



# R & E Grant Application 13 Biennium

Project #:  
13-050

## *Phillips Reservoir Monitoring and Evaluation*

### ***Project Information***

**R&E Project Request:** \$3,148.50  
**Match Funding:** \$348.50  
**Total Project:** \$3,497.00  
**Start Date:** 5/1/2014  
**End Date:** 6/30/2015  
**Project Email:** timothy.d.bailey@state.or.us  
**Project Biennium:** 13 Biennium  
**Organization:** ODFW - Grande Ronde Watershed District Office

### ***Applicant Information***

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### ***Past Recommended or Completed Projects***

Number	Name	Status
11-036	Luger Pond Handicap Fishing Access Development	Completed
09-057	Phillips Reservoir Fishery Restoration	Completed
09-183	Phillips Reservoir Creel Survey	Completed
09-219	North Powder Pond Fishing Access Improvement	Completed
09-264	Grande Ronde Watershed District Fishery Monitoring	Completed
09-265	Phillips Reservoir Trap Nets	Completed
11-066	Phillips Reservoir Fishery Restoration - Phase II	Completed
11-074	Northeast Oregon Spring Chinook Creel Surveys	Completed
11-146	Phillips Reservoir Creel Survey 2013	Completed
11-158	Grande Ronde Watershed Monitoring Equipment	Completed
11-159	2013 Northeast Oregon Spring Chinook Creel Surveys	Completed
13-001	Phillips Reservoir Creel Survey 2013 - Phase 2	Approved

### ***Project Summary***

This project is part of ODFW's 25 Year Angling Plan.

**Activity Type:** Monitoring

**Summary:** The proposed grant would fund the purchase of fish tags and other supplies enabling the implementation of the Phillips Reservoir Tiger Muskie Monitoring and Evaluation Plan. The monitoring and evaluation plan is intended to determine the efficacy of attaining fishery management goals and objectives through the introduction and on-going stocking of sterile tiger muskie to control the over-abundance of introduced yellow perch.

**Objectives:** Fishery management objectives are shown in the attachment "Fishery Management Objectives".

Our monitoring and evaluation objectives are described in the attached Phillips Reservoir Tiger Muskie Monitoring and Evaluation Plan (M & E Plan).

**Fishery Benefits:** Implementation of the M & E Plan will allow us to evaluate the efficacy of our current management approach at Phillips Reservoir to improve the rainbow trout fishery by controlling yellow perch abundance. We will use the m & e results to determine in 2018, whether or not to continue stocking of tiger muskie.

The intended outcome of the tiger muskie introduction, and supporting M & E Plan, are to improve the recreational fishery at Phillips Reservoir.

**Watershed Benefits:** Reduction of yellow perch abundance in Phillips Reservoir would improve rearing conditions for native redband trout that use the reservoir. The overabundant population of yellow perch, which are very efficient planktivores, remove the larger sized zooplankton from the reservoir, which are important prey items for redband trout using the reservoir. Thus rearing conditions for redband trout using the reservoir are not good. Reduced yellow perch abundance should lead to more availability of zooplankton species preferred by redband trout and other gamefish species.

Additionally, reduction of zooplankton abundance can result in greater volumes of algae, including deleterious blue-green algae, creating a concern for water quality and human health. Reduction of perch numbers could prevent such a situation from occurring.

**Current Situation:** Phillips Reservoir once supported a very popular fishery for primarily rainbow trout (some of trophy size), but also bass and crappie. Introduction of yellow perch caused a severe decline in the trout fishery. Creel survey data show 35,000 angler-days before the perch introduction and 3,100 angler-days in 2010 after introduction, a decline of over 90%.

Thirty-two percent of the 2008 angler survey respondents indicated that they no longer fish at Phillips Reservoir due primarily to the decline in trout abundance and size. Anglers that target trout when they fish the reservoir showed the following level of satisfaction with the fishery: 4% very satisfied, 27% satisfied, 40% unsatisfied and 29% very unsatisfied.

The fishery was supported by the stocking of fingerling sized rainbow trout, which

was highly cost effective. Fingerling trout survived and grew very poorly once yellow perch were introduced, eliminating this as a viable management option. The fishery is now supported by stocking of legal-sized rainbow trout (put and take fishery) and an experimental release of sub-legal sized trout. Before introduction of perch the weight of the trout per length was much greater.

Per the 2008 angler survey, approximately 21 percent of the respondents would like a perch fishery to exist, but would like the average size of the fish to increase. The average size of perch in gillnet samples has been 7-8 inches.

From 2009 - 2013, the district implemented a project to mechanically remove yellow perch from the reservoir, partially funded by the R & E Program, intended to reduce their abundance. Even though this project removed approximately 1.4 million yellow perch from the reservoir, abundance estimates do not indicate a measureable decrease in the population. Neither has there been a trend of increasing size, growth or survival of stocked rainbow trout.

After Oregon Fish and Wildlife Commission approval to introduce tiger muskie into Phillips reservoir to control the yellow perch population and restore the rainbow trout fishery, the first release of 25,000 five-inch juvenile tiger muskie occurred in June 2013.

**Alternatives:** From the standpoint of M & E, we have chosen the measurement of the metrics we think are necessary to evaluate the tiger muskie introduction. While there are other techniques available for evaluating the chosen metrics, we have chosen what we believe are the most efficient in terms of cost and personnel.

With regard to management, a number of other alternatives were considered for achieving fishery objectives at Phillips Reservoir. Documents describing these are available upon request.

**Designer:** The M & E Plan was developed by Terry Shrader, Eastside Recreational Fisheries Biologist, and Tim Bailey, La Grande District Fish Biologist.

**Methods:** See the attached M & E Plan.

**Inspector:** Tim Bailey and Terry Shrader

**Funding Elements:** Purchase of floy tags, fluorescent grit and other supplies needed to support M & E Plan activities through May 2015.

**Partners:** Yes

**Existing Plan:** Baker County - Provide jet boats to assist in Spring 2015 sampling.  
Yes

**Affected Contacted:** Phillips Reservoir Fishery Management Plan. See the attached plan.  
Yes

**Affected** Yes  
**Supportive:**  
**Affected**  
**Comments:** A special use permit application has been submitted to the Wallowa Whitman National Forest, Whitman Ranger District to use a USFS-owned boat launch as base of operation for spring sampling.

***Project Schedule/Participants/Funding***

Activity	Date	Participants
Purchase equipment for gastric lavage	5/15/2014	LG District
Spring Gillnet Sample	5/25/2014	LG District
Spring Electrofishing	6/1/2014	LG District/Rec Fish Prgm
Sample marked fish in fishery	7/31/2014	LG District
Purchase tags and supplies for spring trap net sampling	1/15/2015	LG District
Spring trap net sampling	4/1/2015	LG District
Mark 3,000 Rb at Irrigon Hatchery with flourescent grit	3/25/2015	LG District
Mark 1,500 yellow perch with double floy tag	4/1/2015	LG District

**Affected**  
**Species:** Rainbow Trout  
 Tiger Muskie  
 Yellow Perch

***Project Permits***

Name	Issued By	Secured?	Date Secured	Date Expected
Special Use Permit	USFS	No	1/1/0001	3/1/2014

***Project Monitoring***

This project has no monitoring.

***Project Maintenance***

This project has no maintenance plans.

### ***Project Match Funding***

Funding Source	Cash	In-Kind	Other	Description	Total	Secured?	Conditions?	Comments
R&E Request	\$3,148.50	\$0.00	\$348.50	Grande Ronde Watershed District	\$3,497.00	Yes	No	
				Total Match Funding:	\$3,497.00			

## Project Budget

Item	Item Type	Units	Unit Cost	R&E Funds	Match Funds	Total
16 oz. Specimen Bottles	Supplies/Materials /Services	12	\$6.50	\$39.00	\$39.00	\$78.00
32 oz. specimen bottles	Supplies/Materials /Services	12	\$9.75	\$58.50	\$58.50	\$117.00
Dyed Flourescent Grit	Supplies/Materials /Services	1	\$200.00	\$150.00	\$50.00	\$200.00
Ethanol (70%)	Supplies/Materials /Services	12	\$21.00	\$126.00	\$126.00	\$252.00
Floy Tags	Supplies/Materials /Services	3000	\$0.70	\$2,100.00	\$0.00	\$2,100.00
livewell pump	Supplies/Materials /Services	1	\$50.00	\$25.00	\$25.00	\$50.00
O2/CO2 for livewells	Supplies/Materials /Services	1	\$100.00	\$50.00	\$50.00	\$100.00
Portable Flourescent Lamp	Supplies/Materials /Services	2	\$300.00	\$600.00	\$0.00	\$600.00
					Total Budget:	\$3,497.00

## Project Map

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## Additional Files

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Click a link to view that particular file.

[Fishery Management Objectives](#)

[M & E Plan](#)

[Management Plan](#)

[Signature Authorization](#)

# **Phillips Reservoir Fishery Monitoring and Evaluation Plan**

## **Background Information**

A very productive and popular recreational fishery developed at Phillips Reservoir immediately after construction was completed in 1968. Angler use of this reservoir was high (67,510 angler-days in 1970), considering it is in a relatively sparsely populated region of Oregon. An end came to the productivity of one of the region's most popular trout fisheries as the result of the illegal introduction of yellow perch, first documented in 1991. The perch quickly populated the reservoir and by the mid 1990's they were the dominant species. This expansion led to changes in the reservoir's zooplankton community that impacted the productivity of other gamefish populations in the reservoir, namely rainbow trout, smallmouth bass, and black crappie. The trout fishery severely declined due to this introduction. Angler-days declined from 34,955 in 1981 to 3,103 in 2010.

## **Phillips Reservoir Fisheries Management Plan Implementation**

The Phillips Reservoir Fisheries Management Plan provides a prescription of management actions intended to restore the rainbow trout fishery, per objectives provided in Appendix A. There is significant uncertainty on whether or not the management prescription can overcome existing challenges to accomplish these goals and objectives. Thus, an adaptive approach is warranted where monitoring and evaluation is implemented to assess effectiveness of the management prescription. This document - the Phillips Reservoir Monitoring and Evaluation Plan - outlines the monitoring activities necessary to objectively evaluate the progress toward our management goal of restoring the rainbow trout fishery.

As of January 2013, three management actions have been implemented in an attempt to restore the trout fishery. First, the trout stocking program was changed; the current trout stocking strategy consists of 33,600 legal sized rainbows (Oak Springs Stock) spread out over the months of April through July and 24,600 sub-legals (Oak Springs Stock) released in mid-September. Second, in 2004, 2005, 2009-2012 perch were netted and removed from the reservoir in an attempt to reduce their abundance. Finally, tiger trout were introduced into the reservoir in 2011 to replace the trophy aspect of the trout fishery that once existed with a unique, sterile hybrid. This strategy has maintained a trout fishery at the reservoir, although it does not meet the public's expectation. Creel data collected in 2007 and 2009 and a statistical creel survey in 2010 show that the catch rate is at or above the average, but the length of fish caught are smaller than those caught in the past.

In 2012, after researching various options available to control yellow perch, ODFW staff gained OFWC approval to reclassify tiger muskie from a prohibited species (OAR 635-056-0050) to a controlled species (OAR 635-056-0075) specifically for introduction into Phillips reservoir for fishery management purposes. This provided ODFW with legal authority to proceed with the proposed introduction of tiger muskie into Phillips Reservoir for the purpose of controlling yellow perch abundance to improve the trout fishery. Beginning in 2013, and continuing for an initial evaluation period of five years, tiger muskie will be released annually into Phillips Reservoir to achieve a target density of 1-2 adult tiger muskie adults per acre, which should be effective at controlling over abundant prey species without negatively impacting the

target management species (trout). Tiger muskie will be managed primarily as a catch-and-release fishery; high minimum length limits will allow these fish to grow to sizes that they can consume the greatest number of perch. Adjustment of stocking numbers and the determination of whether or not to continue the program after the five year evaluation period will be based on results from activities outlined in this monitoring and evaluation plan. It is anticipated a targeted sport fishery could develop for tiger muskie. Management decisions regarding tiger muskie will be made based on their intended purpose - to control yellow perch abundance for restoring the trout fishery - and not their value as a targeted sport fishery should one develop.

### **Biological Objectives Indicative of Fisheries Effects**

In addition to the fishery goals and objectives outlined in Appendix A, it is important to set biological objectives to provide indicators that management actions are affecting the system in a way necessary to attain fishery objectives. Biological responses will likely occur before fishery improvements will be detected. The primary indicators used will be the effectiveness of management actions (rainbow trout stocking, tiger trout stocking, tiger muskie stocking and mechanical perch removal) to reduce perch biomass and achieve improved growth and survival of rainbow trout stocked in the reservoir as fingerlings or sub-legals.

The intended density of adult tiger muskie in the reservoir is 1-2 fish/acre, although at this density, adequate samples to characterize the population in terms of density, growth and survival will be difficult. Therefore, monitoring of tiger muskie effects will be focused primarily on their impacts on yellow perch and the success of the hatchery trout program. Although there are many examples of using tiger muskie to control undesirable prey species in conjunction with maintaining or improving a hatchery trout program, higher abundance of tiger muskie would likely lead to them overrunning the perch prey base and then negatively impacting abundance of stocked rainbow trout and native fish species. Thus, careful monitoring of prey abundance is required. In terms of response time, it is anticipated it will take a minimum of three years after the initial introduction for tiger muskie to begin have a measurable effect on the yellow perch population and a minimum of five years before any level of control is achieved.

## **Fisheries Monitoring and Evaluation Plan**

### **Objective 1: Characterize recreational fishery.**

Task 1.1: Conduct angler creel surveys during the 5-year evaluation period to monitor the efficacy of the tiger muskie and tiger trout introductions.

Rationale: Creel surveys will be critical in analyzing the efficacy of the tiger muskie and tiger trout introductions in improving conditions in the reservoir for a hatchery trout program. Meeting management objectives for the trout fishery is the ultimate goal of the muskie introduction, while tiger trout were introduced because it was thought that their piscivorous nature and the abundant perch in the reservoir offered a better chance of producing trophy trout for which Phillips was historically known. Creel census and gillnet sampling to monitor the trout fishery

were limited during the 1990's, and early 2000's, so there is little data to characterize the decline of the fishery, post perch introduction.

Approach: A statistical creel survey is planned for 2013. The results of this and other recent creel information will be used as baseline information to compare against once muskie are introduced. Although muskie will hopefully be introduced Spring 2013, they will not appreciably affect the system so any creel information collected that year can be included in the baseline.

In 2014 or 2015, the Warmwater Program could potentially provide seasonal time for May and June and the La Grande District could use interns from July on. It will be imperative to conduct a creel in 2017 because the decision as to whether to continue the tiger muskie program must be made prior to the 2018 field season.

The primary objectives for the creel survey would be to 1) determine catch rate and size distribution of rainbow trout, tiger trout, and yellow perch by anglers, 2) determine catch rate and size distribution of warmwater game species by anglers, and 3) estimate total and season angler pressure from April/May through October.

Task 1.2: Conduct angler opinion surveys during the 5-year evaluation period to monitor any potential changes in angler satisfaction resulting from management efforts.

Rationale: The 2008 angler opinion survey conducted by ODFW was used to develop management objectives for Phillips Reservoir. It documented angler dissatisfaction with the state of the trout fishery at that time. Management actions taken to improve the fishery will ultimately be measured by improvements in the quality of the trout fishery and the level of angler satisfaction with the fishery. Angler opinion surveys conducted concurrently with angler creel surveys will allow correlation of angler satisfaction to angler success with the most judicious use of staff time.

Approach: Incorporate an angler opinion survey similar to the 2008 angler opinion survey into the 2013 creel survey to reinforce baseline information on angler satisfaction. As with the creel survey, it will be imperative to conduct an angler opinion survey in 2017 because the decision as to whether to continue the tiger muskie program must be made prior to the 2018 field season. Ideally, an additional creel/angler opinion survey should be conducted midway through the initial 5-year evaluation period (2015).

## **Objective 2: Monitor performance of stocked trout.**

Task 2.1: Develop quantitative survival estimates for hatchery sub-legal rainbow trout stocked in the fall.

Rationale: The survival and growth of rainbow trout stocks in the reservoir are important factors in assessing the effectiveness of stocking various strains of hatchery trout. It will be important to develop quantitative estimates of the survival of sub-legal trout stocked in the fall. There is no baseline data on the survival of rainbow trout fingerlings released into Phillips Reservoir in the past. As the abundance of yellow perch decreases, it is hoped that their negative impact on trout survival will also diminish. However, because of the high variability of fingerling survival based on size and timing of release and the particular reservoir environment, no objective is provided for this metric. Rather, an improving trend in survival will provide evidence that reservoir conditions are improving for trout. This information will be used to make decisions on future stock selection and hatchery releases.

Approach: In Spring 2012, 3,000 catchable trout were stocked throughout the reservoir to mix and be captured in Merwin traps along with surviving sub-legal trout stocked in Fall 2011. This resulted in a 95% confidence interval of less than 1% of the point estimate for survival. However, 2013 will be the last year of the large-scale Merwin trapping effort so either in 2013 or 2014, alternative methods, possibly reduced-scale Merwin trapping or South Dakota trapnets should be used to see what level of effort is needed to generate accurate population and survival estimates. This methodology should be determined before the 2016 field season so baseline and project-effect levels of survival can be compared prior to the 2018 decision point.

Task 2.2: Monitor the growth of sub-legal rainbow trout.

Rationale: Trout fingerlings released in the 1970's and 1980's achieved 5" of growth in length from their first to second fall in the reservoir. Annual growth of rainbow trout in other Baker County reservoirs range from 2.6 to 7.3 inches. The interim objective for growth of sub-legal rainbows stocked in the fall will be for them to increase in average length by 4" from their first to second spring in the reservoir.

Approach: Fall-stocked sub-legal rainbow trout will be adipose marked to distinguish them from wild trout naturally occurring in the reservoir and stocked legal-sized rainbow trout. Methods used to generate quantitative survival estimates for hatchery sub-legal rainbow trout stocked in the fall (Task 2.1), as well as efforts to monitor changes in reservoir fish biomass contribution (Task 3.3) should capture enough fish to provide data on growth of stocked sub-legal rainbow.

Task 2.3: Monitor the growth of legal-sized rainbow trout.

Rationale: As yellow perch density changes, the ability of hatchery trout fingerlings to grow and survive to produce the trophy component of the fishery changes.

Approach: 3,000 legal-sized trout stocked for the purpose of estimating sub-legal trout survival will be marked with a fluorescent spray dye. These legal-sized trout will be stocked every year about the same time and their fluorescent spray mark will differentiate them from other catchable trout stocked later in the season. If a subsample is measured when they are stocked, we will be able to follow the growth of each cohort as they are recovered throughout the project and determine if their growth responds to changes in yellow perch density. Methods used to generate quantitative survival estimates for hatchery sub-legal rainbow trout stocked in the fall (Task 2.1), as well as efforts to monitor changes in reservoir fish biomass contribution (Task 3.3) should capture enough fish to provide data on growth of dye-marked stocked legal-sized rainbow.

Task 2.4: Monitor the growth and survival of stocked tiger trout.

Rationale: Tiger trout have been introduced to replace, at least on an interim basis, the trophy aspect of the trout fishery that once existed. While tiger trout have performed well under a wide range of environmental conditions and species assemblages, it is unknown to what extent they will achieve their intended purpose in Phillips Reservoir. Although there will likely be issues with differences in size, condition, or timing at stocking that may complicate or preclude comparison, tiger trout survival and/or growth through the evaluation period may be another metric that can be used to monitor the effects of tiger muskie.

Approach: Assuming equal catchability as rainbow trout, methodology developed for Tasks 2.1 and 3.3 will also allow us to estimate survival of stocked tiger trout. However, as the growth and survival of tiger trout is secondary to that of stocked rainbow trout, considerations should be given to methodology to generate accurate survival estimates for the latter.

**Objective 3: Monitor changes in reservoir food web, with respect to yellow perch abundance.**

Task 3.1: Monitor changes in yellow perch population density.

Rationale: The intended density of tiger muskie in the reservoir will be so low that it will be difficult to characterize the population through sampling. Therefore, monitoring yellow perch abundance is an indirect measure of the tiger muskie introduction effort. Although there are many examples of using tiger muskie to control undesirable prey species in conjunction with maintaining or improving a hatchery trout program, higher abundance of tiger muskie would likely lead to them overrunning the perch prey base and then negatively impacting abundance of stocked rainbow trout and native fish species. Thus, careful monitoring of prey abundance, in this case yellow perch is required. Fish

managers from other states have found that managing the prey species at approximately 30% of the biomass provides the needed level of control while protecting other species from undesirable levels of predation and competition. Thus, as an interim target, it is desired that perch biomass not exceed 30% of the fish community by weight, as determined by proportion of fish caught in annual gillnet or trap net samples collected in the spring.

Approach: Past perch population estimates were generated by releasing double-tagged perch essentially concurrent with the initiation of Merwin trapping. Given the number of fish tagged and the number of captured/examined, we were 95% sure that the perch population estimate was within ~18% of the true number. The same will hold true with the 2013 perch population estimate as the full Merwin trapping effort will be repeated for the final time. Future more-limited trapping efforts with trapnets and/or Merwin traps are predicted to catch in the range of 40% of the perch that “historic” trapping captured. If this is the case and we continue to tag 500 perch, we can be 95% sure that the perch population estimates are within ~22-24% of the actual number. With the decrease in number of perch handled and examined for marks, the number marked would need to be increased to tighten confidence limits on perch population estimate; 1,000 tagged perch, might approach the accuracy of past population estimates.

In addition, we will attempt to correlate population estimates generated through mark-recapture using trapping to boat electrofishing catch-per-unit-effort (CPUE). Although the effectiveness of this technique will likely be limited at higher perch densities due to the asymptotic nature of the relationship, if the tiger muskie introduction is effective in reducing perch abundance, identification of the electrofishing CPUE/perch abundance relationship will facilitate monitoring of perch abundance with respect to the 30% biomass goal.

Task 3.2: Monitor changes in yellow perch population growth rates.

Rationale: As yellow perch population density is driven below the carrying capacity of the reservoir, intra-specific competition should decrease and perch growth rates should hypothetically increase.

Approach: This analysis is not critical to the evaluation of the success of our management actions. Age/growth analysis of perch performed in 2013 should provide a baseline for comparison to the results of a similar analysis performed in the final year of the initial evaluation period (2017). Standard protocol for complete age analysis – scales collected from 10 fish in every 10-mm length increment above 150 mm – will provide the information necessary for comparison.

Task 3.3: Monitor changes in reservoir fish biomass contribution.

Rationale: As was explained in the rationale for Task 3.1, fishery managers from other states suggest that as an interim target that perch biomass not exceed 30% of

the fish community by weight. Methodology utilized to achieve Task 3.1 will generate one index of fish community species biomass distribution, while the methodology outlined below will generate another index. The advantage of this methodology is that it is much more comparable to a long-term dataset available in district records.

Approach: District personnel may set two experimental gillnets in May at pre-established locations used in previous annual inventory trend netting. This information will then be comparable to historic gillnet sets. Although gillnet capture efficiency tends to be biased against warmwater species, this bias existed in past netting efforts. If we acknowledge and accept those biases, this netting methodology will generate another index of whether perch abundance is moving toward the 30% biomass target.

#### **Objective 4: Monitor tiger muskellunge diet.**

Task 4.1: Determine tiger muskie diet.

Rationale: Although the literature shows muskie will utilize perch, it also suggests that they will select against them as they are spiny-rayed fish. Diet analysis will illustrate the degree to which perch are being utilized as forage.

Approach: Stomachs will be collected from any dead muskie encountered, while stomach contents of live muskie encountered during sampling will be collected using gastric lavage and through a sieve (1-mm opening) and preserved in 70% ethanol for examination in the lab. Food items will be examined using a variable power (7-30X) binocular dissecting microscope and identified to the lowest practical taxonomic level (most often to order, but in some cases, sub-order or family), and counted. Identification of partially digested fish remains to family will be accomplished using a variety of keys available for diagnostic bones.

Percentage contribution to the diet (by volume) of each category of food item will be calculated on the basis of the entire volume of food. Volume of other specific food items consumed will be calculated by multiplying the number of individuals by the average volume per individual. Average displacement (volume) per individual will be measured by placing representative individuals in a graduated centrifuge tube partially filled with water. This allowed volume estimation even if only partial remains of a prey item were found in a stomach.

#### **Objective 5: Monitor for upstream movement of tiger trout.**

Task 5.1: Monitor for presence/absence of tiger trout in Powder River upstream of Phillips Reservoir.

Rationale: Bull trout reside in tributaries of the Powder River upstream of Phillips Reservoir. While tiger trout are primarily sterile, there is the small possibility that they could either interbreed with bull trout and/or compete for habitat, should they leave the reservoir and migrate to reaches occupied by bull trout.

Approach: Releases of tiger trout in 2011 and 2012 have not met either the target number or size, as a direct result no tiger trout were captured in sampling activities in 2011. Thus at this time, it is unlikely that significant numbers of tiger trout exist in the reservoir. Once in-reservoir sampling has documented significant survival of tiger trout, then sampling should occur in the Powder River, to determine movement upstream. Presence/absence of tiger trout in electrofishing samples will be used to document upstream movement into the 8 Km reach above Phillips. One randomly selected 100 m site will be sampled in each 1 km reach of river. One pass will be completed with block nets.

## **Limnological Monitoring and Evaluation Plan**

### **Objective 1: Monitor Basic limnological characterization of the reservoir**

Rationale: The rule language changing the status of tiger muskie from prohibited to controlled states “Department will develop an environmental monitoring plan for Phillips Reservoir which should include:

a) Basic limnological characterization of the reservoir (nutrient concentrations, light penetration, vertical profiles of physical and chemical characteristics of reservoir water, zooplankton, and phytoplankton composition and densities).”

Approach: As the goal of this aspect of the M&E program is to monitor changes in water quality over the initial 5-year period following introduction of tiger muskie, complete limnological characterization of the reservoir is not necessary. This fact and the general homogeneity of the water mass in the lake reduces the number of sampling sites needed to monitor changes in basic limnological characteristics of the lake. Sampling will occur from May through October during years when a fisheries creel clerk is employed to take advantage of the additional manpower.

#### **Task 1.1: Monitor changes in reservoir nutrient concentration.**

Approach: Replicate integrated epilimnetic water samples for nutrient analysis will be collected at monthly intervals at a deep water station using a 15-m long, 2.54-cm diameter acrylic tube suspended vertically in the water column. Additionally, replicate water samples will be collected using a non-metallic Van Dorn bottle from the surface to depth at 5-m intervals at three times during the growing season - prior to spring stratification, late in the summer stratification and after the autumn overturn. Ideally, water samples will be analyzed for concentrations of total phosphorus, soluble reactive phosphorus, orthophosphate,

nitrate-nitrogen, nitrate-nitrogen, total Kjeldahl-nitrogen, ammonia-nitrogen, but budget constraints might limit the number of parameters tested.

Task 1.2: Monitor changes in reservoir light penetration.

Approach: At weekly intervals, a standard 20 cm (7.9 in) Secchi disk will be lowered into the water on the shaded side of the boat until it just disappears from sight. This depth is recorded to the nearest 0.1 meter. The disk is then lowered an additional meter and raised until it reappears. These two values are then recorded separately. The depth of disappearance and reappearance of the disk is averaged, and the depth is measured to the nearest 0.1 meter.

Task 1.3: Monitor changes in physical and chemical characteristics of reservoir water.

Approach: Temperature and dissolved oxygen profiles will be measured at 1 m increments weekly at the deepest point in the lake using a YSI temperature/dissolved oxygen meter. Total alkalinity and specific conductance of water samples collected monthly from depths corresponding to the epilimnion, metalimnion, and hypolimnion will be measured using electronic meters. Seasonal and spatial variability in pH requires more careful monitoring; measurements from water collected every other week from depths corresponding to the epilimnion, metalimnion, and hypolimnion should adequately track changes.

Task 1.4: Monitor changes in zooplankton community composition and density.

Approach: Zooplankton will be sampled bi-weekly at a deep water station by making replicate vertical tows at twice the Secchi depth or the entire water column above the thermocline (whichever is greater) at a rate of 0.5 m/s with a Wisconsin-type plankton net with 153  $\mu\text{m}$  mesh and a 0.12 m diameter opening. In areas shallower than the above depth, tows will be started from just above the bottom. Zooplankton will be preserved with 70% ethanol and stained with rose Bengal. A one milliliter aliquot of each well-mixed sample will be used for analysis where zooplankters will be identified to the lowest practical taxonomic level, counted, and a subsample of the dominant taxa measured. To provide a statistically valid count at least 100 organisms will be counted from each sample. Size frequency distributions for cladocerans will be determined by measuring from the anterior margin of the head to the base of the tail spine. Copepods will be measured from the anterior margin of the head to the base of the caudal rami.

Task 1.5: Monitor changes in reservoir chlorophyll concentration.

Approach: Water samples for chlorophyll analysis will be collected at two week intervals (Table 2) at a deep water station. Replicate integrated water samples for chlorophyll analysis will be collected using a 15-m long, 2.54-cm diameter acrylic

tube suspended vertically in the water column, buffered with MgCO<sub>3</sub>, filtered through 0.45µm filter paper, and stored in the freezer until processed. Spectrophotometric determination of concentrations of chlorophyll-*a*, *b*, and *c*, as well as pheophytin-*a*, will be performed using standard methods for acetone extraction on two distinct sub-samples from each composite sample (APHA 1976).

Task 1.6: Monitor changes in reservoir phytoplankton composition and density.

Approach: Phytoplankton will be collected at a deep water station three times during the growing season using the same integrated hose sampler methodology used to collect samples for chlorophyll-*a*. One composite sample, consisting of three combined replicate water samples, will be collected for each sample site/time. All samples will be preserved with Lugol's iodine and held in the dark on ice until delivery to the laboratory where they will be concentrated by allowing to settle at least 24 hours and siphoning off most of the water. Enumeration will be accomplished in a Sedgwick-Rafter counting cell using a one milliliter aliquot taken from the well mixed concentrate. Phytoplankters will be reported by taxonomic group. The groups include:

- Chrysophyta
  - Diatoms
    - centric
    - pennate
- Chlorophyta
  - Green algae
    - coccolids
    - filamentous
- Cyanophyta
  - Blue-green algae
    - colonial
    - filamentous
- Others

Only algae that are alive at the time of preservation, based on cell contents, will be enumerated. Algae will be identified to the lowest practical taxonomic level and enumerated in sequentially viewed fields along transects of the counting chamber. Counting will continue until at least 100 units are counted and until no new taxa are observed. A unit is defined as a discrete algal particle (cell, filament or colony); when filamentous fragments are encountered they will be counted as whole organisms.

Task 1.7: Monitor changes in reservoir benthic macroinvertebrate community composition and density.

Approach: The benthic macroinvertebrate fauna in Phillips Reservoir will be collected with duplicate Ekman dredge samples at 5 m depth intervals to 20 m at

the deepest part of the lake with no compositing of individual samples. Bottom materials will be washed through a U.S. Standard No. 30 sieve (pore size 0.59 mm), preserved in 70% ethanol and returned to the laboratory. Samples will be placed in a saturated salt solution to float organisms free from the sediment and debris. The organisms will be transferred back into 70% ethanol containing rose bengal, a stain selective for tissues. Macroinvertebrates will be counted and identified to the lowest taxonomic level practical.

**APPENDIX A:** Fishery management goals and objectives as outlined in the Phillips Reservoir Fisheries Management Plan.

Fishery Management Goal: Restore the recreational trout fishery to characteristics (catch rates, size of fish, etc.) approaching those experienced in the 1970's and 1980's. Provide opportunities for other species as described in species specific goals and objectives when they can be achieved without significantly impacting attainment of trout fishery goals and objectives.

Overall Management Objective: Average annual angler use of 38,000 angler-days

Trout Management Goal: Manage for a productive trout fishery that provides both stock and trophy-sized fish.

Objective: Catch Rate 0.50 fish/hour

Objective: Size distribution of catch representative of the fishery prior to perch introduction.

Warmwater Species Management Goal: Manage to provide fishery for trophy-sized bass. No management emphasis on black crappie.

Objective: Bass abundance and size optimized to achieve trophy size to the extent that they do not negatively impact stocked rainbow trout and the effective introduction of tiger muskie.

Perch Management Goal: Provide harvest opportunity as long as objectives of the trout fishery can be met.

Objective: Catch rate 1 fish/hr

Objective: Average length of catch is 10 inches.

**APPENDIX B.** Schedule for fisheries sampling at Phillips Reservoir. “XX” denotes that activity should be carried out in order to evaluate program, “CC” indicates that activity is not critical but would be beneficial to evaluation of program if carried out.

Task Acti vity	Year	Is activity planned?	Apr	May	Jun	Jul	Aug	Sep	Oct
1.1 Creel survey	2013	XX	XX XX	XX		XX XX		XX XX	
	2014								
	2015	XX	XX X	XX	X	XX X	X	XX X	X
	2016	CC	CC C	C C	C	CC C	C	CC C	C
	2017	XX	XX X	XX	X	XX X	X	XX X	X
1.2 Angler opinion survey	2013	XX	XX X	XX	X	XX X	X	XX X	X
	2014								
	2015	CC	CC C	C C	C	CC C	C	CC C	C
	2016								
	2017	XX	XX X	XX	X	XX X	X	XX X	X
2.1 Survival of subcatchable trout	2013	XX	XX	XX					
	2014	XX	XX	XX					
	2015	XX	XX	XX					
	2016	XX	XX	XX					
	2017	XX	XX	XX					
2.2 Growth of subcatchable trout	2013	XX	XX	XX					
	2014	XX	XX	XX					
	2015	XX	XX	XX					
	2016	XX	XX	XX					
	2017	XX	XX	XX					
2.3 Growth of catchable RBT	2013	XX	XX	XX					
	2014	XX	XX	XX					
	2015	XX	XX	XX					
	2016	XX	XX	XX					
	2017	XX	XX	XX					
2.4 Growth and survival of tiger trout	2013	CC	CC	CC					
	2014	CC	CC	CC					
	2015	CC	CC	CC					
	2016	CC	CC	CC					
	2017	CC	CC	CC					
3.1 Perch density	2013 <sup>a</sup>	XX	XX						
	2014 <sup>b</sup>	CC	CC						
	2015 <sup>b</sup>	CC	CC						
	2016 <sup>b</sup>	XX	XX						
	2017 <sup>c</sup>	XX	XX						
3.2 Perch growth	2013	CC	CC						
	2014								
	2015								
	2016								
	2017	CC	CC						
3.3 Perch % of community biomass	2013	XX	X	X					
	2014	XX	X	X					
	2015	XX	X	X					
	2016	XX	X	X					
	2017	XX	X	X					

**APPENDIX B. (continued)**

<b>4.1</b>	<b>Tiger muskie diet</b>	<b>2013</b>								
		<b>2014</b>	CC	CC C	CC	C	CC C	C	CC C	C
		<b>2015</b>	CC	CC C	CC	C	CC C	C	CC C	C
		<b>2016</b>	CC	CC C	CC	C	CC C	C	CC C	C
		<b>2017</b>	CC	CC C	CC	C	CC C	C	CC C	C
<b>5.1</b>	<b>Tiger trout emigration<sup>d</sup></b>	<b>2013</b>								
		<b>2014</b>								
		<b>2015</b>								
		<b>2016</b>								
		<b>2017</b>								

<sup>a</sup> population estimate using full Merwin trapping effort

<sup>b</sup> Population estimate or density estimate using modified trapping effort and/or electrofishing.

<sup>c</sup> Ideally perch density estimate would be generated using full Merwin trapping effort.

<sup>d</sup> Surveys in Powder River will be performed annually if and when a population of tiger trout becomes established in the reservoir.

**APPENDIX C.** Schedule for limnological sampling for Phillips Reservoir. Nutrients to be sampled include total phosphorus, soluble reactive phosphorus, orthophosphate, nitrate-nitrogen, total Kjeldahl-nitrogen, ammonia-nitrogen.

Task	Parameter measured	Frequency <sup>a</sup>	Location <sup>b</sup>	May	Jun	Jul	Aug	Sep	Oct
1.1	Nutrient concentration	Monthly	Epilimnion composite	XX	XX	XX	XX	XX	XX
		Strat After strat	5-m interval	XX late	XX late	XX late	XX late		
1.2	Secchi	Weekly		XX	XX	XX	XX	XX	XX
1.3	pH	Bi-weekly	Zonal	XX	XX	XX	XX	XX	XX
1.3	Total alkalinity, specific conductance	Monthly	Zonal	XX	XX	XX	XX	XX	XX
1.3	D.O. and Temperature	Weekly	Surface to depth, 1 m intervals	XX	XX	XX	XX	XX	XX
1.4	Zooplankton	Bi-weekly	Epi&mesolimnion <sup>c</sup>	XX	XX	XX	XX	XX	XX
1.5	Chlorophyll	Bi-weekly	Epilimnion composite	XX	XX	XX	XX	XX	XX
1.6	Phytoplankton	Mid-month	Epilimnion composite	XX		XX		XX	
1.7	Benthic inverts	Mid-month	5m, 10m, 15m, 20m	XX		XX		XX	

<sup>a</sup> Bi-weekly means every other week. Strat refers to three sampling occasions: prior to spring stratification (late May), late in the summer stratification (late July), and after the autumn overturn (late September).

<sup>b</sup> Zonal denotes 3 samples: epilimnion, metalimnion, and hypolimnion.

<sup>c</sup> Sample at twice the secchi depth or the entire water column above the thermocline, whichever is deeper.

# **Phillips Reservoir Fishery Management Plan**

**Oregon Department of Fish & Wildlife**

## OVERVIEW

### Site Description

Mason Dam impounds the Powder River at approximately RM 131 creating Phillips Reservoir. Phillips Reservoir is located in northeast Oregon, approximately 17 miles southwest of Baker City (Figure 1). It was constructed by the U.S. Bureau of Reclamation in 1968 for the purposes of irrigation, flood control, and recreation. The impoundment is five miles long at full pool, has a surface area of 2,235 acres and a storage capacity of 90,500 acre-feet (Johnson et al. 1985). The full pool elevation includes flood storage which rarely occurs. The normal full pool management volume to meet irrigation needs is 73,570 acre-feet with surface area of approximately 1,800 acres.

At 4,070 feet above sea level at full pool, the reservoir is mesotrophic in nature, is characterized by moderate to high phosphorus and chlorophyll concentrations, low to moderate water transparencies, and blue-green algal blooms (Johnson et al. 1985). Macrophytes are common in most of the littoral areas in the upper lake, at or near full pool management level.

The watershed upstream of the reservoir encompasses 105,345 acres and extends 15-20 miles upstream. The Powder River is formed by the confluence of Cracker Creek and McCully Fork at RM 144. The other Primary tributary of the upper Powder River, Deer Creek, flows directly into the reservoir at approximately RM 134. Other minor tributaries flowing into the reservoir include Miners, Smith, Dean, Clear and Union creeks. The headwater streams originate in the Elkhorn Mountains, with peaks reaching 9,000 feet in elevation. Runoff is dominated by snowmelt in the spring, with low flows occurring from July through October.

The reservoir is surrounded primarily by gently sloping forested terrain except at its western perimeter where it meets the Powder River valley. Much of the valley upstream of the reservoir has been mined for gold and remains a maze of tailing piles. The lands surrounding the reservoir are managed by the United States Forest Service, Wallowa Whitman National Forest (WWNF). The WWNF operates three campgrounds around the lake: the 67 unit Union Creek campground on the north side of the lake including full hookups for RV's and a boat launch, and two smaller more primitive campgrounds on the southwest side of the reservoir. Two additional boat launches exist, on the north side of the reservoir near the dam, and on the south side of the reservoir at Southshore Campground.

Stream habitat and water quality upstream of the reservoir have been degraded by extensive gold mining activities. The majority of the eight-mile reach of the Powder River valley upstream of the reservoir extending to Sumpter was placer mined by the Sumpter Valley Gold Dredge. This occurred at its largest scale prior to the 1950's, but continues today with measurable impact to fish habitat, particularly in Cracker Creek upstream from Sumpter. This has left the valley with its alluvial material aligned in an organized system of tailing piles leaving no semblance of the river's historic floodplain. Among this maze of tailings is the now confined river channel and approximately 250 acres of ponds that exist between the rows of tailing piles.

Fish Habitat in the upper Powder River has also been affected by traditional land use practices of timber harvest, livestock grazing and out-of-stream water use. The river upstream of the reservoir is dewatered due to irrigation diversions in the summer months. However, high quality habitats exist in areas that have not been negatively impacted by mining as evidenced by the presence of bull trout.

The Powder River flows for approximately three miles through Wallowa Whitman National Forest, immediately downstream of Mason Dam. Here the habitat is in relatively good condition. Water temperatures are good throughout the summer as water is released from the bottom of the reservoir for irrigation use downstream in the Baker Valley.

Habitats downstream of the National Forest become increasingly degraded. The impacts are those generally associated with agricultural activities including reduced riparian vegetation, loss of channel stability, loss of in-channel habitat diversity, reduced instream flows and passage barriers. Habitat quality in the Baker Valley and below is generally fair to poor (RM 115 to the mouth).

### **Fish Resources**

A wide array of both introduced and native fish species are found throughout the Powder River Basin (Table 1). Native fish including redband trout, bull trout (*Salvelinus confluentus*), suckers (largescale [*Catostomus macrocheilus*], bridgelip [*Catostomus columbianus*] and mountain [*Catostomus platyrhynchus*]), redband shiner (*Richardsonius balteatus*), dace (*Rhinichthys sp.*), sculpins (*Cottus sp.*) and northern pikeminnow (*Ptychocheilus oregonensis*) inhabit the Powder River and its tributaries upstream of the reservoir. All but bull trout are widespread in distribution and abundant. Small populations of bull trout exist in Silver Creek and Fruit Creek, tributaries to Cracker Creek and Lake Creek, tributary to Deer Creek. Known occupied bull trout habitat in Silver Creek is approximately 14 miles upstream of Phillips Reservoir, while occupied bull trout habitat in Lake Creek is approximately 6.5 miles upstream of the reservoir.

Phillips Reservoir is inhabited by a number of fish native to the watershed, and introduced non-native species (Table 2). Presence of bull trout was documented for the first time in Phillips Reservoir in 2011. Two bull trout were collected in 2011 during the perch removal project in April. A 215 mm bull trout was captured on April 13<sup>th</sup> and a 234 mm bull trout on April 18<sup>th</sup>. Northern pikeminnow and largescale sucker are abundant in the reservoir as evidenced by attempts to control their numbers with fish toxicants in the 1960's and 1970's (ODFW unpublished reports and data summaries). Largemouth bass (*Micropterus salmoides*) and smallmouth bass (*Micropterus dolomieu*) were introduced into the reservoir by ODFW beginning in the 1970's with the intent of reducing the abundance of northern pikeminnow and providing angling opportunity. They are currently present in the reservoir in relatively small numbers. Black crappie were first found in gillnet samples from the reservoir in 1989, the product of an illegal introduction. While they continue to be present in the reservoir, their abundance has remained relatively low likely due to competition for food resources with yellow perch and cool water temperatures in the lake. Yellow perch were first documented in the reservoir in 1991, also the product of an illegal introduction and are now the dominant fish

species in the reservoir. Naturally produced rainbow/redband trout are present, as well as stocked rainbow trout.

Stocking of hatchery rainbow trout (Oak Springs Stock), began in 1968, the year the reservoir was first filled, and continues presently (Table 3). The strategy has changed over the years, primarily in response to the introduction of yellow perch. From 1968 through 1991, stocking consisted primarily of rainbow trout and coho fingerlings, averaging approximately 165,000 and 109,000, respectively. The stocking of coho was terminated in 1992, while stocking of rainbow trout fingerlings continued through 2003 at an average number of approximately 128,000. The rainbow trout fingerling stocking strategy was terminated because, in the presence of over abundant yellow perch, they were not recruiting into the fishery. The fingerling stocking strategy was replaced with a put and take program of legal-sized rainbows and experimental release of fall sub-legals (put-grow-and take).

The current trout stocking strategy consists of 33,600 legal sized rainbows (Oak Springs Stock) spread out over the months of April through July and 24,600 sub-legals (Oak Springs Stock) released in mid-September. This strategy has maintained a trout fishery at the reservoir, although it does not meet the public's expectation as evidenced from the 2008 angler survey (ODFW 2009).

Yellow perch were first documented in the reservoir in 1991. They became very abundant in the reservoir by the mid to late 1990's (ODFW unpublished data), and being a particle-feeding planktivore, led to changes in the reservoir's zooplankton community (Shrader 2000). This change impacted the productivity of other gamefish populations in the reservoir, namely rainbow trout, smallmouth bass, and black crappie (Shrader 2000). Sampling of warmwater gamefish populations in the late 1990's showed that production of smallmouth bass and black crappie dropped to almost zero (Shrader 2000).

Although Shrader (2000) did not find a biologically significant diet overlap between yellow perch and rainbow trout in Phillips Reservoir, both species demonstrated a preference for larger zooplankton, *Daphnia* in particular. Yellow perch, by virtue of their numbers and selection for larger zooplankton, shifted the size structure toward daphnids generally too small to be consumed by trout. Trout in Phillips likely shifted their diets in response to declining numbers of large *Daphnia*, but Shrader (2000) did not investigate the bioenergetic cost of this diet shift.

A similar, but more intensive study of the interaction between stocked hatchery rainbow trout fingerlings and illegally-introduced three-spine stickleback (*Gasterosteus aculeatus*) in Crane Prairie Reservoir (Shrader 2008) suggests a mechanism that may be operating at Phillips Reservoir. Stickleback in Crane Prairie Reservoir appear to act much like the yellow perch in Phillips; they have become extremely abundant and through a preference for large *Daphnia*, have shifted the size structure of daphnids toward individuals of a size not preferred by rainbow trout fingerlings. Diet monitoring at Crane Prairie Reservoir indicated a fairly short, but critical summer period when competition between rainbow trout and stickleback for *Daphnia* occurred when rainbow trout were likely severely stressed by high epilimnetic water temperatures and low hypolimnetic oxygen levels. During this period fingerling rainbow trout sustained ~88% mortality.

The poor performance of rainbow trout fingerlings after the introduction of yellow perch suggests that there is a negative interaction with yellow perch, either in the form of a diet bottleneck not found in Shrader's (2000) evaluation, or a significant bioenergetic cost in the shifting of trout diets due to scarcity of preferred items.

Others have found that the abundance of large daphnids is often highly correlated with the growth and survival of rainbow trout stocked in lakes and reservoirs (Galbraith 1975, Mills and Schiavone 1982, Tabor et al. 1996, Wang et al. 1996). Wang et al. (1996) reported that *Daphnia pulex* > 1.3 mm formed approximately 77% of the diet of rainbow trout < 300 mm. The collapse of a rainbow trout fishery in Flaming Gorge Reservoir, Wyoming-Utah was caused by a decline in density and size of *Daphnia sp.* (Schneidervin and Hubert 1987).

Perch have now reached their carrying capacity in the reservoir and have become stunted. The average length of yellow perch collected in gillnet samples in 2011 was 206 mm (8.1 inches). Perch collected in Merwin trap nets in 2009 averaged 190 mm (7.5 inches), 186 mm (7.3 inches) in 2010 and 189 mm (7.4 inches) in 2011.

Walleye (*Stizostedion vitreum*) were illegally introduced approximately the same time as yellow perch. Their abundance has remained low with few captured in sampling activities and a few large fish being caught by anglers. Should walleye increase in productivity and abundance, the ecology of the reservoirs fish community would again see significant changes. In addition, Phillips Reservoir would be a source for colonization downstream, a significant concern regarding the conservation of native fish and productivity of recreational fisheries.

### **Fish Management History**

As is the case with many newly constructed reservoirs, a very productive and popular recreational fishery developed immediately after construction of Phillips Reservoir in 1968. Creel surveys documented high angler participation with a peak of 67,510 angler-days in 1970. Angler use of this reservoir was high considering it is in a relatively sparsely populated region of Oregon. However, there have also been fishery management challenges including inter-specific competition between gamefish and native fish and illegal introductions of non-native fish.

Fishery managers foresaw potential issues with inter-specific competition as 134 miles of the Powder River and tributaries upstream of the reservoir and 250 acres of dredge tailing ponds were treated with chemical fish toxicant to remove unwanted non-game fish species prior to first filling of the reservoir. Even so, native non-gamefish species including northern pikeminnow and suckers became a concern to fishery managers as their presence reduced the productivity of stocked rainbow trout and coho salmon. Efforts were made to reduce non-game fish abundance by treatment of the reservoir and streams with chemical fish toxicants again in 1973 and 1977. Game fish abundance responded favorably after these treatments, but non-game fish dominated the reservoir within 3-5 years after treatment.

As the cost of chemical fish toxicants increased and their use became less favored due to environmental concerns, fishery managers employed other measures to control the non-game fish population in the reservoir. Both large and smallmouth bass were introduced into the reservoir

by ODFW, including stocking of both juveniles and adults through the 1970's and as late as 1995. The management intent was for bass to prey on juvenile northern pikeminnow, thereby controlling their numbers, and to provide additional angling opportunity. To what extent bass controlled the abundance of northern pikeminnow in the reservoir is unknown as no monitoring or research was implemented to investigate this, but the fish community in the reservoir seemed to maintain a stable balance through the 1980's.

The fishery thrived through the 1980's, developing a following of both local and regional anglers. The reservoir produced good catch rates of high condition factor trout averaging 12 to 14 inches with significant numbers 14 to 20 inches. The reservoir was also known for producing trophy-sized fish.

An end came to the productivity of one of the region's most popular trout fisheries as the result of the illegal introduction of yellow perch, first documented in 1991. The perch quickly populated the reservoir and by the mid 1990's they were the dominant species. The trout fishery severely declined due to this introduction. Angler-days declined from 34,955 in 1981 to 3,103 in 2010 (Figure 2). Similarly, Fraser (1978) documented an 87% reduction in the mean return of stocked rainbow trout following the establishment of yellow perch in a small Ontario lake.

Three management actions have been implemented in an attempt to restore the trout fishery. First, the trout stocking program was changed to more of a put and take program as described previously. Second, in 2004, 2005, 2009-2011 perch were netted and removed from the reservoir in an attempt to reduce their abundance. Finally, tiger trout were introduced into the reservoir in 2011 to replace the trophy aspect of the trout fishery that once existed with a unique, sterile hybrid.

The current trout stocking program has maintained a trout fishery at the reservoir, although the fishery is not meeting public expectations. Creel data collected in 2007 and 2009 and a statistical creel survey in 2010 show that the catch rate is at or above the average (Figure 3), but the length of fish caught are smaller than those caught in the past (Figure 4).

### **Fishery Management**

The fishery for both trout and warmwater gamefish at Phillips Reservoir has been managed for basic yield. Regulations have generally been standard for lakes and reservoirs in the region. Regulations for trout are: open all year, five per day and 2 daily limits in possession. Regulations for bass are: open all year, five per day and 2 daily limits in possession, and no more than 3 over 15 inches in length. There are no bag limits for other warmwater gamefish in Phillips including crappie, yellow perch and walleye. The only special regulation in place for Phillips Reservoir is a catch and release regulation for recently introduced tiger trout, implemented in 2012. As tiger trout are intended to provide a trophy fishery, the catch and release regulation is intended to allow the initial releases to attain trophy size, and to provide for assessment of their trophy potential in Phillips Reservoir. Once monitoring results provide information on the growth and trophy potential of tiger trout, ODFW will determine to what extent harvest could be allowed; yet maintain the trophy quality of the fishery.

Creel census and gillnet sampling to monitor the trout fishery were limited during the 1990's, and early 2000's, so there is little data to characterize the decline of the fishery, post perch introduction. However, the angler opinion survey documents that anglers are unsatisfied with the trout fishery, which is the species the majority of anglers would like ODFW to manage for (ODFW 2009).

## **MANAGEMENT IMPLEMENTATION**

### **Plan Implementation**

This plan provides a prescription of management actions intended to restore the rainbow trout fishery, per objectives provided below. There is significant uncertainty on whether or not the management prescription can overcome existing management challenges to accomplish these goals and objectives. Thus, an adaptive approach is warranted where monitoring and evaluation is implemented to assess effectiveness of the management prescription. Given this approach, the management prescription detailed should be reviewed and updated as monitoring and evaluation results indicate the need.

The goals and objectives established in this Plan are based on the collective desire of ODFW and stakeholders to restore the fishery. The potential of attaining the goals and objectives will not be fully understood until the range of management possibilities available are implemented on an experimental basis. It is possible that monitoring and evaluation results of viable management actions (in consideration of side boards including Oregon Statutes and Administrative Rules, ODFW policy, federal regulations, funding and logistical factors and other constraining factors) will indicate that the goals and objectives are simply not attainable. Under these circumstances the goals and objectives should be revisited and updated as appropriate. Other situations indicating the need for revision of Plan goals and objectives would be documented changes in public opinion regarding the fishery, conservation issues, changes in state or federal regulations or changes in ODFW policies.

ODFW will determine, with stakeholder input, when review/revision of the elements of this plan are warranted in consideration of the factors listed above, and the availability of resources to do so.

### **Fishery Management Goals and Objectives**

Management actions need to be driven by a vision for what the fishery at Phillips Reservoir is desired to look like in the future. Goals and objectives have been developed for this purpose. The goals and objectives listed below were developed based on the intent of achieving the outcome anglers would like to see as communicated in the 2008 angler survey (ODFW 2009).

**Fishery Management Goal:** Restore the recreational trout fishery to characteristics (catch rates, size of fish, etc.) approaching those experienced in the 1970's and 1980's. Provide opportunities for other species as described in species specific goals and objectives when they can be achieved without significantly impacting attainment of trout fishery goals and objectives.

Overall Management Objective: Average annual angler use of 38,000 angler-days

Trout Management Goal: Manage for a productive trout fishery that provides both stock and trophy-sized fish.

Objective: Catch Rate 0.50 fish/hour

Objective: Size distribution of catch representative of the fishery prior to perch introduction (Figure 5).

Warmwater Species Management Goal: Manage to provide fishery for trophy-sized bass. No management emphasis on black crappie.

Objective: Bass abundance and size optimized to achieve trophy size to the extent that they do not negatively impact stocked rainbow trout and the effective introduction of tiger muskie.

Perch Management Goal: Provide harvest opportunity as long as objectives of the trout fishery can be met.

Objective: Catch rate 1 fish/hr

Objective: Average length of catch is 10 inches.

In addition to the above fishery goals and objectives, it is important to set biological objectives to provide indicators that management actions accomplish the biological outcomes necessary to attain fishery objectives. Biological responses will occur before fishery improvements will be detected. The primary indicators used will be the effectiveness of management actions (rainbow trout stocking, tiger trout stocking, tiger muskie stocking and mechanical perch removal), to reduce perch biomass and achieve improved growth and survival of rainbow trout stocked in the reservoir as fingerlings or sub-legals.

The intended density of tiger muskie in the reservoir is 1-2 fish/acre, although at this density, adequate samples to characterize the population in terms of density, growth and survival will be difficult. Therefore, monitoring of tiger muskie effects will be focused primarily on their impacts on yellow perch and the success of the hatchery trout program. Although there are many examples of using tiger muskie to control undesirable prey species in conjunction with maintaining or improving a hatchery trout program (Doug Krieger and Greg Policky, Aquatic Biologists, Colorado Division of Wildlife (CDOW); Mike Ruggles, Fisheries Biologist, Montana Fish, Wildlife and Parks (MFWP); Bruce Bolding, Washington Department of Fish and Wildlife (WDFW); personal communications), higher abundance of tiger muskie would likely lead to them overrunning the perch prey base and then negatively impacting abundance of stocked rainbow trout and native fish species. Thus, careful monitoring of prey abundance is required.

Fishery managers from other states have found that managing the control species at approximately 30% of the biomass provides the needed level of control while protecting other species from undesirable levels of predation and competition (Greg Policky and Paul Winkle,

Aquatic Biologists, CDOW, personal communications). Thus, as an interim target, it is desired that perch biomass not exceed 30% of the fish community by weight, as determined by proportion of fish caught in gillnet or trap net samples.

Trout fingerlings released in the 1970's and 1980's achieved 5" of growth in length from their first to second fall in the reservoir. Annual growth of rainbow trout in other Baker County reservoirs range from 2.6 to 7.3 inches (ODFW unpublished data). The interim objective for growth of sub-legal rainbows stocked in the fall will be for them to increase in average length by 4" from their first to second spring in the reservoir.

There is limited baseline data on the survival of rainbow trout fingerlings released into Phillips Reservoir in the past. Because of the high variability of fingerling survival based on size and timing of release and the particular reservoir environment, no objective is provided for this metric. Rather, an improving trend in survival will provide evidence that reservoir conditions are improving for trout.

In terms of response time, it is anticipated it will take a minimum of three years after the initial introduction for tiger muskie to begin having a measurable effect on the yellow perch population and a minimum of five years before any level of control is achieved (Jim Fredricks, Idaho Department of Fish and Game (IDFG); Doug Krieger, CDOW; Mike Ruggles and Mike Hensler, MFWP; personal communications).

**Management Species**

The fish species listed below are given management status. These species have an intended purpose for which ODFW will implement management actions to optimize angling opportunity and/or use as a tool for improving fishing opportunities for other species.

<u>Species</u>	<u>Managem</u>	<u>ent Purpose</u>
Rainbow Trout (hatchery-origin)		Angling opportunity, catch, harvest
Interior Redband Trout		Conservation, angling opportunity, catch, harvest
Tiger Trout		Angling opportunity, catch, harvest
Tiger Muskie*		Control of yellow perch abundance (predation)
Largemouth Bass		Angling opportunity, catch, harvest
Smallmouth Bass		Angling opportunity, catch, harvest

\*Note: A secondary management benefit of tiger muskie introduction is the expected development of a targeted recreational fishery. However, management decisions regarding this species will be based on the primary management purpose of controlling yellow perch abundance.

Other non-native species in the reservoir that are not given management status include yellow perch, walleye and black crappie. The presence of these species is likely the result of intentional, illegal introductions. While these species may persist in the reservoir, management actions will not be taken specifically for the purpose of increasing angling opportunity, more specifically increasing abundance. While goals and objectives are included for yellow perch, they are simply

an acknowledgement that they are present in the reservoir and that the management actions included in this Plan will not likely lead to their eradication. Should the suite of actions included in this Plan be ineffective in achieving goals and objectives for management species, other actions, including eradication of yellow perch, could be adopted as a management action in future updates of this Plan.

Native species present in the reservoir will be managed pursuant to ODFW's Native Fish Conservation Policy (OAR 635-007-0502).

### **Management Action Description**

As the illegal introduction of yellow perch is the cause for the collapse of the rainbow trout fishery at Phillips Reservoir, control of their abundance is the primary focus of this Plan. Other actions are focused on shaping fish stocking activities to achieve optimal performance under the existing condition of over abundant yellow perch.

The suite of management actions selected to accomplish fishery management goals/objectives at Phillips Reservoir include:

Continued stocking of rainbow trout, with a long-term goal of an effective put-grow-and take stocking strategy,

Introduction/stocking of sterile tiger trout as a short-term measure to provide trophy-sized trout in the fishery,

Mechanical removal of yellow perch to control their abundance,

Introduction/stocking of sterile tiger muskie to control yellow perch abundance, and

Warmwater gamefish management emphasizing angling opportunity for trophy-sized bass.

At the time of writing, the above management actions appear to be a sound approach for accomplishing management goals/objectives considering both efficacy and feasibility. Implementation of management actions will be carried out within an adaptive management framework where monitoring and evaluation results will inform fishery managers regarding effectiveness. Where needed, management actions will be adjusted to achieve goals and objectives. This could include new actions or adjustment of on-going actions.

### **Trout Stocking Strategy**

ODFW's long-term goal is to implement a put-grow-and-take rainbow trout stocking strategy at Phillips Reservoir. However, the currently implemented sub-legal trout stocking strategy (put-grow-and take), is not providing the product anglers desire, nor is it achieving a favorable return to the creel. However, other management actions described herein are intended to make conditions more favorable for this strategy to succeed in the future.

Under existing conditions, an over abundant population of yellow perch, ODFW's primary short-term goal is to provide a put-and-take trout fishery, with a trophy/quality component. This approach will sustain the trout fishery, while other management actions to address perch abundance are begun.

In the near term, through 2018, the trout stocking strategy will consist of stocking legal-sized rainbow trout (3 fish/pound), sub-legal rainbow trout (8 fish/pound) and sterile tiger trout at 8 fish/pound. The current annual release target for legal-sized rainbow trout is 33,600 fish. If funding and production space are available, the production/release target for legal-sized rainbows should be increased to 50,000 to better meet the trout fishery objective for a catch rate of 0.50 fish/hour, which is not currently being met (ODFW unpublished data). Stocking of legal-sized rainbows should be spread over the primary angling season of April through July.

The release of sub-legal rainbow trout, under current conditions, is primarily for the purpose of evaluation. As the long-term goal is to restore implementation of a put-grow-and-take trout fishery, monitoring the growth and survival of this group will provide an indicator of progress towards this end. Current release numbers are adequate for the on-going evaluation. The release of 24,600 sub-legal (8 fish/pound) rainbows in mid-September should be continued through 2018.

All rainbow trout stocked in Phillips Reservoir should be triploid in order to prevent interbreeding with native redband in the Powder River and tributaries.

Angling regulations for rainbow trout should provide liberal opportunity for harvest under current conditions as there is limited opportunity for trout to grow to quality or trophy size. In 2010, approximately 33,607 legal-sized rainbow trout were stocked throughout the spring and summer. In 2009, 24,990 sublegal-sized trout were stocked in the fall. These release groups would have both contributed to the 2010 fishery. However, statistical creel survey in 2010 reported catch of only 4,841 rainbow trout. This information suggests that the bag limit should be liberalized under current conditions to increase return to the angler.

Should efforts to control yellow perch abundance become successful in improving rainbow trout growth and survival to the point that quality and or trophy rainbow trout can be produced, then harvest opportunity should be reduced.

Stocking of tiger trout, a sterile hybrid resulting from the cross of brown and brook trout, is underway with the goal to provide a quality/trophy-sized trout for the fishery (ODFW 2008). The objectives of the tiger trout introduction are to 1) provide a trophy quality fish (defined as a trout over 18 inches with good condition factor, and 2) for these fish to return well to the creel.

The initial release target for tiger trout is 10,000 fish per year at a size of 8 fish/pound (approximately 6 inches long) in mid-October. Monitoring and evaluation will be utilized to adjust release number and size as results become available. This stocking strategy should be continued through 2015, when a decision will be made regarding further implementation.

At the time of writing, releases of tiger trout have occurred in both 2011 and 2012. Neither group has met the number and size at release goal. While it is anticipated that the target release number can be met, it is uncertain that the release size target can be met at the production facility currently rearing these fish, Klamath Hatchery. Options should be considered for attaining the target size at release including moving the fish to another production facility, or a spring release allowing more growth time in the hatchery.

In order to allow the tiger trout to quickly grow to quality and trophy size, restrictive angling regulations will be implemented. Initially, angling will be restricted to catch and release only. If the releases prove to be successful, harvest opportunities will be provided, but will remain more restrictive than general zone trout regulations to maintain trophy-sized fish.

### Mechanical Removal of Yellow Perch

A pilot project has been underway since 2009 to mechanically remove yellow perch from the reservoir, the management intent being reduced yellow perch abundance leading to improved growth and survival of stocked rainbow trout and larger yellow perch. The pilot project is being implemented for five years, at the end of which the project will be evaluated. Future implementation will be based on results of the evaluation. The final year for implementation for the pilot project is 2013. After the removal effort in the spring of 2013, the results will be summarized, evaluated and future course of action determined.

The removal is accomplished by deploying six to eight Merwin trap nets in the reservoir immediately after ice-out (perch spawning time). The trap nets are deployed for a 2-3 week period when yellow perch spawning behavior makes them highly susceptible to capture by this method. Yellow perch are removed from the nets and hauled to local farmers where the fish are applied as fertilizer. All non-target species are returned to the reservoir. Over one million perch have been removed from the reservoir to date. However, preliminary results suggest the level of fish community response has not been large enough to see improvements in the fishery. For a more detailed description of the project and summary of data through 2011, see Bailey (2012).

### Biological Control of Yellow Perch

In December 2012, the Oregon Fish and Wildlife Commission approved amendment of administrative rules to reclassify tiger muskie from a prohibited species (OAR 635-056-0050) to a controlled species (OAR 635-056-0075) specifically for introduction into Phillips reservoir for fishery management purposes. This provided ODFW with legal authority to proceed with the proposed introduction of tiger muskie into Phillips Reservoir for the purpose of controlling yellow perch abundance to improve the trout fishery (ODFW 2012).

Beginning in 2013, tiger muskie will be released annually into Phillips Reservoir. Initial plans are to release tiger muskie fry, which are available at no cost from the Utah Division of Wildlife Resources (UDWR). However, depending on availability of these fish from UDWR and effectiveness of a fry release, fish may be obtained from other certified disease free sources.

The management intent is to achieve an adult tiger muskie density of 1-2 adults per acre. Fishery managers in other western states have found this density to be effective at controlling over abundant prey species without negatively impacting the target management species. Actual monitoring and evaluation results will be used as available to adjust stocking numbers to achieve the intended result.

The annual stocking of tiger muskie will continue for an initial evaluation period of five years (2013-2017). At the end of the initial evaluation period, monitoring and evaluation results will be considered and determination made on whether or not to continue releases.

It is anticipated a targeted sport fishery could develop for tiger muskie. However, this is considered a secondary benefit, and not the intended purpose for the introduction. Management decisions regarding tiger muskie will be made based on their intended purpose, to control yellow perch abundance for restoring the trout fishery.

The anticipated development of a targeted recreational fishery for tiger muskie will be regulated as catch and release or a high length limit to minimize harvest in order to maintain the population of adult tiger muskie needed to achieve the intended management purpose of yellow perch control.

In the case that monitoring and evaluation indicates tiger muskie adults are over-stocked, or it is determined tiger muskie should be eradicated from the reservoir, more liberal harvest regulations may be implemented.

#### Warmwater Gamefish Management

The Phillips Reservoir angler survey (ODFW 2009) documents that there is a relatively small, but dedicated population of anglers that would like ODFW to manage for a trophy bass fishery at Phillips Reservoir. Per the warmwater species management goals described previously, ODFW plans to manage for a trophy bass fishery, to the extent that the bass population does not negatively impact the trout fishery and introduction of tiger muskie.

While the long-term management intent is to provide a trophy bass fishery at Phillips Reservoir, specific management actions to accomplish this will be delayed, pending results of tiger muskie introduction. Fingerling/fry tiger muskie have been shown to be highly susceptible to predation by bass and other centrarchid fishes (Stein et al. 1981; Tomcko et al. 1984; Wahl 1999) and therefore would likely limit the success of tiger muskie introduction utilizing release of fingerlings. Because controlling abundance of yellow perch in the reservoir is the overarching management need, and tiger muskie introduction a primary tool to accomplish this, management actions to increase the abundance of bass in the reservoir will be delayed until the evaluation phase of the introduction is completed.

Future management tools to increase the abundance of trophy-sized bass could include restrictive angling regulations and stocking of adult/juvenile bass. The intention of restrictive angling regulations would be to facilitate recruitment of adult bass and protect trophy-sized individuals from harvest. Stocking of adult bass could include out-plants from Davis Lake in Central Oregon, or other approved sources, to bolster the number of adult bass in the reservoir.

Management status will not be given to other warmwater species currently in the reservoir (black crappie), or any that would be illegally introduced in the future.

## **MANAGEMENT ALTERNATIVES CONSIDERED**

As described in Shrader and Bailey (2009), an array of management possibilities, focused on the overabundance of yellow perch, exist for addressing the fishery management problems at Phillips Reservoir. It is clear from this discussion that there is uncertainty surrounding all the potential management actions. ODFW has selected to implement those actions that show the most promise in consideration of ODFW rules and policies, state statutes, available staff and financial resources, ecology of the reservoir, ability of management actions to affect change, the weight of scientific evidence supporting the success of a particular action and other regulatory hurdles. A summary of the management actions considered, but not chosen for implementation at this time, is provided below.

### **Chemical Control of Yellow Perch**

Historically, chemical control or “rehabilitation” of waters with rotenone in conjunction with reservoir drawdown was deemed an extremely popular and effective means of dealing with overabundant forage species. The use of chemicals, however, has been declining in recent years in response to several factors including increased cost, increased emphasis on biological control, increased public adversity to using chemicals or toxicants, and the often limited benefit of such treatments (Noble 1981). Another major disadvantage of chemical treatment is the indiscriminate mortality of all aquatic organisms in treated waters as well as potential impact on listed or sensitive aquatic and terrestrial species in the project area.

Despite the reputation of chemical rehabilitation being the “silver bullet” for control of overabundant forage populations, treatments are rarely 100% effective. In the case of yellow perch, their tremendous fecundity means that unless the kill is complete, they will quickly repopulate a lake and return to pretreatment levels (Noble 1981). For example, the Utah Division of Wildlife Resources chemically rehabilitated Hyrum and Newton Reservoirs using rotenone in the late 1980’s. The reservoirs had stunted populations of yellow perch despite the presence of larger predators (largemouth bass) and heavy recreational fisheries that targeted perch. Despite intensive and thorough efforts, perch were not totally eliminated and quickly returned to pre-treatment densities (Schaugaard 2000). ODFW had better success treating Tenmile Lakes for overabundant perch and bluegill populations in the 1960’s after many years of trap netting did little to reduce them (Ray Temple, ODFW, personal communication). This control effort was extremely labor-intensive and extremely difficult because of dense vegetation and cold-water inputs in the lake. However, it was extremely effective and resulted in elimination of perch from the lake for about 40 years.

Chemical treatment of a reservoir is much more complex and time consuming now than it has been in the past. In the case of Phillips Reservoir, the physical factors associated with any potential treatment present an obstacle. Phillips Reservoir has a storage capacity of 90,500 acre-feet and, although ODFW does not have control over water level management, it can potentially be drawn down to 428 acre-feet of storage. This would reduce the cost and increase the potential effectiveness of any treatment. However, the amount of vegetation present and the volume of water coming into the reservoir decrease the probability of a complete kill. In addition, the presence of mine tailing ponds in the upper end of the reservoir would complicate any proposed

treatment. These ponds, which are periodically inundated, may also contain yellow perch and would have to be treated. Due to subsurface flow between the ponds, rotenone treatments conducted in the 1960's and 1970's were not successful in eradicating fish from these ponds.

Phillips Reservoir is located on national forest land and there is a small likelihood that bull trout (*Salvelinus confluentus*) and redband trout (*Oncorhynchus mykiss*) could be killed during any chemical treatment. Additionally, there is an active bald eagle nest site nearby. As a result, any proposed treatment would have to go through the federal NEPA process (Dave Loomis, ODFW, personal communication). This lengthy and complex process requires a public scoping process and development of an Environmental Impact Statement (EIS). Additionally, any chemical rehabilitation process involving rotenone would require obtaining a discharge permit from the Oregon Department of Environmental Quality. This process is also lengthy, complex, and time consuming. While administrative hurdles required for initiation of a chemical treatment of Phillips Reservoir are not insurmountable, the workload required would be significant and would force district staff to drop other critical responsibilities. For example, in 1997, Umpqua District personnel began development of an EIS associated with a proposed chemical renovation of Diamond Lake to control illegally-introduced tui chub. This effort began as a result of a 1996 Oregon Fish and Wildlife Commission directive to ODFW to return the lake to its former status as described in the management plan. The draft EIS considered all reasonable management options including ODFW's preferred option of chemical treatment. ODFW District personnel spent years of planning, attending public meetings, and conducting additional studies that led to the development of an EIS in 2001 for which no decision was reached, because of concerns raised during the process. A working group was then established and another EIS published by the Umpqua National Forest in 2004 for which a record of decision was made supporting chemical treatment. The treatment was then completed in 2006, the total cost of the planning process and implementation totaling 6 million dollars, having taken 10 years in planning, development and implementation.

### **Biological Control of Perch Populations**

The concept of biological control of overabundant yellow perch populations is extremely attractive and intuitively appealing. Almost all warm to coldwater predatory fish – basses (*Micropterus* and *Morone* spp.), crappies (*Pomoxis* spp.), walleye, northern pike, lake trout, muskellunge, etc. - will eat perch (Scott and Crossman 1973). Thus, a number of predatory fish were investigated as potential biological control agents for yellow perch in Phillips Reservoir.

#### **Hybrid Bass**

Hybrid bass, striped bass (*Morone saxatilis*) x white bass (*M. chrysops*) hybrids have been stocked with varying success in attempts to control abundant forage fish populations (Gilliland and Clady 1981; Ott and Malvestuto 1981; Gestring 1987). As with tiger muskies, hybrid bass introduction is an attractive option for biological control because they are highly piscivorous (Ott and Malvestuto 1981; Germann 1982) and reproductively sterile.

The problem with introduction of hybrid bass is three-fold: their cost, their potential competition with perch, and their suspected preference for trout over spiny-rayed fish. ODFW presently

obtains disease-free hybrid bass from a private company in California for approximately \$1 per fingerling. Phillips Reservoir, at average stocking rates would require approximately \$25,000 annually or, in other words, 5 times the amount the Warmwater Program annually budgets for the entire state's warmwater fish stocking needs. Secondly, yellow perch may be the worst species to try to control with introductions of fingerling hybrid bass because of the high potential for competition. Stocked fingerling hybrid bass feed mostly on zooplankton and benthic invertebrates in inshore habitats (Ott and Malvestuto 1981; Austin and Hurley 1987). In Phillips Reservoir, this would put them in direct competition with extremely large numbers of young of year (YOY) yellow perch. It would not be until at least their second year that hybrid bass would become piscivorous (we don't know what their growth rates would be in Phillips Reservoir) and even then they may still compete with perch seasonally for food (chironomids and insect larvae; Germann 1982; Gestring 1987). As a result, this very expensive program may fail because of the superior competitive abilities of the huge number of yellow perch present in Phillips Reservoir. Stocking larger fingerling hybrid bass could result in higher survival of the stocked fish (Sutton and Ney 2001), but would increase the cost of the program significantly. Finally, hybrids have been shown to eat salmonids (Gestring 1987) and may actually prefer soft-rayed fish, e.g. trout, over spiny-rayed forage, i.e., perch. Therefore the impacts of hybrid bass introduction on both native trout and the hatchery trout program must be considered.

### Walleye

Walleye are a species whose native range overlaps with yellow perch. Thus, they are effective predators of yellow perch. Houde (1967) found walleye as small as 0.35 inch feeding on YOY perch. Parsons (1971) found that YOY perch comprised up to 93% of the diet of YOY and age 1+ walleye in Lake Erie. Smith and Pycha (1960), and Collette et al. (1977) also noted that YOY perch were important diet items of YOY and older walleye. Possibly because of the apparent importance of perch as prey for walleye, in many systems studied, walleye abundance is strongly correlated with perch abundance (Hartman 1972; Nepszy 1977). There is considerable debate, however, as to whether this is due to biological (Forney 1971; Nepszy 1977) or environmental causes (Collette et al. 1977).

It has proven very difficult to predict the outcome of walleye introductions into western reservoirs (Venditti 1994) even if yellow perch (the preferred prey of walleye) are present (McMahon and Bennett 1996). Even within their native range, it has often proved difficult to predict the effect of walleye predation on forage fish. Snow (1988) reported that stocking muskellunge and walleye in Clear Lake, Wisconsin for 26 years failed to reach the objectives of improving bluegill and yellow perch size structure or growth. This may be because prey availability seems to be more important than prey selectivity in determining what walleye eat (Collette et al. 1977; Bolding et al. 1996). Seminoe Reservoir, Wyoming was managed primarily for a hatchery rainbow trout and wild brown trout fishery prior to the illegal introduction of walleye (McMahon and Bennett 1996). After walleye significantly reduced native forage populations of minnows, crayfish, and suckers, they switched to trout as their primary forage. By the early 1970's, walleye were essentially consuming the entire annual stocking of hatchery trout within a few weeks of stocking. Walleye recruitment began to fail and led to a "near-simultaneous decline of walleye and trout populations" (McMahon and Bennett 1996).

ODFW surveys have verified the illegal introduction of walleye into Phillips Reservoir (Shrader 1997). Presently ODFW is managing against this illegal introduction by removing all length and bag limits. Predicting the outcome of this illegal introduction in Phillips Reservoir, if walleye were to become well-established and abundant, is difficult. Several generalizations can be made of the few instances where walleye introductions into western reservoirs containing salmonids appeared to have resulted in acceptable fisheries (McMahon and Bennett 1996). In these situations 1) walleye spawning habitat is limited, 2) flushing rates keep walleye densities low, or 3) walleye recruitment is stable enough to support a limited fishery. In contrast, Phillips Reservoir has three factors that have been identified as contributing to the failure of walleye introductions to result in stable fisheries. These factors are 1) high reservoir fluctuation resulting in high variation in forage fish abundance, 2) lack of cover during summer drawdown that makes forage fish extremely vulnerable to predation, and 3) low biotic diversity in the reservoir such that if recruitment of the preferred forage species is low there is often not another species for walleye to switch to (McMahon and Bennett 1996). Maintaining a walleye-trout fishery at Phillips would be extremely difficult, requiring intensive management and the switch to stocking entirely catchable hatchery trout.

### Saugeye

Saugeye are a predatory hybrid whose parent species (walleye x sauger) ranges overlap with yellow perch. As discussed previously, walleye have been illegally introduced into Phillips Reservoir, but there does not appear to be significant reproduction occurring in the reservoir as few have been encountered in fish sampling procedures and few have been reportedly caught by anglers. Saugeye have shown to be productive in waters where walleye have not (Lynch et al. 1982; Johnson et al. 1988; Fiss et al. 1997) including reservoirs with high turbidity and low water retention times, conditions that both exist at times at Phillips Reservoir. Considering that saugeye could perform better in Phillips Reservoir than walleye and are a predominantly sterile hybrid, they are due consideration as a potential biological control of yellow perch. They are known to prey on yellow perch and other fish species, beginning at a small size (Walter 2000; Ermer 2001; Denlinger et al. 2006) which would suggest that saugeye would prey on yellow perch in Phillips Reservoir, if introduced. In addition, they have been shown to be an influence on centrarchid populations when introduced for the purpose of controlling abundance (Galinat et al. 2002; Denlinger et al. 2006).

Saugeye are a hybrid from interbreeding of walleye and sauger, known to occur naturally and have been artificially produced in hatcheries for fisheries management purposes (Scott and Crossman 1973). As with most hybrids, the biology of saugeye is intermediate between those of the parent species (Johnson et al. 1988). Additionally, because they are predominantly sterile (Fiss et al. 1997; Hearn 1986) more of their energy is put into growth meaning a faster growing intermediate of the parent species. Their propagation for fisheries management has been primarily for three purposes: 1) to provide a hybrid that performs better than the parent species (walleye) in reservoirs with turbid waters and low water retention times, 2) as a predator to improve recruitment and improve growth of panfish (Galinat et al. 2002; Pope et al. 1996) and generally improve recreational fisheries where walleye have not performed well.

While saugeye show promise as a predatory fish to control perch numbers in Phillips Reservoir, there is significant biological risk. Documentation shows that some proportion of saugeye are reproductively viable and reproduce (Hearn 1986; Fiss et al. 1997; Johnson et al. 1988), albeit not at a level that would maintain a population. Successful reproduction has been documented from saugeye x saugeye crosses, saugeye x walleye crosses and saugeye x sauger crosses (Fiss et al. 1997; Hearn 1986). In the event that saugeye would emigrate from the reservoir, which is likely, they would likely prey on native fish. While it is not likely that saugeye would sustain their numbers through reproduction outside of the reservoir, their ability to reproduce would make them more persistent, increasing the impact on native fishes and increasing their rate of dispersion outside of the reservoir.

### Largemouth and smallmouth bass

Largemouth and smallmouth bass have been shown to prey on yellow perch (Seaburg and Moyle 1964; Emig 1966; Serns and Hoff 1984; Shrader 1994) and both are present in Phillips Reservoir. Examination of the literature, however, suggests that largemouth bass may potentially be more effective predators on yellow perch than smallmouth bass. Age 0+ yellow perch comprised over 75% of the diet of largemouth bass between 6 and 10 inches in Dryden Lake, New York, while over 29% of the diet of bass over 10" was yellow perch (primarily age 0+ and age 1; Green 1982).

Attempting biological control of yellow perch using largemouth bass and/or smallmouth bass is problematic. Efforts to bolster bass numbers in Phillips Reservoir will only be effective if age-2 or, preferably, adult bass are introduced. Natural production of sufficient bass numbers to affect perch densities is impossible given the competitive advantage perch have over bass YOY. As a result, ongoing stocking of bass would be required until perch densities have decreased substantially. Additionally, environmental factors will probably do more to affect perch density than the minimal predation offered by bass populations. For example, even large populations of largemouth and pickerel in Dryden Lake, New York weren't able to suppress abundant populations of perch, sunfish, or panfish (Green 1982).

### Water level management and its effects on perch populations

Jenkins (1970) stated that water level fluctuation is "potentially the most effective management tool for the reservoir biologist." In the case of yellow perch in Phillips Reservoir, spring water level manipulations could potentially affect spawning success and recruitment. Henderson (1985) determined that recruitment of yellow perch was not a function of temperature during hatching, spawning, or the first year of perch life, but rather a function of water level or, more precisely, the quantity and quality of habitat available during spawning and fry survival. Their conclusion – that increased inundation of terrestrial vegetation during spawning was related to the formation of large perch year classes – has been supported by others (Riel 1965; Beckman and Elrod 1971; Nelson and Walburg 1977).

In addition to altering the actual amount of spawning habitat available, water level manipulations can increase mortality of eggs after they have been deposited. Physical disturbance of eggs either through wind action (Clady and Hutchinson 1975; Clady 1976; Thorpe 1977; Herman et

al. 1982) or desiccation due to falling water levels (Benson 1973; Thorpe 1977) negatively impacts egg survival and year-class strength. Burns (1966) reported that carp populations in Fort Randall Reservoir, South Dakota were successfully managed through water level manipulation. By timing a drawdown right after carp egg deposition, they were able to increase egg mortality through desiccation. One complication in using that strategy in Phillips Reservoir is the physical nature of the reservoir; in Fort Randall Reservoir, this strategy worked because carp spawned in shallows that were exposed by a small drawdown (Burns 1966), but in Phillips Reservoir, a much larger drawdown would be needed.

Fall drawdown can be used to concentrate forage fish in open water and allow predators' easier access (Riel 1965; Cross and Waite 1988). Vegetation and turbidity control achieved through drawdown often leads to greater reservoir productivity through higher water clarity, less prey refugia, and increased nutrient input from terrestrial input (Noble 1981).

While water level management shows promise as a fishery management tool at Phillips Reservoir, it is unlikely that water managers would allow water level manipulations (release of stored water) for this purpose. The primary use of water stored in Phillips Reservoir is irrigation. Water is stored/accumulated in the reservoir during the winter and spring, generally from October through May and released for irrigation use downstream, June through September. Managers do not have a way of predicting the volume of water that will be stored during any given storage season. The volume of water stored annually fails to meet the legally authorized demand for irrigation water a significant proportion of the time (filling of the reservoir). For these reasons, water managers would be reluctant to release more water from the reservoir during the storage season than what is necessary to meet in-stream flow requirements for the Powder River below the reservoir. Much of the storage in the reservoir occurs after the time period when perch spawn (April and early May) meaning that if water were released to lower pool elevation, water managers may not be able to regain this volume latter meaning that water uses would be shorted.

With the above said, there may be rare occasions when surplus water is available to release. Fishery managers should be aware of storage conditions to make use of these rare opportunities.

## **MONITORING AND EVALUATION**

### **Biological Objectives Indicative of Fisheries Effects**

In addition to the fishery goals and objectives outlined in previously, it is important to set biological objectives to provide indicators that management actions are affecting the system in a way necessary to attain fishery objectives. Biological responses will likely occur before fishery improvements will be detected. The primary indicators used will be the effectiveness of management actions (rainbow trout stocking, tiger trout stocking, tiger muskie stocking and mechanical perch removal) to reduce perch biomass and achieve improved growth and survival of rainbow trout stocked in the reservoir as fingerlings or sub-legals.

The intended density of adult tiger muskie in the reservoir is 1-2 fish/acre, although at this density, adequate samples to characterize the population in terms of density, growth and survival

will be difficult. Therefore, monitoring of tiger muskie effects will be focused primarily on their impacts on yellow perch and the success of the hatchery trout program. Although there are many examples of using tiger muskie to control undesirable prey species in conjunction with maintaining or improving a hatchery trout program, higher abundance of tiger muskie would likely lead to them overrunning the perch prey base and then negatively impacting abundance of stocked rainbow trout and native fish species. Thus, careful monitoring of prey abundance is required. In terms of response time, it is anticipated it will take a minimum of three years after the initial introduction for tiger muskie to begin having a measurable effect on the yellow perch population and a minimum of five years before any level of control is achieved.

### **Objective 1: Characterize recreational fishery.**

Task 1.1: Conduct angler creel surveys during the 5-year evaluation period to monitor the efficacy of the tiger muskie and tiger trout introductions.

Rationale: Creel surveys will be critical in analyzing the efficacy of the tiger muskie and tiger trout introductions in improving conditions in the reservoir for a hatchery trout program. Meeting management objectives for the trout fishery is the ultimate goal of the muskie introduction, while tiger trout were introduced because it was thought that their piscivorous nature and the abundant perch in the reservoir offered a better chance of producing trophy trout for which Phillips was historically known. Creel census and gillnet sampling to monitor the trout fishery were limited during the 1990's, and early 2000's, so there is little data to characterize the decline of the fishery, post perch introduction.

Approach: A statistical creel survey is planned for 2013. The results of this and other recent creel information will be used as baseline information to compare against once muskie are introduced. Although muskie will hopefully be introduced Spring 2013, they will not appreciably affect the system so any creel information collected that year can be included in the baseline.

In 2014 or 2015, the Warmwater Program could potentially provide seasonal time for May and June and the La Grande District could use interns from July on. It will be imperative to conduct a creel in 2017 because the decision as to whether to continue the tiger muskie program must be made prior to the 2018 field season.

The primary objectives for the creel survey would be to 1) determine catch rate and size distribution of rainbow trout, tiger trout, and yellow perch by anglers, 2) determine catch rate and size distribution of warmwater game species by anglers, and 3) estimate total and season angler pressure from April/May through October.

Task 1.2: Conduct angler opinion surveys during the 5-year evaluation period to monitor any potential changes in angler satisfaction resulting from management efforts.

Rationale: The 2008 angler opinion survey conducted by ODFW was used to develop management objectives for Phillips Reservoir. It documented angler dissatisfaction with the state of the trout fishery at that time. Management actions taken to improve the fishery will ultimately be measured by improvements in the quality of the trout fishery and the level of angler

satisfaction with the fishery. Angler opinion surveys conducted concurrently with angler creel surveys will allow correlation of angler satisfaction to angler success with the most judicious use of staff time.

Approach: Incorporate an angler opinion survey similar to the 2008 angler opinion survey into the 2013 creel survey to reinforce baseline information on angler satisfaction. As with the creel survey, it will be imperative to conduct an angler opinion survey in 2017 because the decision as to whether to continue the tiger muskie program must be made prior to the 2018 field season. Ideally, an additional creel/angler opinion survey should be conducted midway through the initial 5-year evaluation period (2015).

## **Objective 2: Monitor performance of stocked trout.**

Task 2.1: Develop quantitative survival estimates for hatchery sub-legal rainbow trout stocked in the fall.

Rationale: The survival and growth of rainbow trout stocks in the reservoir are important factors in assessing the effectiveness of stocking various strains of hatchery trout. It will be important to develop quantitative estimates of the survival of sub-legal trout stocked in the fall. There is no baseline data on the survival of rainbow trout fingerlings released into Phillips Reservoir in the past. As the abundance of yellow perch decreases, it is hoped that their negative impact on trout survival will also diminish. However, because of the high variability of fingerling survival based on size and timing of release and the particular reservoir environment, no objective is provided for this metric. Rather, an improving trend in survival will provide evidence that reservoir conditions are improving for trout. This information will be used to make decisions on future stock selection and hatchery releases.

Approach: In Spring 2012, 3,000 catchable trout were stocked throughout the reservoir to mix and be captured in Merwin traps along with surviving sub-legal trout stocked in Fall 2011. This resulted in a 95% confidence interval of less than 1% of the point estimate for survival. However, 2013 will be the last year of the large-scale Merwin trapping effort. so either in 2013 or 2014, alternative methods, possibly reduced-scale Merwin trapping or South Dakota trap nets should be used to see what level of effort is needed to generate accurate population and survival estimates. This methodology should be determined before the 2016 field season so baseline and project-effect levels of survival can be compared prior to the 2018 decision point.

Task 2.2: Monitor the growth of sub-legal rainbow trout.

Rationale: Trout fingerlings released in the 1970's and 1980's achieved 5" of growth in length from their first to second fall in the reservoir. Annual growth of rainbow trout in other Baker County reservoirs range from 2.6 to 7.3 inches. The interim objective for growth of sub-legal rainbows stocked in the fall will be for them to increase in average length by 4" from their first to second spring in the reservoir.

Approach: Fall-stocked sub-legal rainbow trout will be adipose marked to distinguish them from wild trout naturally occurring in the reservoir and stocked legal-sized rainbow trout. Methods

used to generate quantitative survival estimates for hatchery sub-legal rainbow trout stocked in the fall (Task 2.1), as well as efforts to monitor changes in reservoir fish biomass contribution (Task 3.3) should capture enough fish to provide data on growth of stocked sub-legal rainbow.

Task 2.3: Monitor the growth of legal-sized rainbow trout.

Rationale: As yellow perch density changes, the ability of hatchery trout fingerlings to grow and survive to produce the trophy component of the fishery changes.

Approach: 3,000 legal-sized trout stocked for the purpose of estimating sub-legal trout survival will be marked with a fluorescent spray dye. These legal-sized trout will be stocked every year about the same time and their fluorescent spray mark will differentiate them from other catchable trout stocked later in the season. If a subsample is measured when they are stocked, we will be able to follow the growth of each cohort as they are recovered throughout the project and determine if their growth responds to changes in yellow perch density. Methods used to generate quantitative survival estimates for hatchery sub-legal rainbow trout stocked in the fall (Task 2.1), as well as efforts to monitor changes in reservoir fish biomass contribution (Task 3.3) should capture enough fish to provide data on growth of dye-marked stocked legal-sized rainbow.

Task 2.4: Monitor the growth and survival of stocked tiger trout.

Rationale: Tiger trout have been introduced to replace, at least on an interim basis, the trophy aspect of the trout fishery that once existed. While tiger trout have performed well under a wide range of environmental conditions and species assemblages, it is unknown to what extent they will achieve their intended purpose in Phillips Reservoir. Although there will likely be issues with differences in size, condition, or timing at stocking that may complicate or preclude comparison, tiger trout survival and/or growth through the evaluation period may be another metric that can be used to monitor the effects of tiger muskie.

Approach: Assuming equal catchability as rainbow trout, methodology developed for Tasks 2.1 and 3.3 will also allow us to estimate survival of stocked tiger trout. However, as the growth and survival of tiger trout is secondary to that of stocked rainbow trout, considerations should be given to methodology to generate accurate survival estimates for the latter.

### **Objective 3: Monitor changes in reservoir food web, with respect to yellow perch abundance.**

Task 3.1: Monitor changes in yellow perch population density.

Rationale: The intended density of tiger muskie in the reservoir will be so low that it will be difficult to characterize the population through sampling. Therefore, monitoring yellow perch abundance is an indirect measure of the tiger muskie introduction effort. Although there are many examples of using tiger muskie to control undesirable prey species in conjunction with maintaining or improving a hatchery trout program, higher abundance of tiger muskie would likely lead to them overrunning the perch prey base and then negatively impacting abundance of stocked rainbow trout and native fish species. Thus, careful monitoring of prey abundance, in

this case yellow perch is required. Fish managers from other states have found that managing the prey species at approximately 30% of the biomass provides the needed level of control while protecting other species from undesirable levels of predation and competition. Thus, as an interim target, it is desired that perch biomass not exceed 30% of the fish community by weight, as determined by proportion of fish caught in annual gillnet or trap net samples collected in the spring.

Approach: Past perch population estimates were generated by releasing double-tagged perch essentially concurrent with the initiation of Merwin trapping. Given the number of fish tagged and the number of captured/examined, we were 95% sure that the perch population estimate was within ~18% of the true number. The same will hold true with the 2013 perch population estimate as the full Merwin trapping effort will be repeated for the final time. Future more-limited trapping efforts with trap nets and/or Merwin traps are predicted to catch in the range of 40% of the perch that “historic” trapping captured. If this is the case and we continue to tag 500 perch, we can be 95% sure that the perch population estimates are within ~22-24% of the actual number. With the decrease in number of perch handled and examined for marks, the number marked would need to be increased to tighten confidence limits on perch population estimate; 1,000 tagged perch, might approach the accuracy of past population estimates.

In addition, we will attempt to correlate population estimates generated through mark-recapture using trapping to boat electrofishing catch-per-unit-effort (CPUE). Although the effectiveness of this technique will likely be limited at higher perch densities due to the asymptotic nature of the relationship, if the tiger muskie introduction is effective in reducing perch abundance, identification of the electrofishing CPUE/perch abundance relationship will facilitate monitoring of perch abundance with respect to the 30% biomass goal.

Task 3.2: Monitor changes in yellow perch population growth rates.

Rationale: As yellow perch population density is driven below the carrying capacity of the reservoir, intra-specific competition should decrease and perch growth rates should hypothetically increase.

Approach: This analysis is not critical to the evaluation of the success of our management actions. Age/growth analysis of perch performed in 2013 should provide a baseline for comparison to the results of a similar analysis performed in the final year of the initial evaluation period (2017). Standard protocol for complete age analysis – scales collected from 10 fish in every 10-mm length increment above 150 mm – will provide the information necessary for comparison.

Task 3.3: Monitor changes in reservoir fish biomass contribution.

Rationale: As was explained in the rationale for Task 3.1, fishery managers from other states suggest that as an interim target that perch biomass not exceed 30% of the fish community by weight. Methodology utilized to achieve Task 3.1 will generate one index of fish community species biomass distribution, while the methodology outlined below will generate another index.

The advantage of this methodology is that it is much more comparable to a long-term dataset available in district records.

Approach: District personnel may set two experimental gillnets in May at pre-established locations used in previous annual inventory trend netting. This information will then be comparable to historic gillnet sets. Although gillnet capture efficiency tends to be biased against warmwater species, this bias existed in past netting efforts. If we acknowledge and accept those biases, this netting methodology will generate another index of whether perch abundance is moving toward the 30% biomass target.

#### **Objective 4: Monitor tiger muskellunge diet.**

Task 4.1: Determine tiger muskie diet.

Rationale: Although the literature shows muskie will utilize perch, it also suggests that they will select against them as they are spiny-rayed fish. Diet analysis will illustrate the degree to which perch are being utilized as forage.

Approach: Stomachs will be collected from any dead muskie encountered, while stomach contents of live muskie encountered during sampling will be collected using gastric lavage and through a sieve (1-mm opening) and preserved in 70% ethanol for examination in the lab. Food items will be examined using a variable power (7-30X) binocular dissecting microscope and identified to the lowest practical taxonomic level (most often to order, but in some cases, sub-order or family), and counted. Identification of partially digested fish remains to family will be accomplished using a variety of keys available for diagnostic bones.

Percentage contribution to the diet (by volume) of each category of food item will be calculated on the basis of the entire volume of food. Volume of other specific food items consumed will be calculated by multiplying the number of individuals by the average volume per individual. Average displacement (volume) per individual will be measured by placing representative individuals in a graduated centrifuge tube partially filled with water. This allowed volume estimation even if only partial remains of a prey item were found in a stomach.

#### **Objective 5: Monitor for upstream movement of tiger trout.**

Task 5.1: Monitor for presence/absence of tiger trout in Powder River upstream of Phillips Reservoir.

Rationale: Bull trout reside in tributaries of the Powder River upstream of Phillips Reservoir. While tiger trout are primarily sterile, there is the small possibility that they could either interbreed with bull trout and/or compete for habitat, should they leave the reservoir and migrate to reaches occupied by bull trout.

Approach: Releases of tiger trout in 2011 and 2012 have not met either the target number or size, as a direct result no tiger trout were captured in sampling activities in 2011. Thus at this time, it

is unlikely that significant numbers of tiger trout exist in the reservoir. Once in-reservoir sampling has documented significant survival of tiger trout, then sampling should occur in the Powder River, to determine movement upstream. Presence/absence of tiger trout in electrofishing samples will be used to documented upstream movement into the 8 Km reach above Phillips. One randomly selected 100 m site will be sampled in each 1 km reach of river. One pass will be completed with block nets.

## **Limnological Monitoring and Evaluation Plan**

### **Objective 1: Monitor Basic limnological characterization of the reservoir**

Rationale: The rule language changing the status of tiger muskie from prohibited to controlled states “Department will develop an environmental monitoring plan for Phillips Reservoir which should include: a) Basic limnological characterization of the reservoir (nutrient concentrations, light penetration, vertical profiles of physical and chemical characteristics of reservoir water, zooplankton, and phytoplankton composition and densities).”

Approach: As the goal of this aspect of the M&E program is to monitor changes in water quality over the initial 5-year period following introduction of tiger muskie, complete limnological characterization of the reservoir is not necessary. This fact and the general homogeneity of the water mass in the lake reduces the number of sampling sites needed to monitor changes in basic limnological characteristics of the lake. Sampling will occur from May through October during years when a fisheries creel clerk is employed to take advantage of the additional manpower.

Task 1.1: Monitor changes in reservoir nutrient concentration.

Approach: Replicate integrated epilimnetic water samples for nutrient analysis will be collected at monthly intervals at a deep water station using a 15-m long, 2.54-cm diameter acrylic tube suspended vertically in the water column. Additionally, replicate water samples will be collected using a non-metallic Van Dorn bottle from the surface to depth at 5-m intervals at three times during the growing season - prior to spring stratification, late in the summer stratification and after the autumn overturn. Ideally, water samples will be analyzed for concentrations of total phosphorus, soluble reactive phosphorus, orthophosphate, nitrate-nitrogen, nitrite-nitrogen, total Kjeldahl-nitrogen, ammonia-nitrogen, but budget constraints might limit the number of parameters tested.

Task 1.2: Monitor changes in reservoir light penetration.

Approach: At weekly intervals, a standard 20 cm (7.9 in) Secchi disk will be lowered into the water on the shaded side of the boat until it just disappears from sight. This depth is recorded to the nearest 0.1 meter. The disk is then lowered an additional meter and raised until it reappears. These two values are then recorded separately. The depth of disappearance and reappearance of the disk is averaged, and the depth is measured to the nearest 0.1 meter.

Task 1.3: Monitor changes in physical and chemical characteristics of reservoir water.

Approach: Temperature and dissolved oxygen profiles will be measured at 1 m increments weekly at the deepest point in the lake using a YSI temperature/dissolved oxygen meter. Total alkalinity and specific conductance of water samples collected monthly from depths corresponding to the epilimnion, metalimnion, and hypolimnion will be measured using electronic meters. Seasonal and spatial variability in pH requires more careful monitoring; measurements from water collected every other week from depths corresponding to the epilimnion, metalimnion, and hypolimnion should adequately track changes.

Task 1.4: Monitor changes in zooplankton community composition and density.

Approach: Zooplankton will be sampled bi-weekly at a deep water station by making replicate vertical tows at twice the Secchi depth or the entire water column above the thermocline (whichever is greater) at a rate of 0.5 m/s with a Wisconsin-type plankton net with 153  $\mu\text{m}$  mesh and a 0.12 m diameter opening. In areas shallower than the above depth, tows will be started from just above the bottom. Zooplankton will be preserved with 70% ethanol and stained with rose Bengal. A one milliliter aliquot of each well-mixed sample will be used for analysis where zooplankters will be identified to the lowest practical taxonomic level, counted, and a subsample of the dominant taxa measured. To provide a statistically valid count at least 100 organisms will be counted from each sample. Size frequency distributions for cladocerans will be determined by measuring from the anterior margin of the head to the base of the tail spine. Copepods will be measured from the anterior margin of the head to the base of the caudal rami.

Task 1.5: Monitor changes in reservoir chlorophyll concentration.

Approach: Water samples for chlorophyll analysis will be collected at two week intervals (Table 2) at a deep water station. Replicate integrated water samples for chlorophyll analysis will be collected using a 15-m long, 2.54-cm diameter acrylic tube suspended vertically in the water column, buffered with  $\text{MgCO}_3$ , filtered through 0.45 $\mu\text{m}$  filter paper, and stored in the freezer until processed. Spectrophotometric determination of concentrations of chlorophyll-*a*, *b*, and *c*, as well as pheophytin-*a*, will be performed using standard methods for acetone extraction on two distinct sub-samples from each composite sample (APHA 1976).

Task 1.6: Monitor changes in reservoir phytoplankton composition and density.

Approach: Phytoplankton will be collected at a deep water station three times during the growing season using the same integrated hose sampler methodology used to collect samples for chlorophyll-*a*. One composite sample, consisting of three combined replicate water samples, will be collected for each sample site/time. All samples will be preserved with Lugol's iodine and held in the dark on ice until delivery to the laboratory where they will be concentrated by allowing to settle at least 24 hours and siphoning off most of the water. Enumeration will be accomplished in a Sedgwick-Rafter counting cell using a one milliliter aliquot taken from the well mixed concentrate. Phytoplankters will be reported by taxonomic group. The groups include:

- Chrysophyta
- Diatoms

- centric
- pennate
- Chlorophyta
  - Green algae
    - coccolids
    - filamentous
- Cyanophyta
  - Blue-green algae
    - colonial
    - filamentous
- Others

Only algae that are alive at the time of preservation, based on cell contents, will be enumerated. Algae will be identified to the lowest practical taxonomic level and enumerated in sequentially viewed fields along transects of the counting chamber. Counting will continue until at least 100 units are counted and until no new taxa are observed. A unit is defined as a discrete algal particle (cell, filament or colony); when filamentous fragments are encountered they will be counted as whole organisms.

Task 1.7: Monitor changes in reservoir benthic macroinvertebrate community composition and density.

Approach: The benthic macroinvertebrate fauna in Phillips Reservoir will be collected with duplicate Ekman dredge samples at 5 m depth intervals to 20 m at the deepest part of the lake with no compositing of individual samples. Bottom materials will be washed through a U.S. Standard No. 30 sieve (pore size 0.59 mm), preserved in 70% ethanol and returned to the laboratory. Samples will be placed in a saturated salt solution to float organisms free from the sediment and debris. The organisms will be transferred back into 70% ethanol containing rose bengal, a stain selective for tissues. Macroinvertebrates will be counted and identified to the lowest taxonomic level practical

**APPENDIX A.** Schedule for fisheries sampling at Phillips Reservoir. “XX” denotes that activity should be carried out in order to evaluate program, “CC” indicates that activity is not critical but would be beneficial to evaluation of program if carried out.

Task Acti vity	Year	Is activity planned?	Apr	May	Jun	Jul	Aug	Sep	Oct
1.1 Creel survey	2013	XX	XX XX	XX		XX XX		XX XX	
	2014								
	2015	XX	XX X	XX	X	XX X	X	XX X	X
	2016	CC	CC C	C C	C	CC C	C	CC C	C
	2017	XX	XX X	XX	X	XX X	X	XX X	X
1.2 Angler opinion survey	2013	XX	XX X	XX	X	XX X	X	XX X	X
	2014								
	2015	CC	CC C	C C	C	CC C	C	CC C	C
	2016								
	2017	XX	XX X	XX	X	XX X	X	XX X	X
2.1 Survival of subcatchable trout	2013	XX	XX	XX					
	2014	XX	XX	XX					
	2015	XX	XX	XX					
	2016	XX	XX	XX					
	2017	XX	XX	XX					
2.2 Growth of subcatchable trout	2013	XX	XX	XX					
	2014	XX	XX	XX					
	2015	XX	XX	XX					
	2016	XX	XX	XX					
	2017	XX	XX	XX					
2.3 Growth of catchable RBT	2013	XX	XX	XX					
	2014	XX	XX	XX					
	2015	XX	XX	XX					
	2016	XX	XX	XX					
	2017	XX	XX	XX					
2.4 Growth and survival of tiger trout	2013	CC	CC	CC					
	2014	CC	CC	CC					
	2015	CC	CC	CC					
	2016	CC	CC	CC					
	2017	CC	CC	CC					
3.1 Perch density	2013 <sup>a</sup>	XX	XX						
	2014 <sup>b</sup>	CC	CC						
	2015 <sup>b</sup>	CC	CC						
	2016 <sup>b</sup>	XX	XX						
	2017 <sup>c</sup>	XX	XX						
3.2 Perch growth	2013	CC	CC						
	2014								
	2015								
	2016								
	2017	CC	CC						
3.3 Perch % of community biomass	2013	XX	X	X					
	2014	XX	X	X					
	2015	XX	X	X					
	2016	XX	X	X					
	2017	XX	X	X					

**APPENDIX A.** (continued)

<b>4.1</b>	<b>Tiger muskie diet</b>	<b>2013</b>									
		<b>2014</b>	CC	CC C	CC	C	CC C	C	CC C	C	
		<b>2015</b>	CC	CC C	CC	C	CC C	C	CC C	C	
		<b>2016</b>	CC	CC C	CC	C	CC C	C	CC C	C	
		<b>2017</b>	CC	CC C	CC	C	CC C	C	CC C	C	
<b>5.1</b>	<b>Tiger trout emigration<sup>d</sup></b>	<b>2013</b>									
		<b>2014</b>									
		<b>2015</b>									
		<b>2016</b>									
		<b>2017</b>									

- <sup>a</sup> population estimate using full Merwin trapping effort
- <sup>b</sup> Population estimate or density estimate using modified trapping effort and/or electrofishing.
- <sup>c</sup> Ideally perch density estimate would be generated using full Merwin trapping effort.
- <sup>d</sup> Surveys in Powder River will be performed annually if and when a population of tiger trout becomes established in the reservoir.

**APPENDIX B.** Schedule for limnological sampling for Phillips Reservoir. Nutrients to be sampled include total phosphorus, soluble reactive phosphorus, orthophosphate, nitrate-nitrogen, total Kjeldahl-nitrogen, ammonia-nitrogen.

Task	Parameter measured	Frequency <sup>a</sup>	Location <sup>b</sup>	May	Jun	Jul	Aug	Sep	Oct
1.1	Nutrient concentration	Monthly	Epilimnion composite	XX	XX	XX	XX	XX	XX
		Strat After strat	5-m interval	XX late	XX late	XX late	XX late		
1.2	Secchi	Weekly		XX	XX	XX	XX	XX	XX
1.3	pH	Bi-weekly	Zonal	XX	XX	XX	XX	XX	XX
1.3	Total alkalinity, specific conductance	Monthly	Zonal	XX	XX	XX	XX	XX	XX
1.3	D.O. and Temperature	Weekly	Surface to depth, 1 m intervals	XX	XX	XX	XX	XX	XX
1.4	Zooplankton	Bi-weekly	Epi&mesolimnion <sup>c</sup>	XX	XX	XX	XX	XX	XX
1.5	Chlorophyll	Bi-weekly	Epilimnion composite	XX	XX	XX	XX	XX	XX
1.6	Phytoplankton	Mid-month	Epilimnion composite	XX		XX		XX	
1.7	Benthic inverts	Mid-month	5m, 10m, 15m, 20m	XX		XX		XX	

<sup>a</sup> Bi-weekly means every other week. Strat refers to three sampling occasions: prior to spring stratification (late May), late in the summer stratification (late July), and after the autumn overturn (late September).

<sup>b</sup> Zonal denotes 3 samples: epilimnion, metalimnion, and hypolimnion.

<sup>c</sup> Sample at twice the secchi depth or the entire water column above the thermocline, whichever is deeper.

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Table 1. Fish species known to occur in the Powder Subbasin. From the Powder Subbasin Plan.

Species	Origin	Distribution
Redband trout( <i>Oncorhynchus mykiss gibbsi</i> ) N		Widespread
Rainbow trout ( <i>Oncorhynchus mykiss</i> ) N		Widespread
White sturgeon ( <i>Acipenser transmontanus</i> )	N	Rare in Powder Arm of Brownlee Reservoir
Mountain whitefish ( <i>Prosopium williamsoni</i> ) N		Mainstem
Brook trout ( <i>Salvelinus fontinalis</i> ) I		Widespread
Bull trout ( <i>Salvelinus confluentus</i> ) N		Elkhorn tributaries
Lake trout ( <i>Salvelinus namaycush</i> ) I		Few high lakes
Mottled sculpin ( <i>Cottus bairdi</i> )	N	Mainstem and tributaries
Slimy sculpin ( <i>Cottus cognatus</i> ) N		Mainstem and tributaries
Torrent sculpin ( <i>Cottus rhotheus</i> ) N		Mainstem and tributaries
Shorthead sculpin ( <i>Cottus confuses</i> ) N		Mainstem and tributaries
Piaute sculpin ( <i>Cottus beldingi</i> ) N		Mainstem and tributaries
Carp ( <i>Cyprinus carpio</i> )	I	Low Gradient Streams
Northern pikeminnow ( <i>Ptychocheilus oregonensis</i> )	N	Mainstem
Chiselmouth ( <i>Acrocheilus alutaceus</i> )	N	Widespread
Peamouth ( <i>Mylocheilus caurinus</i> )	N	Widespread
Longnose dace ( <i>Rhinichthys cataractae dulcis</i> )	N	Widespread
Speckled dace ( <i>Rhinichthys osculus</i> )	N	Widespread
Redside shiner ( <i>Richardsonius balteatus balteatus</i> )	N	Widespread
Largescale sucker ( <i>Catostomus macrocheilus</i> )	N W	Widespread
Mountain sucker ( <i>Catostomus platyrhynchus</i> )	N	Widespread
Bridgelip sucker ( <i>Catostomus columbianus</i> )	N	Widespread
Black crappie ( <i>Poxomis nigromaculatus</i> )	I	Lakes, Ponds, Low Gradient
White crappie ( <i>Poxomis annularis</i> )	I	Lakes, Ponds, Low Gradient
Largemouth bass ( <i>Micropterus salmoides</i> )	I	Lakes, Ponds, Low Gradient
Smallmouth bass ( <i>Micropterus dolomieu</i> )	I	Lakes, Ponds, Low Gradient
Bluegill ( <i>Lepomis macrochirus</i> )	I	Lakes, Ponds, Low Gradient
Pumpkinseed ( <i>Lepomis gibbosus</i> )	I	Lakes, Ponds, Low Gradient
Warmouth ( <i>Lepomis gulosus</i> )	I	Lakes, Ponds, Low Gradient
Yellow perch ( <i>Perca flavescens</i> )	I	Lakes, Ponds, Low Gradient
Channel catfish ( <i>Ictalurus punctatus</i> )	I	Lakes, Ponds, Low Gradient
Flathead catfish ( <i>Pylodictis olivaris</i> )	I	Lakes, Ponds, Low Gradient
Brown bullhead ( <i>Ameiurus nebulosus</i> )	I	Lakes, Ponds, Low Gradient

Table 2. Fish species known to occur in Phillips Reservoir.

Redband trout( <i>Oncorhynchus mykiss gibbsi</i> )	Bridgelip sucker ( <i>Catostomus columbianus</i> )
Rainbow trout ( <i>Oncorhynchus mykiss</i> )	Largescale sucker ( <i>Catostomus macrocheilus</i> )
Northern pikeminnow ( <i>Ptychocheilus oregonensis</i> )	Largemouth bass ( <i>Micropterus salmoides</i> )
Chiselmouth ( <i>Acrocheilus alutaceus</i> )	Smallmouth bass ( <i>Micropterus dolomieu</i> )
Redside shiner ( <i>Richardsonius balteatus balteatus</i> )	Black crappie ( <i>Poxomis nigromaculatus</i> )
Yellow perch ( <i>Perca flavescens</i> )	Walleye ( <i>Stizostedion vitreum</i> )
Brown bullhead ( <i>Ameiurus nebulosus</i> )	Bull trout ( <i>Salvelinus confluentus</i> )

Table 3. Fish stocked in Phillips Reservoir by ODFW, 1968-2012.

Year	Rainbow Fingerling	Rainbow Sub-legal	Rainbow Legal	Tiger Trout	Coho Fingerling	Cutthroat Fingerling	Smallmouth Bass	Largemouth Bass
1968	199,811							
1969	199,85	8			100,464			
1970	200,71	8			100,094			
1971	203,39	5			118,848			
1972	166,58	0			118,568	50,080		
1973	67,796				97,721		5,999	4,790
1974	252,13	6			121,915			
1975	222,17	2			100,700	61,180		
1976	250,14	0			100,640	38,794		
1977	156,26	6						
1978	190,02	0			66,750			485
1979	148,88	6			118,950			227
1980	149,97	0			105,385		2,734	372
1981	149,91	3			97,500			
1982	149,93	8			99,825			
1983	NA				NA			
1984	NA				NA			
1985	152,76	0			80,960			
1986	98,230				132,840			
1987	223,01	0			113,960			
1988	119,96	1			98,000			
1989	100,58	0			102,388			
1990	115,87	5			200,180			
1991	127,20	5			6,000			
1992	164,82	5						
1993	147,36	3						
1994	143,98	8						
1995	129,31	2	8,000					13,268
1996	136,08	0	8,000					
1997	176,95	6	8,113					
1998	136,00	0	9,194					
1999	115,60	6	13,491					
2000	130,47	0	16,533					
2001	86,488		15,016					
2002	85,995		17,500					
2003	85,981	25,026	20,120					
2004		24,905	21,919					
2005		26,555	11,931					
2006		24,071	32,420					
2007		25,814	22,460					
2008		29,001	31,385					
2009		24,990	30,202					
2010			33,607					
2011		29,487	26,005	1,600				
2012		29,741	36,349	8,112				



# La Grande District

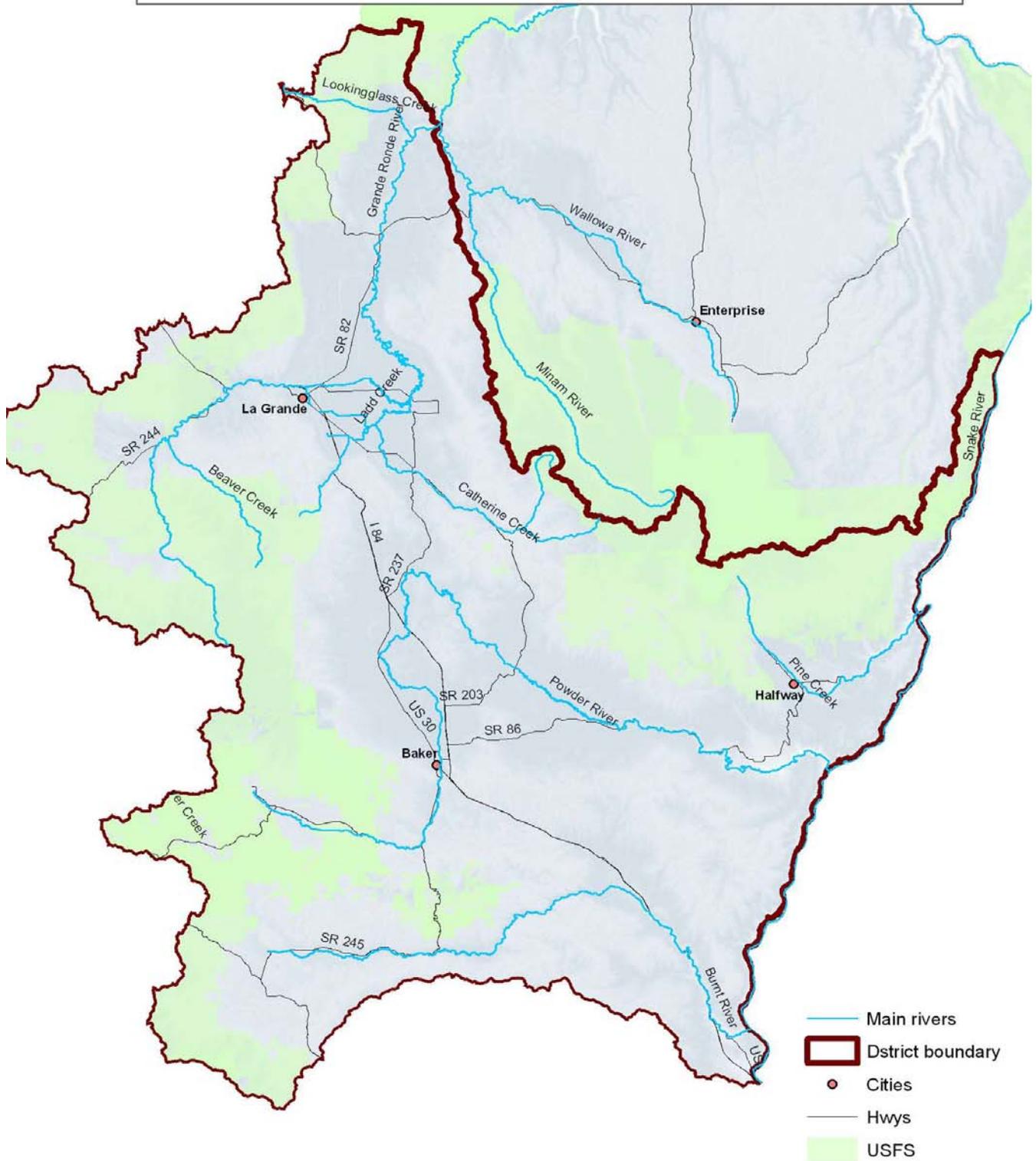


Figure 1. Map

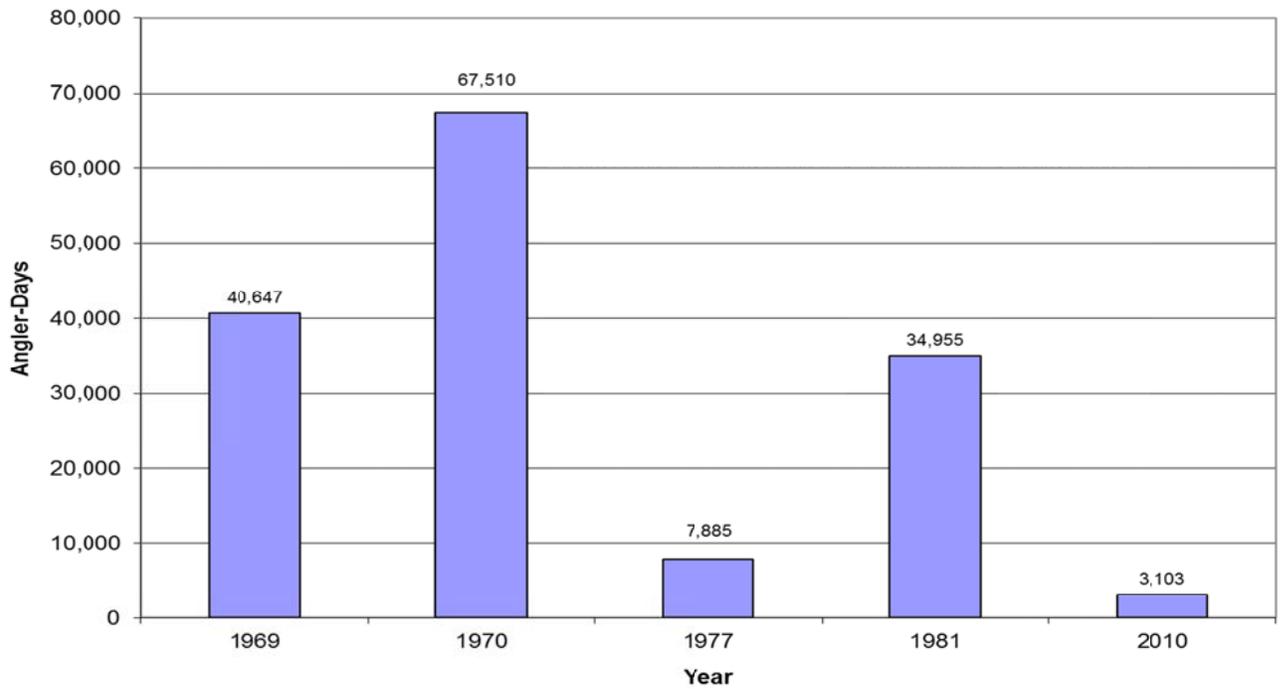


Figure 2. Angler-days documented at Phillips Reservoir by statistical creel survey.

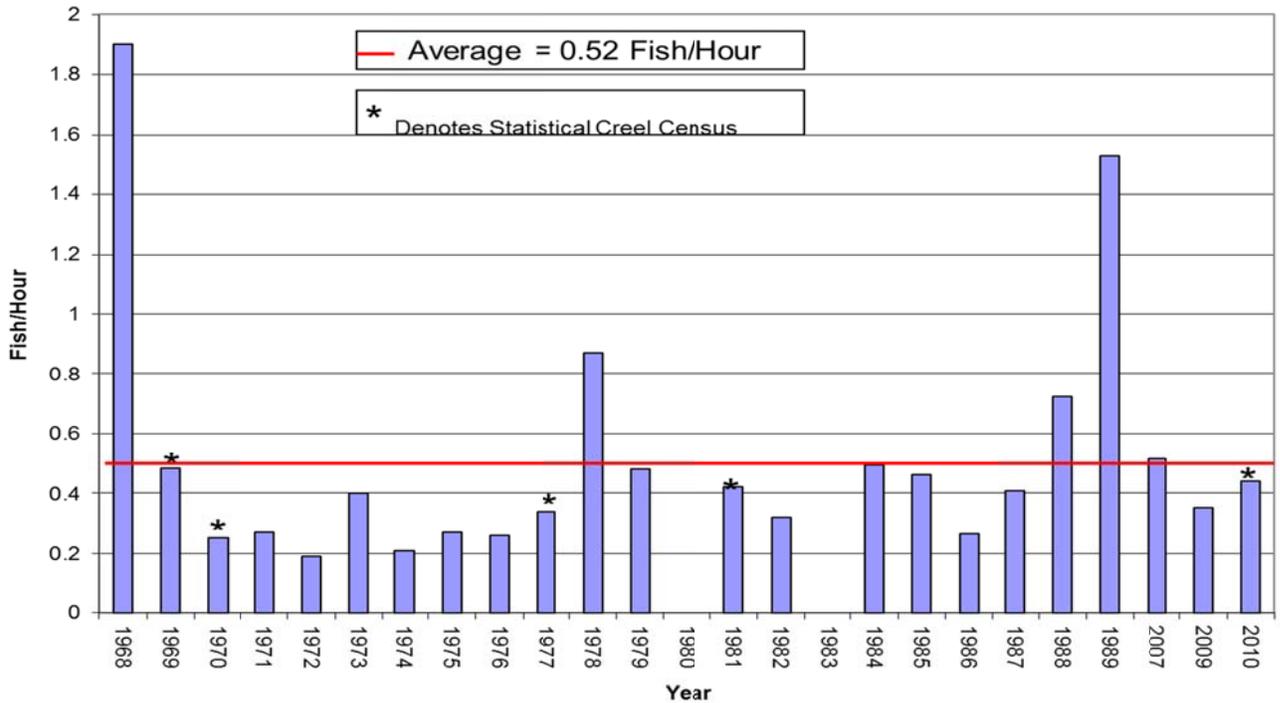


Figure 3. Catch rates (fish/hour) of rainbow trout caught at Phillips Reservoir, 1968 - 2010.

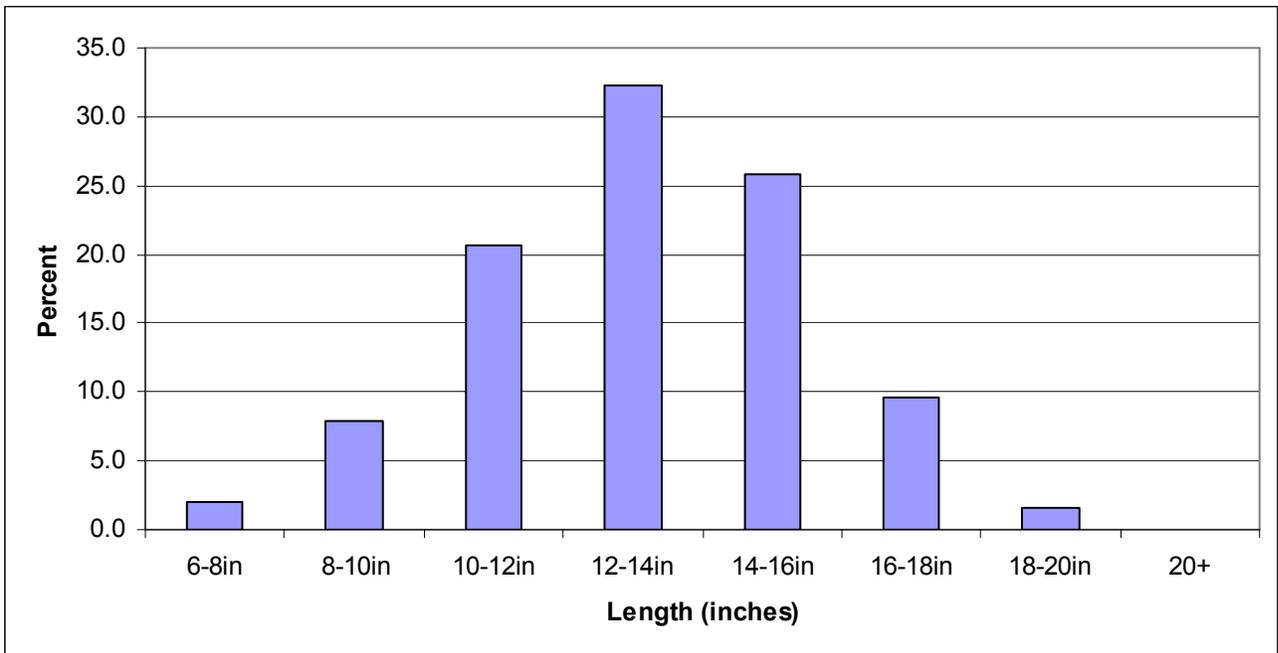
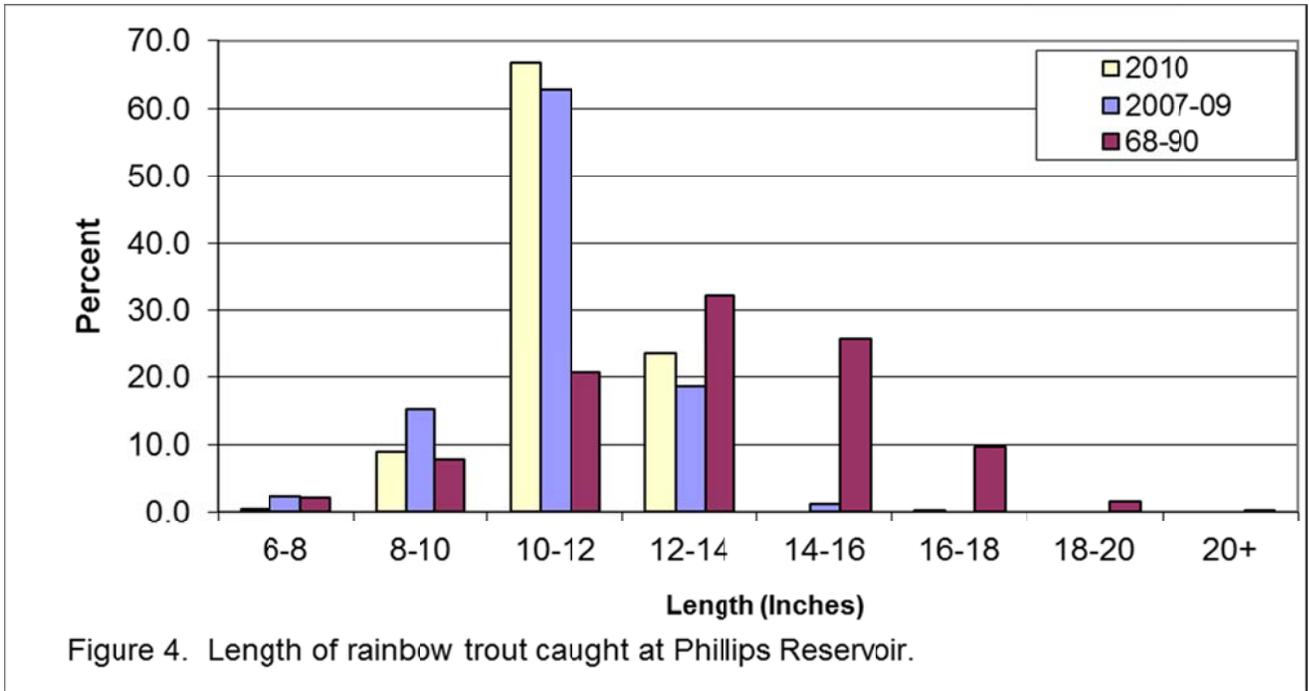


Figure 5. Objective length distribution of rainbow trout caught at Phillips Reservoir.



## **Fishery Management Goals and Objectives**

Management actions need to be driven by a vision for what the fishery at Phillips Reservoir is desired to look like in the future. Goals and objectives have been developed for this purpose. The goals and objectives listed below were developed based on the intent of achieving the outcome anglers would like to see as communicated in the 2008 angler survey (ODFW 2009).

Fishery Management Goal: Restore the recreational trout fishery to characteristics (catch rates, size of fish, etc.) approaching those experienced in the 1970's and 1980's. Provide opportunities for other species as described in species specific goals and objectives when they can be achieved without significantly impacting attainment of trout fishery goals and objectives.

Overall Management Objective: Average annual angler use of 38,000 angler-days

Trout Management Goal: Manage for a productive trout fishery that provides both stock and trophy-sized fish.

Objective: Catch Rate 0.50 fish/hour

Objective: Size distribution of catch representative of the fishery prior to perch introduction (Figure 5).

Warmwater Species Management Goal: Manage to provide fishery for trophy-sized bass. No management emphasis on black crappie.

Objective: Bass abundance and size optimized to achieve trophy size to the extent that they do not negatively impact stocked rainbow trout and the effective introduction of tiger muskie.

Perch Management Goal: Provide harvest opportunity as long as objectives of the trout fishery can be met.

Objective: Catch rate 1 fish/hr

Objective: Average length of catch is 10 inches.

## Signature Authorization Page

I hereby make an application for financial assistance under the terms and conditions of the R&E Program as described in my project application.

I understand that if my project is approved for funding, the following will apply:

- All project sponsors must sign a grant agreement containing the terms and conditions on which funding will be released.
- Project expenses which occur before the grant agreement is signed or after the expiration date will not be paid by the R&E Program.
- Copies of all necessary permits must be submitted to the R&E Program.
- Project sponsors must certify compliance with local, state, and federal regulations and laws.
- Landowner, monitoring and maintenance agreements must be submitted to the R&E Program.
- Regular progress reports may be required, and at the end of each project a Completion Report must be submitted.
- Educational products resulting from projects are public domain.
- All information submitted to either party under this application is subject to the federal Freedom of Information Act.

Project: Phillips Reservoir Monitoring and Evaluation

Applicant: Tim Bailey

Date: 12-9-13

Regional Manager: \_\_\_\_\_

Date: 12/9/13