Presence/absence surveys in Guano Creek did not detect redband trout in 1992 and 1995 (ODFW, Aquatic Inventory Project, unpublished data). The Guano population fails the abundance criterion until abundance is appropriately documented.

Using a probability sample design, ODFW conducted an SMU level population estimate of redband trout in 1999 in the Catlow Valley basin (Dambacher et al. 2001). Population and density estimates were conducted at 33 randomly selected, spatially balanced sample sites throughout the SMU. Redband trout were estimated at 54,866 +/- 33% (95% CI ) age 1+ individuals. Average density among the sites was 0.423 age 1+ /m$^2$ (moderate). The large confidence interval suggests density varies widely among sample sites.

### *Productivity*

Data are not available to quantitatively assess productivity and the intrinsic potential population increase for redband trout in the Catlow Valley 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 or disturbance events. Connectivity to a diversity of high quality habitats capable of supporting multiple life history types during extreme environmental conditions enables population to rebound quickly. 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

environment constraint, 2) expresses multiple life history strategies, 3) is widely distributed, and 4) relatively abundant. A population may also pass the criterion if data 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, hatchery fish, or significant habitat degradation may negatively affect productivity and cause a population to fail the criterion. In many populations the intrinsic potential productivity is uncertain; these populations fail the criterion until productivity can be adequately assessed.

Habitat surveys in Catlow Valley streams documented the best habitat was limited to canyon reaches and areas with cold spring water input (Dambacher and Stevens 1996, Dambacher and Jones In Press, Bowers et al. 1999). Although these areas act as refuge during drought cycles, the high gradient reaches are less than ideal habitats, which limits the intrinsic productivity. These populations will likely respond slowly to improved environmental conditions. Only the Rock Creek population passes the productivity criterion based on data that demonstrate redband trout quickly re-colonized available stream habitat at high densities during a wet year (Table 4).

**Table 4. Factors influencing productivity of Catlow Valley SMU redband trout populations.**

| Population | Factors | Pass/Fail |
|---|---|---|
| Home | Distribution adequate; abundance moderate; not connected to habitat capable of supporting a migratory life history; portions of habitat highly degraded (Bowers et al. 1999, Dambacher and Stevens 1996) – actions to improve habitat quality are being implemented (USFWS 1997) but fish and habitat response has not been documented. | Fail |
| Threemile | Extremely limited distribution and abundance; lacks a migratory life history; portions of habitat highly degraded (Bowers et al. 1999, Dambacher and Stevens 1996) – actions to improve habitat quality are being implemented (USFWS 1997) including reconnecting the stream to Threemile Reservoir but fish and habitat response has not been documented. Comparisons of abundance between 1970s and 1990s indicate a negative trend in abundance (Kunkel 1976, Dambacher and Jones In Press). | Fail |
| Skull | Extremely limited distribution and low abundance; a migratory life history has not been documented; data suggests productivity may be episodic, resulting in a discontinuous age class structure (Dambacher and Jones In Press); numerous habitat improvement projects completed under the USFWS Conservation Agreement (USFWS 1997) including passage at Skull Creek Reservoir – fish and habitat response to these projects has not been documented. | Fail |
| Rock | Distribution and abundance high; surveys show recolonization of habitat during high water years with large fish at high density (Dambacher et al. 2001, ODFW Aquatic Inventory Project, unpublished data); land management changes on Hart Mountain Antelope Refuge has improved habitat condition. | Pass |
| Guano | Distribution and abundance is not documented, but likely extremely limited; no evidence of natural production of redband trout. | Fail |

***Reproductive Independence***

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

Stocking of hatchery origin rainbow trout has not occurred in Threemile, Skull, and Home creeks. Hatchery rainbow trout were stocked regularly in Rock Creek between 1960 and 1979, and in Guano Creek during the 1960s (ODFW, historical stocking records). Stocking activities ceased in 1979. The effects of stocking on native populations are uncertain, although genetic analysis of samples collected in Guano Creek in 2004 is currently in progress. Because hatchery fish are no longer stocked and the SMU is managed for natural production, all populations pass the reproductive independence criterion.

***Hybridization***

A population is considered to pass the hybridization criterion if cutthroat trout x redband trout hybrids are rare (<5% of the population) or non-existent. We recognize the challenges associated with field identification of hybridized individuals and the potential error. Estimates provided here represent the minimum number of hybrids present. For most populations the degree of hybridization is not quantified, but professional judgment and the frequency of hybrids encountered during sampling provides a general indication. In cases where little or no information is available and cutthroat trout and redband trout are sympatric, we assume hybrids are common.

Interspecific hybridization with Lahontan cutthroat trout is a significant threat to redband trout in Guano Creek. Lahontan cutthroat trout were stocked in 1957, 1969, and 1973 and were captured regularly during presence/absence surveys in 1992 (ODFW, Aquatic Inventory Project, unpublished data). Hybrids were not documented during sampling, but records of 'unknown trout' were likely hybrids (ODFW, Aquatic Inventory Project, unpublished data). Since then numerous reports of hybrids have been reported (K. Jones, ODFW Aquatic Inventory Project, pers. comm..). Tissue samples from fish in Guano Creek were collected in 2004 genetic analysis of hybridization. Guano Creek fails the hybridization criterion until analysis can better describe the extent of hybridization. Cutthroat trout are not present in the other Catlow Valley populations and these populations pass the criterion.

***Assessment Conclusions***

The Catlow Valley Redband Trout SMU includes five populations in the closed interior basin of Catlow Valley. Even though redband trout are present in most perennial streams in Catlow Valley, the distribution is highly fragmented. Connection does not exist between any populations, which prevents genetic mixing, limits opportunities to express a migratory life history, and increases risk of extinction from stochastic events. Densities fluctuate accordingly with water years, although Skull and Guano populations appear extremely depressed in all conditions. The Guano population is also potentially threatened by hybridization with cutthroat trout. Eighty percent of the populations met 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.

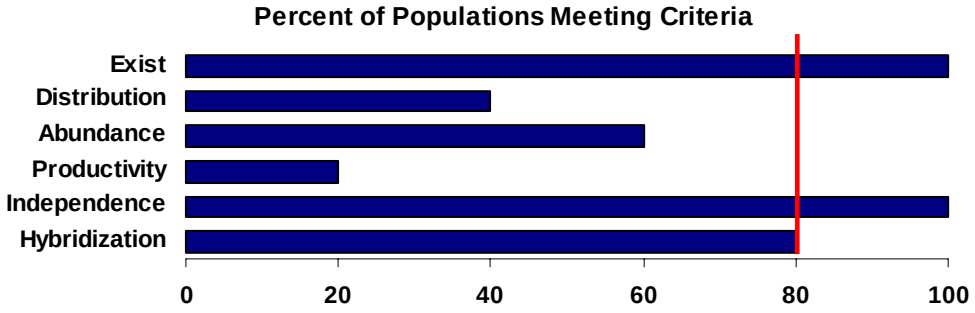


**Figure 1. Assessment outcome for each of the six interim criteria with respect to the 80% threshold identified by the NFCP.**

# Warner Lakes Redband Trout

### *Existing Populations*

Warner Valley is an endorheic basin that contains a complex series of interconnected lakes, marshes, sloughs, and potholes, all of which are remnants of pluvial Lake Warner. The headwaters of Warner Valley drains the Warner Mountains through three major subbasins. Each subbasin is occupied by a redband trout population. Deep Creek flows into Pelican Lake and Crump Lake. A barrier falls splits Deep Creek into Upper and Lower Deep populations. Honey Creek flows into Hart Lake and Twentymile Creek flows into Greaser Reservoir. Populations were identified based on Bowers et al. (1999) and reviews by ODFW staff (Table 1).

**Table 1. Description, existence status, and life history of redband trout populations in the Warner Lakes SMU.**

| Exist | Population | Description | Life History |
|---|---|---|---|
| Yes | Honey | Honey Creek and tributaries, including Camas Creek. | Resident/Migratory |
| Yes | Lower Deep | Deep Creek downstream of Deep Cr. Falls. | Resident/Migratory |
| Yes | Upper Deep | Deep Creek and tributaries upstream of Deep Cr. Falls. | Resident |
| Yes | Twentymile | Twentymile and Twelvemile Creeks & tributaries. | Resident/Migratory |

For the purpose of this review Lower Deep is identified as a distinct population, although it is uncertain if it functions as an independent population. Fingerlings and adfluvial adults have been captured below the falls and in Pelican and Crump lakes and are assumed to have originated below Deep Creek Falls (C. Edwards, ODFW Lakeview field office, pers. comm.). There is a possibility that some or all of these individuals originated from the Upper Deep population.

### *Distribution*

Redband trout appear to be distributed throughout the perennial streams and lakes of Warner Valley as conditions permit. Distribution of redband trout varies according to water years and annual fluctuation of instream flows. During drought years distribution constricts as streams and lakes dry and become uninhabitable. Trout re-colonize these streams during wet cycles, re-expanding the distribution. Many of the large lakes in Warner Valley dried in 1992 and redband trout were found in the lakes before and after the dry period (USFWS 1998).

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. Only the Lower Deep population fails the distribution criterion (Table 2).

**Table 2. Distance of current distribution, total stream distance in each basin, presence of each basin occupied,and presence of migratory corridors for redband trout populations in the Warner Lakes Rdband Tout SMU.**

| Population | Current (km) | Total Basin Distance (km) | % Occupied | Connected to Oher Pps. | Pass/ Fail |
|---|---|---|---|---|---|
| Honey | 82.9 | 410.6 | 20.0 | Yes | Pass |
| Lower Deep | -- | 15.5 | -- | Yes | Fail |
| Upper Deep | 141.7 | 561.1 | 25.2 | No | Pass |
| Twentymile | 41.2 | 171.9 | 24.0 | No | Pass |

Current year around distribution of the Lower Deep population is not quantified (Table 2), but is thought to be limited. The lower reaches of Deep Creek are channelized with little or no riparian buffer to provide habitat and minimize impacts from high flow events. A high gradient canyon reach, approximately five provides limited spawning habitat but contain deep, well oxygenated pools. These pools serve as refuge to redband trout from high summer water temperatures in the lower reaches (R. Smith, ODFW Klamath Falls district office, pers. comm..).

Redband trout in Honey, Lower Deep, and Twentymile populations have access to the Warner Lakes and express multiple life histories; however, passage to the lakes is hindered by numerous irrigation diversions. Water year and climactic conditions determine stream flow and irrigation needs, which in turn, influence the migratory success of redband trout between the lakes and upper stream reaches. Honey Creek contains eight diversions, Deep Creek contains two diversions, and Twentymile Creek contains three diversions (R. Smith, ODFW Klamath Falls district office, pers. comm..).

Inter-population connection, although very limited, is possible between two of the four populations. Hydrologic connection is maintained between Crump and Hart lakes during adequate water years, giving Honey and Lower Deep populations the opportunity to mix. The Twentymile population is likely isolated from other populations in the SMU; only in very high water years could large migratory redband trout possibly ascend the concrete diversion dam in the lower river (W. Tinniswood, ODFW Klamath district office, pers. comm.). Deep Creek Falls is a fish barrier that isolates the Upper Deep population. Both populations lack the opportunity for genetic mixing which puts them a greater risk of extinction due to the effects of inbreeding if the populations become very small.

***Abundance***

Data describing the abundance of constituent populations of the Warner Lakes Redband Trout SMU are lacking. 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 average density is classified as 'moderate' or 'high' in three of the previous five years. Populations with a 'low' rating 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.

Using a probability sample design, ODFW conducted an SMU level population estimate of resident redband trout in 1999 in the Warner Valley basin (Dambacher et al. 2001). Population and density estimates were conducted at 24 randomly selected sample sites throughout the SMU, although the lower reaches were not adequately represented (Dambacher et al. 2001). Redband trout in the SMU were estimated at 172,240 +/- 31% (95% CI ) age 1+ individuals. Average density among all sites was 0.216 age 1+ /$m^2$. The large confidence interval suggests density varies widely among sample sites. Average density was calculated for all sites within a population (Table 3). Densities of each population ranged from moderate to high. Based on these data, Honey, Upper Deep, and Twentymile populations pass the abundance criterion.

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

| Population | 1999[a] | 2000[b] | Assessment | Pass/ Fail |
|---|---|---|---|---|
| Honey | 0.24 (5) | -- | High | Pass |
| Lower Deep | -- | -- | -- | Fail |
| Upper Deep | 0.14 (13) | -- | Moderate | Pass |
| Twentymile | 0.36 (6) | 0.04 (6) | High/Low | Pass |

[a] *Dambacher et al. 2001*
[b] *Data for 2000 from Edwards, ODFW, unpublished data.*

A 2000 survey estimated overall densities in Twentymile Creek as relatively low (Table 3). Both 1999 and 2000 surveys in Twentymile Creek found high and moderate densities in mid and headwater reaches, however, due to a summer die off where stream temperatures exceeded 28° C, the 2000 survey documented low densities in the lower reaches (C. Edwards, ODFW Lakeview field office, unpublished data). The difference in densities between years suggests conditions in the lower reaches are highly variable and populations may fluctuate dramatically according to environmental conditions. This is likely true for all of the Warner Lakes redband trout populations. We classify Twentymile as passing the abundance criterion because densities were consistently high in the upper reaches, though we acknowledge that abundance in the lower reaches is unstable and subject to extreme environmental conditions.

Quantitative data describing density of redband trout in Lower Deep do not exist. In the absence of these data this population is assessed based on findings of the 2000 population estimate in Twentymile Creek, field observations, and professional judgment. Conditions similar to lower reaches of Twentymile Creek are assumed to exist in the lowest reaches of Deep Creek. Given these factors the Lower Deep population fails the abundance criterion until status can be better assessed.

Current abundance of adfluvial adults in the Warner Lakes is considered relatively low and thought to be dramatically reduced from historical levels (Bowers et al. 1999). Adfluvial redband trout are regularly captured in the lakes but rarely in high numbers. Recent trapnet sampling shows adult redband trout are seldom captured in the lakes, even in high water years (R. Smith, Klamath Fish District, pers. comm.). Seasonal passage barriers associated with irrigation diversions and presence of non-native warm water fish in Warner Lakes prohibit adfluvial populations from attaining historical levels.

### *Productivity*

Data are not available to quantitatively assess productivity and the intrinsic potential of population increase for redband trout in the Warner Lakes 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 or disturbance events. Connectivity to a diversity of high quality habitats capable of supporting multiple life history types during extreme environmental conditions enables a population to rebound quickly. 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 environment constraint, 2) expresses multiple life history strategies, 3) is widely distributed, and 4) relatively abundant. A population may also pass the criterion if data 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, hatchery fish, or significant habitat degradation may negatively affect productivity and cause a population to fail the criterion. In many populations the intrinsic potential productivity is uncertain; these populations fail the criterion until productivity can be adequately assessed. Both Honey and Upper Deep populations pass the productivity criterion (Table 4).

**Table 4. Factors influencing productivity of Warner Lakes SMU redband trout populations.**

| Population | Factors | Pass/Fail |
|---|---|---|
| Honey | Adequate distribution and abundance; good quality habitat in upper reaches; potential migratory life history during high water years, however barriers to movement and the presence of non-native species in Warner Lakes may limit the expression of adfluvial life history. | Pass |
| Lower Deep | Low density; limited distribution with limited spawning habitat; large individuals rear in deep pools; habitat in lower reaches degraded; barriers to movement and the presence of non-native species in Warner Lakes limits the expression of adfluvial life history. | Fail |
| Upper Deep | High densities; large watershed with a diversity of high quality habitat with good water quality; connected to habitats potentially capable of supporting large migratory adults. | Pass |
| Twentymile | Densities variable; adequate distribution; total or partial year class failures observed in lower reaches (Edwards, ODFW, 2000 unpublished data) suggest recruitment is episodic; lacks adfluvial life history; habitat in lower reaches severely degraded. | Fail |

### *Reproductive Independence*

Data specific to reproductive independence do not exist for the Warner Lakes redband trout SMU. Instead this review uses current and historical stocking records to evaluate risk of introgression of native redband trout with hatchery origin rainbow trout. A population passes the criterion if hatchery origin rainbow trout are not currently stocked within the population, and if any available genetic analyses, when available, reveal minimal evidence of genetic mixing between hatchery and wild stocks.

Stocking of rainbow trout has occurred regularly in Honey, Deep, and Twentymile populations from 1925-1989 (ODFW stocking records). Introduced stocks were primarily of coastal origin. Stocking activities ceased in 1989 and current practices stock rainbow trout only in waterbodies without native fish. Effects of stocking rainbow trout into native redband trout populations are not certain. Behnke (1992) found differences in morphological characters for samples collected in Honey, Deep, and Willow creeks. These differences can be attributed to small sample sizes (n = 8-14), environmentally induced morphological changes, or introgression (D. Markel in USFWS 1998). Detailed genetic analysis is necessary to ascertain the source of these differences. Preliminary genetic examination suggests Warner Lakes redband trout are still genetically distinct and any introgression has reached equilibrium within the larger metapopulation (USFWS 1998). Because hatchery rainbow trout are not currently stocked in waterbodies with native redband trout, all populations pass the reproductive independence criterion.

### *Hybridization*

Non-native cutthroat trout are not present in the Warner Lakes basin and not a threat to redband trout. All populations pass the hybridization criterion.

### *Assessment Conclusions*

The Warner Lakes Redband Trout SMU includes four populations in the interior basin of pluvial Lake Warner. Distribution is widespread in perennial streams and lakes, although multiple irrigation diversions and the presence of non-native warm water fish in Warner Lakes limits the expression of an adfluvial life history. Although densities and abundance are relatively high in the headwater and mid-reaches, densities in the lower reaches may be low and vulnerable to extreme environmental fluctuations and degraded habitat. Only three of the six interim criteria were met, 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.

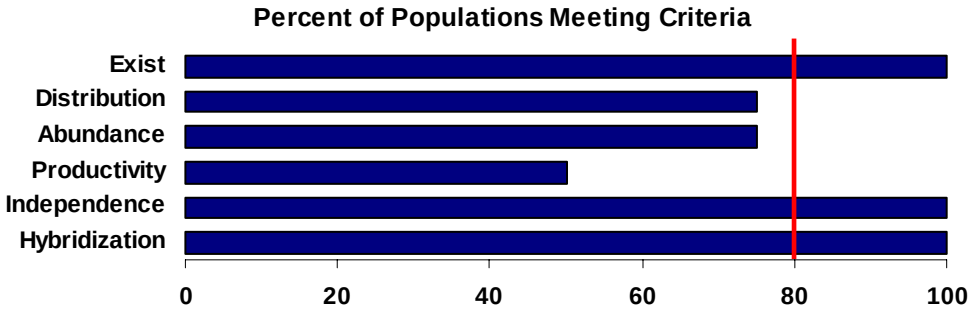


**Figure 1. Assessment outcome for each of the six interim criteria with respect to the 80% threshold identified by the NFCP.**

# Fort Rock Redband Trout

### *Existing Populations*

Historically, at the highest lake levels, Fort Rock basin drained into the Deschutes River basin through Crooked River. Today Fort Rock is a closed interior basin. Silver Lake and Paulina Marsh are just remnants of the basin's large Pleistocene lake. Three redband trout populations, Buck, Silver and Bridge, comprise the Fort Rock SMU (Table 1). All three populations occupy streams that terminate at Paulina Marsh.

**Table 1. Description, existence status, and life history of redband trout populations in the Fort Rock SMU.**

| Exist | Population | Description | Life history |
|---|---|---|---|
| Yes | Buck | Buck Creek. | Resident |
| Yes | Silver | Silver Creek and tributaries. | Resident |
| Yes | Bridge | Bridge Creek. | Resident |

All redband trout populations in the Fort Rock SMU are described as expressing a resident life history, however a few large individuals (>21 inches) have been observed in Buck Creek and anecdotal reports exist of large fish in both Silver and Buck creeks (R. Smith, ODFW Klamath Fish District, pers. comm.). Historically, the Fort Rock populations regularly expressed an adfluvial life history, rearing in Paulina Marsh and spawning in the headwater streams. Since then the Paulina Marsh has been drained and it now provides little or no habitat to support an adfluvial life history (Bowers et al. 1999).

### *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. Buck and Bridge 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 presence of migratory corridors for redband trout populations in the Fort Rock SMU (Flitcroft and Dambacher 2001).**

| Population | Current (km) | Total Basin Distance (km) | % Occupied | Connected to Other Pops. | Pass/ Fail |
|---|---|---|---|---|---|
| Buck | 30.0 | 78.5 | 38.5 | No | Pass |
| Silver | 34.1 | 474.1 | 7.8 | No | Fail |
| Bridge | 29.9 | 68.4 | 43.6 | No | Pass |

The distribution of redband trout in Silver Creek appears limited relative to the size of the basin. Redband trout only occupy 8% of the total stream distance in the Silver Creek watershed (Table 2). In 1968 Behnke (1992) found redband trout in upper Buck and Bridge creeks, but only brook trout in tributaries of Silver Creek. Thompson Valley Reservoir is a barrier to upstream migration, preventing redband trout from moving into the upper basin. Although the historic distribution likely did not include all streams in the basin, this statistic serves as a red flag to identify populations in which distribution may be drastically constricted and warrants further investigation.

Paulina Marsh has been drained and channelized for agricultural purposes (Bowers et al. 1999). During normal precipitation cycles populations are isolated by a lack of connection at Paulina Marsh and impassable irrigation structures and diversions. Buck and Bridge creeks are able to connect only during extended periods of above average precipitation. These periods are infrequent; Paulina Marsh last filled in 1982 (B. Bowersox, ODFW Lakeview Fish District, pers. comm.). In addition, a large irrigation diversion dam on Silver Creek prevents fish from moving into Silver Creek. Data describing movement and life history do not exist. Therefore we assume the populations in the Fort Rock SMU are functionally disconnected until movement data suggests otherwise (Table 2).

### *Abundance*

Data describing the abundance of constituent populations of the Fort Rock SMU over the last 30 years do not exist, therefore minimum abundance thresholds cannot be calculated. Instead, mean density of a given population serves as a surrogate criterion. Mean density estimates were 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 those years for which data are present.

Using a probability sample design, ODFW conducted an SMU level population estimate of redband trout in 1999 in the Fort Rock Basin (Dambacher et al. 2001). Population and density estimates were conducted at 30 randomly selected, spatially balanced sample sites throughout the SMU. Redband trout in the entire SMU were estimated at 56,964 +/- 23 % (95% CI) age 1+ individuals. Average redband trout densities for the SMU were moderate relative to other eastern Oregon streams (Dambacher and Jones In Press). Sites with the highest densities were located in narrow canyon reaches, protected from the effects of grazing and other land uses (Dambacher et al. 2001). Average density was calculated for all sites within a population (Table 3). Based on these data, all populations in the Fort Rock redband trout SMU pass the abundance criterion.

**Table 3. Mean density, age 1+ fish/$m^2$ (number of samples), of redband trout populations collected during 1999 basin wide population estimate (Dambacher et al. 2001).**

| Population | 1999 | Assessment | Pass / Fail |
|---|---|---|---|
| Buck | 0.09 (9) | Moderate | Pass |
| Silver | 0.18 (11) | Moderate | Pass |
| Bridge | 0.23 (10) | High | Pass |

### *Productivity*

Data are not available to quantitatively assess productivity and the intrinsic potential of population increase for redband trout in the Fort Rock 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 or disturbance events. Connectivity to a diversity of high quality habitats capable of supporting multiple life history types during extreme environmental conditions enables populations to rebound quickly. 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 environment constraint, 2) expresses multiple life history strategies, 3) is widely distributed, and

4) relatively abundant. A population may also pass the criterion if data 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, hatchery fish, or significant habitat degradation may negatively affect productivity and cause a population to fail the criterion. In many populations the intrinsic potential productivity is uncertain; these populations fail the criterion until productivity can be adequately assessed.

Given the lack of connection to habitat capable of supporting a migratory life history all populations fail the productivity criterion except Buck. Estimates of density collected in 1976 in Buck Creek were similar to those of 1999. In 1976 densities were moderate (0.17 age 1+ fish /$m^2$) in the upper reaches and high (0.21 age 1+ fish /$m^2$) in the lower reaches (Kunkel 1976). These data suggest the population trend was stable through various climatic cycles or the population was able to rebound after period of depressed abundance. Only the Buck population passes the productivity criterion (Table 4), though productivity for the entire SMU warrants investigation.

**Table 4. Factors influencing productivity of Fort Rock SMU redband trout populations.**

| Population | Factors | Pass/Fail |
|---|---|---|
| Buck | Low to moderate densities; distribution minimally adequate; expression of a migratory life history limited by lack of consistent connection to habitats capable of producing large fish; headwater habitats in good condition; densities in 1976 sampling similar to 1999, generally indicating a stable trend in abundance through various climactic cycles (Kunkel 1976; Dambacher et al. 2001); brook trout abundant in upper reaches. | Pass |
| Silver | Moderate densities; distribution minimally adequate; expression of migratory life history limited by lack of consistent connection to habitat capable of producing large fish; brook trout abundant in upper reaches; potential interbreeding with hatchery rainbow trout stocked in reservoirs. | Fail |
| Bridge | High densities; distribution minimally adequate; expression of migratory life history limited by lack of consistent connection to habitat capable of producing large fish; high quality habitat in canyon reaches. | Fail |

### *Reproductive Independence*

Data specific to reproductive independence do not exist for the Fort Rock redband trout SMU. Instead this review uses current and historical stocking records to evaluate the 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 genetic mixing between hatchery and wild stocks.

Planting of hatchery rainbow trout has occurred in all three populations, though most extensively in Silver Creek. Bridge Creek was stocked three times between 1943 and 1958. Buck Creek was stocked with rainbow trout ten times between 1925 and 1960. Silver Creek was stocked up to three times annually between 1925 and 1984 (ODFW stocking records). Stocking of hatchery rainbow trout in rivers and streams ceased in 1984. Native redband trout sampled in 1964 from Buck Creek showed a slight evidence of breeding with hatchery rainbow trout based on morphological characters (Behnke 1992).

Currently, hatchery rainbow trout are only stocked in Thompson Reservoir (Silver Creek). In high water years it is suspected that hatchery rainbow trout can leave the reservoir and potentially spawn with native redband trout downstream. However, the threat may be minimal since the reach downstream of Thompson Reservoir is dewatered annually for irrigation purposes, minimizing the likelihood that redband trout are present in this reach (Bowers et al. 1999). Given the current stocking program, the Silver Creek population fails the reproductive independence criterion until the effect of hatchery rainbow can be genetically assessed.

### *Hybridization*

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

### *Assessment Conclusions*

The Fort Rock Redband Trout SMU is comprised of three populations in the Silver Lake basin. Populations occupy tributaries of Paulina Marsh which has been diked, channelized, and drained for agricultural purposes. Populations are only connected during consecutive high water years, severely limiting the opportunities for the expression of a migratory life history and inter-population mixing. Lack of a migratory life history and degraded habitat impacts the potential productivity This SMU is classified as 'at risk' because 80% of the populations meet only three of the six interim criteria. 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.

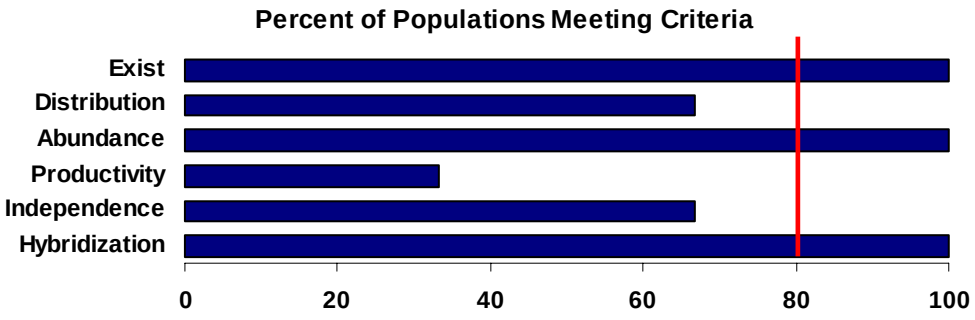


**Figure 1. Assessment outcome for each of the six interim criteria with respect to the 80% threshold identified by the NFCP.**

# Chewaucan Redband Trout

### *Existing Populations*

The Chewaucan Redband Trout SMU is comprised of four populations (Table 1). Three populations, Chewaucan, Crooked, and Willow, are within the Lake Abert basin and were historically connected to the Chewaucan Marsh. The fourth population, Foster, occupies a small isolated stream in the Summer Lake basin. Lake Abert and Summer Lake are remnants of ancient Lake Chewaucan and naturally separated by large sand dunes. Populations were identified based on Bowers et al. (1999) and reviews by ODFW staff (Table 1).

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

| Exist | Population | Description | Life History |
|---|---|---|---|
| Yes | Chewaucan | Chewaucan River and tributaries upstream of Rivers End Reservoir. | Resident/Migratory |
| Yes | Crooked | Crooked Creek and tributaries. | Resident/ Migratory |
| Yes | Willow | Willow Creek and tributaries. | Resident/Migratory |
| Yes | Foster | Foster Creek – Summer Lake Basin. | Resident |

### *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. Only the Foster population fails the distribution criterion (Table 2).

**Table 2. Distance of current distribution, total stream distance in each basin, percent of each basin occupied, and presence of migratory corridors for redband trout populations in the Chewaucan SMU.**

| Population | Current (km) | Total Basin Distance (km) | % Occupied | Connected to Other Pops. | Pass / Fail |
|---|---|---|---|---|---|
| Chewaucan | 295.5 | 995.4 | 29.7 | Yes | Pass |
| Crooked | 30.7 | 219.8 | 14.0 | No | Pass |
| Willow | 29.9 | 130.2 | 23.0 | No | Pass |
| Foster | ≈ 2 | -- | -- | No | Fail |

Historically, Chewaucan, Willow, and Crooked populations were connected to Chewaucan Marsh. The marsh supported the migratory life history of redband trout and provided the opportunity for populations to mix. However, the Chewaucan Marsh was diked, channelized, and drained for agricultural purposes. In addition, three large weirs were constructed on the lower Chewaucan River, as well as one on Crooked Creek and one on Willow Creek, that were all impassable to fish movement. These activities eliminated the migratory life history of redband trout. In 1994 Rivers End Reservoir was constructed near the mouth of the river and since then large migratory redband trout have been observed in the Chewaucan River and Crooked Creek (Tinniswood In Press). However, migratory fish returning upstream to the upper Chewaucan and Crooked Creek were unable to pass the weirs, preventing mixing between all populations. Beginning in 2000 adfluvial adults downstream of the weirs in Chewaucan River were trapped and hauled upstream allowing for Willow Creek and Crooked Creek redband trout to potentially mix with redband trout in the Chewaucan River. A fish ladder was completed on

the lowest weir on the Chewaucan River in 2004 and passage projects at the two other weirs will be completed in 2006. Given that passage is now possible on the Chewaucan River, the Chewaucan redband trout population is considered to be connected to other populations (Table 2). Fish rearing in Rivers End Reservoir are still unable to move past the weirs on Willow and Crooked creeks.

Foster Creek is a small, spring-fed stream that flows into Summer Lake from Winter Rim. The distribution of redband trout is less than two kilometers and the population is isolated from other streams and populations. Based on this extremely limited distribution and isolation, the Foster population is at risk of extinction due to stochastic events and fails the distribution criterion (Table 2).

### *Abundance*

Data describing the abundance of constituent populations of the Chewaucan Redband Trout SMU over the last 30 years do not exist, therefore minimum abundance thresholds cannot be calculated. 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 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 (Table 3).

**Table 3. Mean density, age 1+ fish/m$^2$ (number of samples), of redband trout populations collected during 1999 basin wide population estimate (Dambacher et al. 2001).**

| Population | 1999 | Assessment | Pass / Fail |
|---|---|---|---|
| Chewaucan | 0.14 (30) | Moderate | Pass |
| Crooked | 0.19 (3) | Moderate | Pass |
| Willow | 0.15 (2) | Moderate | Pass |
| Foster | -- | Moderate | Pass |

Using a probability sample design, ODFW conducted an SMU level population estimate of redband trout in 1999 in the Lake Abert Basin (Dambacher et al. 2001). Population and density estimates were conducted at 35 randomly selected, spatially balanced sample sites throughout the SMU. Redband trout in the entire SMU were estimated at 147,878 +/- 41 %( 95% CI) age 1+ individuals. Average redband trout density for the SMU was moderate relative to other eastern Oregon streams (Dambacher and Jones In Press). Average density was calculated for all sites within a population (Table 3). Based on these data, all populations in Lake Abert basin pass the abundance criterion.

Measures of density from the Chewaucan River and Dairy Creek collected in 1998 were relatively low (Bowers et al. 1999). Densities ranged from 0.005 to 0.072 age 1+ fish/m$^2$, only two of eight sites had densities greater than 0.05 age 1+ fish/m$^2$. Although this may be a cause of concern for redband trout in both streams, these sample sites were not representative of the population as a whole; sites were not randomly selected or surveyed in the tributary streams. Dairy Creek and parts of the Chewaucan River are subject to poor habitat quality and recreational fishing pressure. The differences exhibited between the 1999 and 1998 data sets reflect the variable nature of redband trout abundance at a local scale.

Density and abundance of redband trout in Foster Creek has not been adequately evaluated. A survey of redband trout in 1998 captured 17 fish in one 100 meter sample site (ODFW, Lakeview field office, unpublished data). Even though this measure may not be representitiveof the population, it does provide a general indication of abundance given the short distance of the distribution. Based on these data, a conservative estimate, classifies density of redband trout at this site as 'moderate'. However, it is unknown if a 2002 forest fire has impacted abundance (B. Tinniswood, ODFW Klamath Watershed District Office, pers. comm.). The Foster Creek redband trout population passes the abundance criterion, although a more thorough evaluation of abundance is necessary.

***Productivity***

Data are not available to quantitatively assess productivity and the intrinsic potential of population increase for redband trout in the Chewaucan 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 or disturbance events. Connectivity to a diversity of high quality habitats capable of supporting multiple life history types during extreme environmental conditions enables populations to rebound quickly. The expression of a migratory life history can produce large, highly fecund adults that further increases the intrinsic 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 environment constraint, 2) expresses multiple life history strategies, 3) is widely distributed, and 4) relatively abundant. A population may also pass the criterion if data 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, hatchery fish, or significant habitat degradation may negatively affect productivity and cause a population to fail the criterion. In many populations the intrinsic potential productivity is uncertain; these populations fail the criterion until productivity can be adequately assessed. Only the Chewaucan population passes the productivity criterion (Table 4).

**Table 4. Factors influencing productivity of Chewaucan SMU redband trout populations.**

| Population | Factors | Pass/Fail |
|---|---|---|
| Chewaucan | Moderate abundance; widely distributed throughout diverse habitats; access to Lands End Reservoir fosters a migratory life history; habitat in lower Chewaucan River and Dairy Creek severely degraded – habitat in tributaries and upper reaches in good condition; brook trout present in upper reaches, largemouth bass and brown bullheads present in lower river. | Pass |
| Crooked | Moderate abundance; adequately distributed; habitat degraded; no access to Rivers End Reservoir therefore migratory fish unable to return to spawning grounds. | Fail |
| Willow | Moderate abundance; adequately distributed; lacks connectivity to habitats capable of supporting a migratory life history; habitat quality degraded. | Fail |
| Foster | Moderate abundance; severely limited distribution; lacks a migratory life history, habitat impacted by forest fire in 2002. | Fail |

### *Reproductive Independence*

Data specific to reproductive independence do not exist for the Chewaucan Redband Trout SMU. Instead this review uses 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 genetic mixing between hatchery and wild species.

Planting of domestic rainbow trout was extensive in the Chewaucan population from 1925 to 1998. Rainbow trout were also stocked periodically in Crooked Creek during the same period and Willow Creek in the 1940's. The stocking program was eliminated in 1998 due to concerns of risk to native redband trout (Bowers et al. 1999). Foster Creek has not been stocked with domestic rainbow trout.

The extent and impact of interbreeding between redband trout and domestic rainbow trout is uncertain. Behnke (1992) found a slight hybrid influence in Dairy Creek (Chewaucan population), however, he stated that trout predominately retain the native genotype and should be considered to be representative of native redband trout. All populations pass the reproductive independence criterion since stocking of rainbow trout has ceased and evidence of mixing is minimal.

### *Hybridization*

Non-native cutthroat trout are not present in the Chewaucan Redband Trout SMU and not a threat to redband trout. All populations pass the hybridization criterion.

### *Assessment Conclusions*

The Chewaucan Redband Trout SMU consists of four populations, three in Lake Abert basin and one in Summer Lake Basin. Lake Abert and Summer Lake are remnants of ancient lake Chewaucan and naturally separated by large sand dunes. Redband trout in Lake Abert basin are distributed throughout the basin and moderately abundant. Degraded habitat conditions and barriers to migration are the most persistent threats to populations in the SMU. Foster Creek population has an extremely limited distribution and is isolated from large water bodies and other populations. The SMU met four of the six interim criteria and is classified as 'potentially 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.

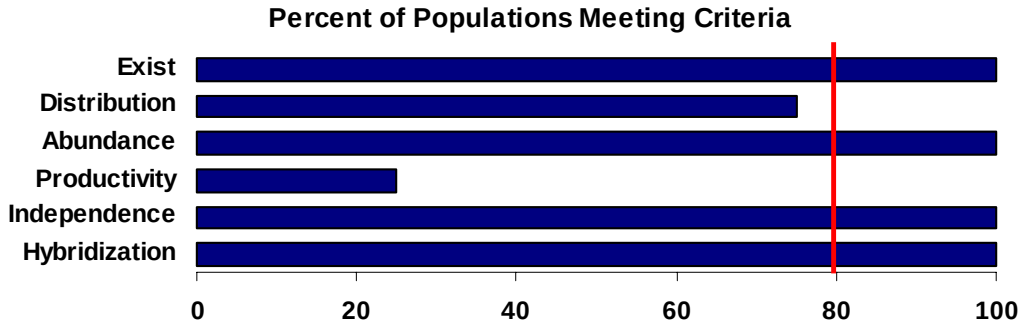


**Figure 1. Assessment outcome for each of the six interim criteria with respect to the 80% threshold identified by the NFCP.**

# 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.

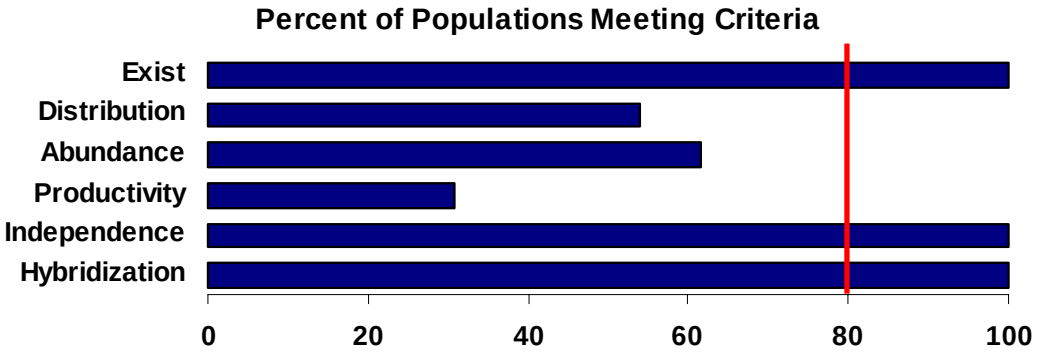


**Figure 1. Assessment outcome for each of the six interim criteria with respect to the 80% threshold identified by the NFCP.**

# Upper Klamath Basin Redband Trout

### *Existing Populations*

The Klamath River basin consists of discrete upper and lower segments separated near Klamath Falls. The lower portion of the basin resembles fish fauna assemblages of Rogue River and other coastal streams. The upper portion is characterized by a fish assemblage typical of other interior basins and is distinct from the lower river (Minckley et al. 1986). The Upper Klamath Lake basin contains the remnants of Pleistocene Lake Modoc, which redband trout likely invaded from interior connections (Behnke 1992). Lake Modoc eventually drained when it cut an outlet to the Pacific Ocean. Coastal steelhead trout are native to Klamath River and migrated into Upper Klamath Lake until 1917 when the construction of Copco Dam blocked fish passage. The steelhead trout in Klamath River are genetically and morphologically distinct from the native redband trout in Upper Klamath Lake (Behnke 1992). Currently, the Upper Klamath Lake basin supports the largest and most functional adfluvial redband trout populations of Oregon interior basins.

The Upper Klamath Basin Redband Trout SMU is comprised of ten populations. These populations are highly variable in regard to genetics, life history, and disease resistance, and appear to share little gene flow among populations in spite of proximity and absence of physical barriers (Buchanan et al. 1994). However, the population structure of the upper Klamath Basin is still uncertain. Redband trout populations are identified based on genetic and life history studies (Buchanan et al 1994), current ODFW management plans (Fortune 1997), and review by ODFW Staff (Table 1). The population structure, as defined in this review, is not definitive, but reflects populations as they are currently managed. Additional genetic analysis and life history studies are necessary to better define populations.

**Table 1. Description, existence status, and life history of redband trout populations in the Upper Klamath Basin SMU.**

| Exist | Population | Description | Life history |
|---|---|---|---|
| Yes | Jenny | Jenny Creek above falls and tributaries. | Resident |
| Yes | Klamath River | Klamath River and tributaries below Link River Dam; includes Spencer Creek. | Resident/Migratory |
| Yes | Cascade Complex | Cherry, Sevenmile, Rock, Nanny, Threemile, Moss, Denny and Fourmile creeks and tributaries. | Resident/Migratory |
| Yes | Wood River | Wood River and tributaries including Annie, Sun, Fort, Crooked and Agency creeks. | Resident/Migratory |
| Yes | Lower Williamson | Lower Williamson River up to falls, including Spring, Larkin, and Sunnybrook creeks and Kirk Springs. | Resident/Migratory |
| Yes | Upper Williamson | Williamson River above falls & tributaries including Klamath Marsh. | Resident |
| Yes | Lower Sprague | Lower Sycan River up to Sycan Marsh and Sprague River up to the Forks. | Resident/Migratory |
| Yes | Upper Sycan | Streams above Sycan Marsh outlet. | Resident/Migratory |
| Yes | Upper Sprague | N.F. and S.F. Sprague River and tributaries. | Resident/Migratory |
| Yes | Lost River | Lost River including Miller and Rock creeks, Gerber Reservoir and tributaries. | Resident/Migratory |

Redband trout in individual streams of the Cascade Complex population may prove to be separate populations. Irrigation diversions and habitat degradation in the lower reaches likely

prevent movement among streams, limiting the ability of fish in these streams to function as a single population. Redband trout in the streams of the Cascade Complex are treated as one population, however, if isolating factors persist then the population may need to be re-defined.

Redband trout in the Upper Sycan and Upper Sprague rivers show unique allozyme characteristics, which suggest they are more closely related to redband trout in Jenny and Upper Williamson, than those in the Lower Sprague (Buchanan et al. 1994). Based on these findings the Upper Sycan and Upper Sprague are considered separate populations, however further genetic research is necessary to more accurately delineate populations in the Sprague River basin. Passage to and from the Upper Klamath Lake is possible and has been documented for redband trout and shortnose sucker (R. Smith, ODFW Klamath District Office, pers. comm.).

### *Distribution*

Redband trout in the Upper Klamath Basin are widely distributed throughout the watershed. Trout are present in the major tributaries of Upper Klamath and Agency lakes and in headwater streams in the Gearhart and Cascade mountains. Connectivity between most populations is likely with habitable water conditions in the lakes and adequate flow over irrigation diversions in the lower reaches of many rivers.

Oregon Basin redband trout populations pass the distribution criterion if they satisfy 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. The redband trout SMUs are quantitatively evaluated based on a 1:100,000 GIS hydrography of redband trout distribution. Similar GIS data for Upper Klamath Basin do not exist. Current knowledge of distribution in the Upper Klamath Basin includes rivers, streams, and tributaries where redband trout are present but does not define upper and lower limits, therefore quantitative analysis of distribution is not possible. Instead, Upper Klamath Basin redband trout populations are assessed based on professional judgment and knowledge of Klamath Basin geography. A population passes the criterion if year-round distribution is thought to be greater than ten km and is not isolated from other populations. Although this metric is not as rigorous as those used in the other Oregon basin redband trout SMUs, it provides a similar and adequate assessment of the interim criteria and identifies populations where distribution is drastically constricted. Four populations; Jenny, Cascade Complex, Upper Williamson, and Lost River, fail the distribution criterion (Table 2).

**Table 2. Status evaluation of the distribution criterion for redband trout populations in the Upper Klamath Basin SMU.**

| Population | Greater than 10 km | Connected to Other Pops. | Pass/Fail |
|---|---|---|---|
| Jenny | Yes | No | Fail |
| Klamath River | Yes | Yes | Pass |
| Cascade Complex | No | Yes | Fail |
| Wood | Yes | Yes | Pass |
| Lower Williamson | Yes | Yes | Pass |
| Upper Williamson | Yes | No | Fail |
| Lower Sprague | Yes | Yes | Pass |
| Upper Sycan | Yes | Yes | Pass |
| Upper Sprague | Yes | Yes | Pass |
| Lost River | No | No | Fail |

Jenny Creek and the Upper Williamson River are isolated by natural barrier falls and fail the distribution criterion. Both populations are unable to mix with other populations prohibiting gene flow and genetic mixing, and increasing risk of extinction due to inbreeding and genetic drift if populations become very small.

Redband trout distribution in Lost River is not well documented or understood. The presence of redband trout appears to be dramatically impacted by habitat degradation and water withdrawal. Redband trout may only exist in a few locations, including Miller Creek where flow is subject to the operation of Gerber Reservoir and may go dry in fall and winter (Smith and Messmer 2001). The Lost River population fails the criterion until distribution can be better documented.

Redband trout distribution in the Cascade Complex is highly fragmented. The total stream distance occupied by redband trout in the complex is thought to be less than ten km. (R. Smith, ODFW Klamath District Office, pers. comm.). In addition some streams in the complex lack regular connection to Klamath Lake and other populations. This population fails the distribution criterion.

The Klamath River population is impacted by three large dams and associated impoundments. Very few fish have been documented moving through fish ladders at each dam. Adult redband trout passage over the J.C. Boyle Dam has declined dramatically over the past 50 years. In 1959 5,529 redband trout moved over the J.C. Boyle Dam; 70 redband trout passed the dam in 1991 (Buchanan 1992). Water quality within the impoundments is poor during the summer months limiting connectivity and productivity. Lake Ewauna typically is characterized by high temperatures, low dissolved oxygen, and a high pH in the summer (Smith and Messmer 2001). Even though the population passes the criterion, these factors significantly impact distribution .

***Abundance***

Data describing the constituent populations of the Upper Klamath Basin SMU over the past 30 years do not exist; therefore minimum abundance thresholds can not be calculated. Current data sets describing abundance vary among populations in type, consistency, and temporal and spatial extent. As a result a consistent evaluation across all populations based on one metric is not feasible. Instead populations are assessed using one of three metrics; number of spawning adults, estimated biomass, or estimated densities.

Unlike bull trout, guidelines to identify populations at risk of inbreeding and genetic drift do not exist specifically for redband trout species. Instead we relied on more general recommendations. For the purposes of this review, populations of redband trout with less than 50 adults are considered to be at risk of inbreeding depression and potential decrease in viability or reproductive fitness (Franklin 1980). Populations less than 500 adults are at risk of loss of genetic variation due to genetic drift (Franklin 1980, Soule 1980, Lande 1988, USFWS 2004). Populations with fewer than 50 adults fail the abundance criterion. The sum of interconnected populations also must exceed 500 adults to avoid the risk of genetic drift. Thus, an SMU or an isolated population must exceed 500 adults in order to pass the abundance criterion.

When available, mean density and biomass estimates are compared to density and biomass benchmarks for redband trout populations in eastern Oregon streams (Dambacher and Jones In press) (Table 3). The benchmarks were developed using the interquartile values of density from 82 samples and of biomass from 50 samples in Crooked River and Catlow Valley basin streams pre-1998. A population passes the abundance criterion if the average density or biomass 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 estimates for the last five years are not available, the criterion is applied to only those years for which data are present.

**Table 3. Benchmarks of abundance for ≥ age 1+ redband trout taken from interquartile values of 82 estimates of density and 50 estimates of biomass in eastern Oregon pre-1998 (Dambacher and Jones In Press).**

| Abundance rating | Fish/ $m^2$ | Grams/ $m^2$ |
|---|---|---|
| Low | ≤ 0.059 | ≤ 2.0 |
| Moderate | 0.06 - 0.19 | 2.1 – 4.9 |
| High | ≥ 0.20 | ≥ 5.0 |

All density and biomass estimates included in the assessment were calculated using depletion-removal methods (Zippen 1958). At a minimum, sample sites were block-netted and a two-pass removal procedure was followed with backpack electrofisher and a 50% reduction criterion between passes for age 1+ redband trout. Not all sample sites were randomly selected, therefore density estimates may not always be representative of the population. In all cases, mean estimates are an average of individual density estimates and are not extrapolated to total stream area.

Measures of density and biomass are intended to be an approximate indicator of abundance. Abundance within a population varies widely and fluctuates with water year and habitat condition. Water years 1998 and 1999 were particularly wet with above average precipitation and snowpack. Conversely, 1994 and 2003 were extremely dry years. Fluctuations in precipitation between years were considered when evaluating abundance and trends of redband trout. Low densities may be attributed to a dry year, but low densities during a wet cycle are a cause for concern.

In summary, Upper Klamath Basin populations must either exceed 50 spawning adult fish, have densities greater than 0.059 age 1+ fish/$m^2$, or biomass greater than 2.0 g/$m^2$ to pass the abundance criterion, depending on available data. The three measures are not assumed to be equivalent. We recognize these metrics are not directly comparable to the other Oregon basin redband trout SMUs, but given the available datasets for the Upper Klamath Basin, they are able to adequately identify populations of extremely limited abundance and effectively evaluate the interim criteria. Six populations pass the abundance criterion (Table 4).

**Table 4. Abundance, density, and biomass ratings for Upper Klamath Basin redband trout populations.**

| Population | > 50 adults | Density Rating | Biomass Rating | Pass/Fail |
|---|---|---|---|---|
| Jenny | -- | -- | -- | Pass |
| Klamath River | Yes | Moderate | -- | Pass |
| Cascade Complex | -- | -- | -- | Fail |
| Wood | Yes | -- | -- | Pass |
| Lower Williamson | Yes | -- | -- | Pass |
| Upper Williamson | -- | -- | Low | Fail |
| Lower Sprague | -- | -- | Moderate/high | Pass |
| Upper Sycan | -- | Low | Low | Fail |
| Upper Sprague | -- | Moderate | -- | Pass |
| Lost River | -- | -- | -- | Fail |

Abundance measures for Jenny Creek do not exist, however local biologists describe this population as abundant (Smith and Messmer 2001). Large redband trout are observed at

relatively high densities in the lower reaches (W. Tinniswood, ODFW Klamath District Office, pers. comm.). This population passes the criterion until abundance can be better addressed.

Spencer Creek is the primary spawning ground for redband trout in the Lower Klamath population. ODFW staff conduct redd surveys on Spencer Creek every year as conditions permit. Even though redd surveys do not translate into absolute number of adults present in the population, the redd counts do provide a general indication of the minimum number of fish present in the system. Redd counts in Spencer Creek averaged 113 (range = 83 - 134) between 1998 and 2004 (ODFW, Klamath District Office, unpublished data) indicating the population exceeds a minimum of 50 adults. Population surveys in Spencer Creek in 2004 documented densities of 0.148 age 1+ redband trout/$m^2$ (moderate) (ODFW, Klamath District Office, unpublished data). In addition, PacifiCorp biologists observed redband trout spawning in the bypass reach below J.C. Boyle dam in 2003. Based on these data the Lower Klamath population passes the abundance criterion.

Quantitative abundance data are not available for redband trout in the Cascade Complex. Redband trout in Rock Creek were thought to be non-existent in the early 1990s after seven years of drought (Buchanan 1994) and since have been reported as present in low numbers. Redband trout abundance has also been reported as low in Threemile and Sevenmile creeks. ODFW and USFS attempted to estimate density for redband trout in Sevenmile Creek in 2002 and found only two redband trout juveniles (Smith and Tinniswood 2002). However, sampling in Cherry Creek in 2004 found redband trout at moderate densities (Table 4). Given observations of extremely low abundance in most streams except Cherry Creek, the Cascade Complex population fails the abundance criterion until abundance can be fully assessed.

Assessments of both the Wood and Lower Williamson populations were based on the minimum number of adults and long term redd and adult counts. Even though redd surveys do not translate into absolute number of adults present in the population, redd counts can provide a general indication of the minimum number of fish present in the system. Redd counts in Fort Creek (Wood population) exceed at least 80 redds annually and typically are much greater (Fig 30a). Fish counts in Wood River have documented peak counts greater than 200 redband trout each year since 2001 (ODFW, Klamath District Office, unpublished data). Similarly, redd counts in Spring Creek and Lower Williamson regularly exceed 100 redds per year (Fig. 30b & c). Both populations pass the abundance criterion.

The Upper Williamson, Lower Sprague, and Upper Sycan populations are assessed based on datasets describing mean biomass (ODFW and The Nature Conservancy, Klamath District Office, unpublished data) (Table 5). Estimates collected between 1995 and 2003 at a few sites serve as an indication of abundance for each population. We recognize the limitations of these data given the inadequate temporal and spatial extent of the dataset. At both sites on the Upper Sycan and two sites in the Upper Williamson biomass measurements are consistently low. A density estimate in Long Creek (Upper Sycan) in 2004 also reflects low abundance (Table 6). Considering these data, the Upper Williamson and Upper Sycan populations fail the criterion until abundance can be thoroughly assessed. The Lower Sprague population passes the criterion.

**Table 5. Biomass estimate (g/m$^2$ of age 1+ fish) and assessment of native redband trout in populations of the upper Klamath basin.**

| Population | Stream | 1995 | 1997 | 1998 | 1999 | 2000 | 2003 | Rating |
|---|---|---|---|---|---|---|---|---|
| Upper Williamson | Royce | 0.99 | 1.77 | 0.92 | 0.87 | 0.45 | -- | Low |
| | Deep | 0.49 | 2.01 | 1.04 | 0.40 | -- | -- | Low |
| | Bull | -- | 5.76 | 2.74 | -- | -- | -- | High/Moderate |
| Lower Sprague | Trout | -- | -- | -- | 11.45 | 4.66 | -- | High/Moderate |
| Upper Sycan | Long | -- | -- | 1.18 | 1.41 | 1.62 | 0.55 | Low |
| | Sycan | -- | -- | -- | -- | 1.30 | -- | Low |

The Upper Sprague population is evaluated based on datasets describing mean density (Table 6) (ODFW, Aquatic Inventory Project and Klamath District Office, unpublished data). The dataset is limited both temporally and spatially, but for the purpose of this review is treated as indicative of population abundance. Densities are expected to fluctuate with water year and stream flow. Density of the Upper Sprague population is generally rated as moderate and the population passes the abundance criterion until abundance can be better assessed.

**Table 6. Density estimate (age 1+fish/m$^2$) and assessment of native redband trout in populations of the upper Klamath basin.**

| Population | Stream | Density | Year | Rating |
|---|---|---|---|---|
| Cascade Complex | Cherry | 0.108 | 2004 | Moderate |
| Upper Sycan | Long | 0.025 | 2004 | Low |
| Upper Sprague | Deming | 0.050 | 1997 | Low |
| | Brownsworth | 0.091 | 1995 | Moderate |
| | | 0.246 | 2004 | High |
| | Boulder | 0.150 | 1992 | Moderate |

The abundance of redband trout in Lost River is thought to be very depressed (Smith and Messmer 2001). Abundance is greatest in Miller Creek, but is dependant on outflow from Gerber Reservoir. Redband trout are present in the tributaries of Gerber Reservoir, but there is a high likelihood these fish are hatchery origin coastal rainbow trout. The Lost River population fails the abundance criterion until abundance can be better assessed and the origin of fish in Gerber Reservoir can be properly identified.

### *Productivity*

Data are not available to quantitatively assess potential productivity of populations of redband trout in the Upper Klamath Basin SMU. A population that is widely distributed and exhibits high densities is assumed to have minimally rebounded from past drought or disturbance events. Connectivity to a diversity of high quality habitats capable of supporting multiple life history types during extreme environmental conditions enables populations to rebound quickly. The expression of a migratory life history can produce large, highly fecund adults that further increase the intrinsic 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 environment constraint, 2) expresses multiple life history strategies, 3) is widely distributed, and 4) relatively abundant. A population may also pass the criterion if data 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, hatchery fish, or significant habitat degradation may negatively affect productivity and cause a population to fail the criterion. In many populations the potential intrinsic productivity is uncertain; these populations fail the criterion until productivity can be adequately assessed.

**Table 7. Factors influencing productivity of Upper Klamath Basin SMU redband trout populations.**

| Population | Factors | Pass/Fail |
|---|---|---|
| Jenny | Isolated population; adequate distribution and apparently abundant; habitat in lower reaches likely support a fluvial life history. | Pass |
| Lower Klamath | Adequate distribution and abundance; habitat supports a migratory life history; Spencer Creek is the only known spawning tributary; high water temperatures, poor water quality during summer months in mainstem; dams and impoundments compromise habitat condition; productivity considered below potential. | Fail |
| Cascade Complex | Extremely limited distribution and abundance; only periodic connection to Klamath Lake due to irrigation withdrawals and diversions; upper habitat impacted by road building and logging; limited expression of migratory life history. | Fail |
| Wood | Highly abundant; adequate distribution; adfluvial life history; habitat quality impacted by diversion and agricultural irrigation withdrawal; Fort Creek redd counts suggest population trend is stable (Fig. 30a). | Pass |
| Lower Williamson | Highly abundant; wide distribution; adfluvial life history; Spring Creek and mainstem Williamson redd counts indicate recent population trend is stable (Fig. 30b & c). | Pass |
| Upper Williamson | Isolated above a barrier falls; distribution adequate; abundance undocumented but likely limited; resident life history; Klamath Marsh drained and channelized, river often dry below the marsh in the summer; upper river impacted by grazing and irrigation withdrawal. | Fail |
| Lower Sprague | Adequate distribution and apparently abundant; adfluvial life history; habitat heavily impacted by grazing and agricultural use; limited by poor habitat quality (Smith and Messmer 2001). | Fail |
| Upper Sycan | Limited abundance; adequate distribution; habitat potentially capable of supporting a migratory life history; upper portion of river designated as federal Scenic River; Sycan Marsh is heavily channelized and drained to support livestock grazing; The Nature Conservancy is taking action to restore the marsh's natural function including restoring perennial flow from the marsh. | Fail |
| Upper Sprague | Adequate distribution and abundance; limited expression of a migratory life history; presence of brook trout and brown trout; poor habitat condition. | Fail |
| Lost River | Extremely limited distribution and abundance; Gerber Reservoir capable of supporting a migratory life history; habitat severely degraded; limited by stocking hatchery rainbow trout. | Fail |

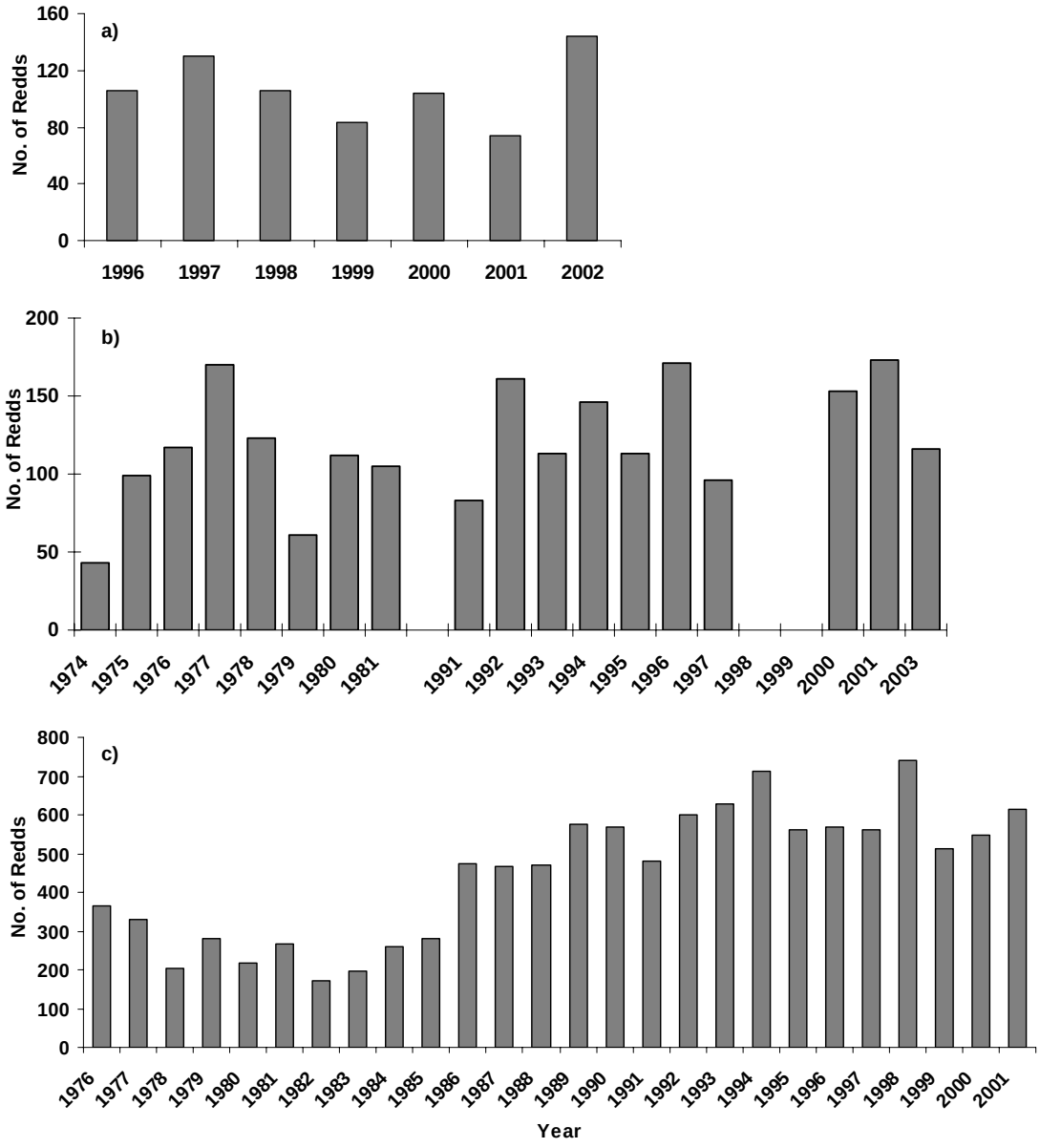


**Figure 30. Redband trout redd counts in: a) Fort Creek (Wood population), b) Williamson River between Spring Creek and Pine Ridge (Lower Williamson population), and c) Spring Creek (Lower Williamson population) (ODFW Klamath District Office, unpublished data).**

### *Reproductive Independence*

Data specific to reproductive independence are not available for the Upper Klamath Basin Redband Trout SMU. Instead this review uses current and historical stocking records to evaluate the risk of hatchery origin rainbow trout to native redband trout. Planting of a coastal stock of rainbow trout in the Upper Klamath Basin began in 1925 and continues currently in some lakes and reservoirs. Planting of hatchery fish in moving waters ceased in 1991 except in Spring Creek, where stocking currently continues. Populations where hatchery rainbow trout are not currently stocked in water bodies with redband trout pass the reproductive independence criterion. Populations fail where coastal rainbow trout are currently stocked on top of redband trout or able to move into streams inhabited by native redband trout (Table 8).

**Table 8. Status of hatchery rainbow trout stocking programs in Upper Klamath Basin Redband trout SMU populations (Klamath River Basin, Oregon, Fish Management Plan, 1997).**

| Population | Status | Pass/Fail |
|---|---|---|
| Jenny | Coastal rainbow trout and steelhead trout are stocked in Hyatt and Little Hyatt reservoirs and are assumed able to leave the reservoirs. Genetic analysis shows some introgression between hatchery rainbow trout and native redband trout (Buchanan et al. 1994). | Fail |
| Lower Klamath | No hatchery rainbow trout stocks are currently planted. | Pass |
| Cascade Complex | Hatchery rainbow trout stocking program ceased in 1991. | Pass |
| Wood | Hatchery rainbow trout stocking program ceased in 1991. | Pass |
| Lower Williamson | No hatchery rainbow trout stocked in Upper Klamath and Agency lakes since 1979. Spring Creek currently stocked with rainbow trout susceptible to *C. shasta* which are assumed to not survive to spawn with native redband trout. This assumption should be verified with genetic analysis and monitoring activities. | Pass |
| Upper Williamson | No hatchery rainbow trout planted since 1930. | Pass |
| Lower Sprague | No hatchery rainbow trout stocks currently planted. | Pass |
| Upper Sycan | No hatchery rainbow trout stocks currently planted. | Pass |
| Upper Sprague | No hatchery rainbow trout stocks currently planted. | Pass |
| Lost River | Not currently stocked, but have been stocked intensely in the past. The impact of stocking is undetermined and it is unknown if native redband trout still exist in tributaries of Gerber Reservoir. | Pass |

### *Hybridization*

Non-native cutthroat trout are not present in the Upper Klamath Basin Redband Trout SMU. All populations pass the hybridization criterion.

### *Assessment Conclusions*

The Upper Klamath Lake basin contains the remnants of Pleistocene Lake Modoc, which redband trout may have entered from interior connections. Currently, the Upper Klamath Lake basin supports the largest and most functional adfluvial redband trout populations of Oregon interior basins, however, some populations are severely limited in distribution and abundance by habitat quality and non-native species. The SMU is comprised of ten populations that vary in life history, genetics, disease resistance, and status. 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.

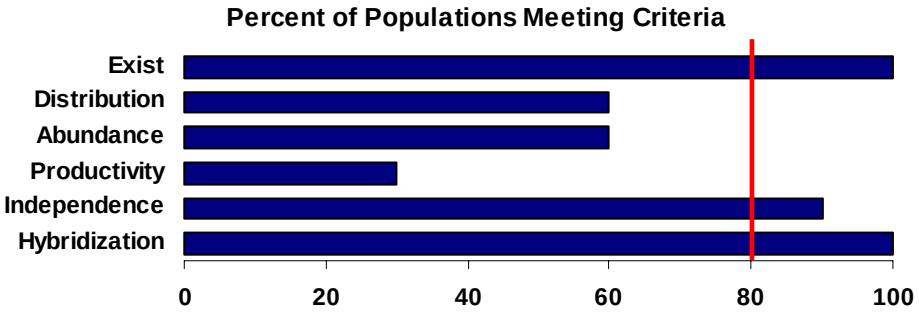


**Figure 1. Assessment outcome for each of the six interim criteria with respect to the 80% threshold identified by the NFCP.**