Attachment 4

FISH INTRODUCTION PROPSOAL

PHILLIPS RESERVOIR TIGER MUSKIE

February 2012

Oregon Department of Fish and Wildlife
3406 Cherry Avenue NE
Salem, OR 97303

FOR CONSIDERATION BY THE OREGON FISH AND WILDLIFE COMMISSION
DECEMBER 6, 2012

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I. PROPOSAL

A. Description of Proposed Introduction

The ODFW Northeast Region in collaboration with the Recreational Fisheries Program and Warmwater Program propose to introduce tiger muskellunge (tiger muskie) into Phillips Reservoir to address fishery and conservation concerns resulting from the illegal introduction of yellow perch. The tiger muskie introduction will involve the ongoing release of hatchery-reared juveniles into the reservoir for a period of at least 5 years to determine the efficacy of the introduction. Source of the tiger muskie depends on the timing of receiving approval and longer-term availability. The Utah Division of Wildlife Resources has offered ODFW fingerling tiger muskie from their warmwater hatchery at no cost. These fish would need to be transported in May. Should this source become unavailable, then juveniles could be purchased from private hatcheries or possibly from another state hatchery. Two-inch fingerlings acquired from Utah would be stocked at a rate of 20 fish per surface acre totaling 36,000 fish, stocked in May. If alternative sources were used, the fish would likely be purchased at a larger size and stocked in the fall at a lower stocking rate. The management intent would be to achieve an adult density in the reservoir of 1-2 fish per acre. All juveniles introduced into Phillips Reservoir would be certified disease free.

Tiger muskie have been artificially produced and stocked by state fish and wildlife agencies in 26 states including the western states of Colorado, Idaho, Montana, Utah, Wyoming and Washington (http://nas.er.usgs.gov/queries/FactSheet.aspx?speciesID=677).

B. Biological Description of Introduction Species

1. Biology

Tiger muskie are a cross between northern pike (*Esox lucius*) and muskellunge (*Esox masquinongy*); males are sterile and although Scott and Crossman (1973) reported that females are often fertile, fertile females have not been observed in over 30 years in the long-term production program in Pennsylvania (Tom Pekarski, Pleasant Mount Fish Hatchery Manager and Mike Kaufmann, Area Fisheries Manager, Pennsylvania Fish & Boat Commission (PFBC), personal communications). The risk of reproduction in an introduced population in Phillips Reservoir would be non-existent as fertile females would have to backcross with northern pike or muskellunge (Jim Gleim, Calamas Fish Hatchery Manager, Nebraska Game and Parks Commission (NGPC), personal communication) and even in it's native range, muskellunge recruitment is so low that many populations are in danger of vanishing (Mike Kaufmann, PFBC, personal communication; Dombeck et al. 1986). This is a major advantage to fisheries managers because they can more carefully control predator numbers and reduce the risk if individuals escaping from the intended waterbody.

The following description of reproduction and growth for the parent species are summarized from Scott and Crossman (1973):

> Both northern pike and muskellunge are spring spawners, spawning shortly after ice-out, muskellunge spawning somewhat later. Spawning takes place in shallow, heavily vegetated flooded areas. Hatching generally occurs within 8 to 14 days at prevailing

water temperatures. The average number of eggs deposited is 32,000 for northern pike and 120,000 for muskellunge. The number of fry produced relative to egg number is generally quite low for both species.

Young northern pike and muskellunge grow rapidly during the first three years of life, slowing once sexual maturity is attained. A length of six inches is usually achieved by the end of the first summer. Muskellunge grow to be quite large, the largest exceeding 60 inches, but most in the range of 30-46 inches. Pike grow to be quite large as well, but attain somewhat smaller size than muskellunge.

Growth of muskellunge and tiger muskellunge is very similar in Pennsylvania, within the native range of pike and muskellunge (Lorantas and Kristine 2005). However, other fish and wildlife agencies report that tiger muskie grow more rapidly than the parent species (www.dnr.state.mn.us/fish/muskellunge/biology.html). Growth is quite rapid through approximately six years of age and then slows significantly. Length at 1 year is approximately 12 inches, 35 inches at 6 years and over 40 inches 10 years and beyond (Lorantas and Kristine 2005). The current angling world record tiger muskie weight is 51 pounds and the Washington State record is 32 pounds (WDFW 2009).

Life expectancy for pike in fast growing regions of Canada can be as low as 10-12 years and in slow growing arctic regions as high as 24-26 years (Scott and Crossman 1973). Life expectancy for muskellunge is similar. Casselman and Crossman (1986) report the average age of indigenous hybrids (tiger muskie) was 7.2 years and the oldest was 18 years.

Tiger muskie are a top-line predator. Fish make up almost entirely the diet of muskellunge and the hybrid tiger muskie from very early in their life history (Bozek et al. 1999; Krska and Applegate 1982; Wahl and Stein 1988). Scott and Crossman (1973) summarize that esocids are relatively unselective feeders that will forage on about anything that is alive and of the right size including fish, amphibians, reptiles, birds and small mammals. In a study of muskellunge diets in northern Wisconsin lakes (within their native range), Bozek et al. 1999 found that the main food items were yellow perch (*Perca flavescens*) and white suckers (*Catostomus commersoni*).

There are differences in prey selectivity between muskellunge, pike and the hybrid, tiger muskie (Engstrom-Heg et al. 1986). Under laboratory conditions, given the choice of white suckers, golden shiners and yellow perch, tiger muskie first selected white suckers, then shiners and finally yellow perch after most of the other prey species were consumed (Engstom-Heg et al. 1986). Tiger muskie are bottom oriented and tend to select bottom oriented prey over those that tended to school in mid-water and selected soft rayed fish over spiney-rayed fish. (Engstom-Heg et al. 1986; Wahl and Stein 1988). While tiger muskie prefer soft rayed, fusiform prey when available, they are opportunistic feeders and will do well irrespective of the forage base (Kohler and Kelly 1991; Drew Cushing, Warmwater Sport Fisheries Coordinator, Utah Division of Wildlife Resources (UDWR); Bruce Bolding, Warmwater Fish Program Manager, Washington Department of Fish and Wildlife (WDFW); Mike Hensler, Regional Fisheries Manager, Montana Department of Fish, Wildlife, and Parks (MFWP); Rick Castell, Fisheries Manager, and Richard Hansen, Cold Water Fisheries Biologist, New Mexico Game and Fish (NMGF); personal communications).

Poor survival of hatchery-reared tiger muskie juveniles has been documented in cases where centrarchid fish are the primary forage fish available. Apparently, being reared on pelletized feed, juvenile tiger muskie are not effective predators and do poorly at capturing prey such as bluegill (*Lepomis macrochirus*) (Tomcko et al. 1984; Stein et al. 1981; Wahl and Stein 1988; Wahl 1999). Neither have tiger muskie been shown to effectively control bluegill abundance (Storck and Newman 1992; Tomcko et al. 1984; Jim Fredricks, Regional Fisheries Manager, Idaho Department of Fish and Game (IDFG), personal communication).

2. Habitat

The parent species native habitats are generally warm heavily vegetated lakes, stumpy weedy bays or slow moving rivers (Scott and Crossman 1973) and are generally shallow water fish (Miller and Menzel 1986). The natural range of muskellunge spans from north to south from Tennessee to mid-Ontario and from east to west from New York to Minnesota (Lake Scientist at www.lakescientist.com/2010/muskellunge; Scott and Crossman 1973). Northern pike has a much broader range including all of Alaska, most of Canada (excepting the pacific Coast) and the upper Midwestern United States (Scott and Crossman 1973).

While some have reported that tiger muskie can do well in steep-sided reservoirs with little aquatic vegetation (Mike Kaufmann, PBFC, personal communication), it is generally thought that they prefer and perform better in shallow, vegetated lakes. Tipping (2001) found tiger muskellunge in Mayfield Reservoir, Washington in shallow water (1.5-2.5 m) macrophytes in summer and fall where they moved less (usually less than 100 m) than in winter through spring. These observations were supported by those of Miller and Menzel (1986) who found that muskellunge became more sedentary with more characteristic "sit and wait" feeding behavior in late summer in littoral habitats. In contrast, Tipping (2001) found that winter-spring movement of some tiger muskie encompassed over half of the reservoir, which is fairly large in size (890 hectares). Miller and Menzel (1986) found after the spring spawning period through mid summer, muskellunge exhibited more "searching predator" behavior, exhibiting relatively high levels of activity during crepuscular periods. During this time they moved from littoral areas to pelagic water. Others have reported tiger muskie "cruising" the shoreline in search of prey (Mike Hensler, MFWP; Rick Castell, NMGF; personal communication). Very large muskellunge are reportedly often found over deeper less vegetated water to a depth of 50 feet (Scott and Crossman 1973). Tiger muskellunge showed high site fidelity in Mayfield Reservoir; particularly in the fall where they returned to within 200 m of the site they had been the previous fall (Tipping 2001).

Northern pike generally follow similar habitat usage patterns as described above for muskellunge and tiger muskie, although they use a wider range of habitats (Scott and Crossman 1973).

C. Objective

The purpose for introducing tiger muskie into Phillips Reservoir is: 1) to test the feasibility of biological control of the yellow perch population, , 2) improved growth and survival of rainbow trout (*Oncorhynchus mykiss*), 3) an improved fishery for rainbow trout and yellow perch, and 4) provide a unique trophy fishery for tiger muskie. Development of a fishery management plan for the reservoir has been underway since 2009. As part of this process, a draft set of fishery management goals and objectives have been developed. The intent of this introduction is to facilitate achievement of these goals and objectives, which are listed below.

Fishery Management Goal: Restore the recreational fishery to characteristics (catch rates, size of fish, etc.) approaching those experienced in the 1970's and 1980's.

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 a trophy fishery for 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.

Perch Management Goal: Manage abundance of perch to 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 the introduction can 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 ability of the introduction, in concert with other management actions (rainbow trout stocking, tiger trout 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, MFWP; Bruce Bolding, 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.

Fish 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 annual gillnet or trap net samples collected in the spring.

Trout fingerlings released in the 1970's and 1980's achieved 5" in growth by 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 no 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 that the proposed stocking densities will result in a tiger muskie population density of 1-2 fish/acre and that it will take a minimum of three years after the initial introduction before the effects on the perch population are measurable and a minimum of five years before perch numbers are controlled (Jim Fredricks, IDFG; Doug Krieger, CDOW; Mike Ruggles and Mike Hensler, MFWP; personal communications).

D. Justification

1. Management needs

The decline of the Phillips Reservoir recreational fishery caused by the illegal introduction of yellow perch is fully described in the Section II.

The public demand for ODFW to make a meaningful effort to address the fishery problems at Phillips Reservoir is well established. Results of the 2008 angler survey (ODFW 2009) clearly show the high level of dissatisfaction with the current fishery, decrease in angler participation, and strong desire by the public to see the trout fishery restored. The county government has shown a high level of interest in the restoration of the reservoir evidenced by their formation of a citizen advisory committee to advise ODFW on this issue. Frequent letters to the editor in the local newspapers and telephone inquiries exemplify the public's interest and discontent with this fishery.

The 2008 angler survey (ODFW 2009) documents angler preference for future reservoir management and current level of satisfaction with the fishery. Trout anglers are dissatisfied with the current fishery. The majority of anglers want to see the trout fishery restored. A smaller but significant proportion of anglers would like to see a fishery for yellow perch maintained and a trophy fishery for bass. Generally, the public desires diverse fishing opportunities at the reservoir including: restoration of the trout fishery (with a trophy component), maintenance of a perch fishery for fish of larger size and a trophy fishery for bass. The extent to which all of these opportunities can be provided is uncertain, but the primary management need is to control abundance of yellow perch, in order to reduce their impact on the reservoir food web. The degree to which yellow perch abundance can be controlled (reduced) will dictate our ability to achieve fishery objectives.

Baker County's interest in restoration of the fishery is largely driven by economics. During the 1970's and 80's, the Phillips Reservoir fishery provided a significant value to the local economy. The estimated economic value of the fishery in 1981 was approximately $770,000. In 2007 dollars this would equate to a value of approximately $1.5 million. More recently, the fishery in 2010 had an estimated value of $138,300, in 2007 dollars. Obviously, the decline of the fishery at Phillips Reservoir has had an impact on the local economy.

To date a number of actions have been implemented to improve the fishery including:

- Changes in the rainbow trout stocking program
- Mechanical removal of yellow perch
- Introduction of tiger trout to provide a unique trophy fish

Changes in the stocking program have not been successful at achieving fishery goals and objectives.

However, mechanical removal does show promise as a short term action to compliment other control measures. The literature shows both successes and failures with regard to mechanical perch removal (Riel 1965; Akroyd 1983; Flick and Webster 1992; Brown 2008; Parker 1958) with most of the successes occurring in smaller waters. Meronek et al. (1996) reported that 61% of the attempts to use nets to physically control panfish or rough fish were successful but did not report on the size of the water where treatments were successful. A combination of control measures – water level drawdown and removal using fyke nets – were unsuccessful in controlling yellow perch in 212-acre Bay Pond and 146-acre Follensby Pond, New York, but an 12-year intensive removal program using Oneida Lake trap nets in the latter pond successfully reduced the standing crop of perch and improved the trout fishery (Flick and Webster 1992). At 19-acre Soldier Lake, Michigan, Bauer et al. (2004) were able to increase the stock density, condition, mean weight, and percentage of larger fish in the perch population following two years of removal using fyke nets.

While yellow perch removal is currently being implemented as a pilot project a Phillips Reservoir it is unlikely that a singular approach that is labor intensive, as is perch removal, will be a viable long-term solution to controlling yellow perch abundance without complimentary efforts. It is unlikely that resources from either the state or county would be available to continue a sustained effort over the long term. Removal of ~94% of the perch population in 86-acre Nepawin Lake likely only resulted in a temporary benefit to the brook (*Salvelinus fontinales*) trout population because of high perch reproductive potential (Yuen 2005).

The tiger trout introduction is not intended as a biological control of yellow perch, but is an experimental action to replace the trophy aspect of the trout fishery that once existed with a unique, sterile hybrid.

It does not appear that the suite of fishery management actions underway at this time will lead to successful restoration of the Phillips Reservoir fishery. Thus, additional methods are needed, primarily focusing on reducing yellow perch abundance in the reservoir.

2. Efficacy of Approach

As described by Shrader and Bailey (2009) and summarized above, an array of management options have been assessed. Weighing the likelihood of implementation, potential effects, risks and benefits of the management options assessed, the ODFW Northeast Region believes that a combination of biological control and mechanical removal provide the best management options. Tiger muskie are the favored biological control agent because they are a top-line predator that have been utilized to successfully control populations of forage fish (Wahl and Stein 1993), they are a sterile hybrid so there is little risk of their establishment as a invasive species, and they have provided popular trophy fisheries in adjoining western states (Richard Hansen and Rick Castell, NMGF; Drew Cushing, UDWR; Dale Allen, Regional Fisheries Manager, and Jim Fredricks, IDFG; Mike Ruggles and Mike Hensler, MFWP; Paul Winkle and Greg Policky, Aquatic Biologists, CDOW; Bruce Bolding, WDFW; personal communications).

With the high abundance of yellow perch in Phillips Reservoir, it would seem that tiger muskie should effectively prey on them and do well. Although many sources suggest that tiger muskie prefer soft-rayed fish to spiney-rayed prey, they are opportunistic and will eat what is available, including yellow perch (Mike Ruggles, MFWP; Bruce Bolding, WDFW; Dale Allen and Jim Fredricks, IDFG; Drew Cushing, UDWR; personal communications). Bozek et al. (1999) found in a study of muskellunge in 34 Wisconsin waters, yellow perch and white suckers were the most common species consumed with perch comprising 34% (by number) of their diet. Introduction of muskellunge into two small (<50 acres) lakes in Wisconsin resulted in the virtual elimination of yellow perch (Gammon and Hasler 1965).

Utah has had mixed results with using tiger muskies to control overabundant perch and panfish populations. Within six years of their introduction, tiger muskie have successfully reduced over-abundant black bullhead (*Ictalurus nebulosus*) and green sunfish (*Lepomus cyanellus*) in Joes Valley Reservoir, a steep-sided irrigation storage reservoir, to the point where it is now a very popular destination fishery for largemouth bass (*Micropterus salmoides*) and bullhead (Drew Cushing, UDWR, personal communication). Growth, average size, and stability of perch, largemouth bass and panfish populations, as well as the popularity of these fisheries in Newton Reservoir have increased following the introduction of tiger muskie in 1994 (Schaugaard 2000, Drew Cushing, UDWR, personal communication). The success of tiger muskie in controlling perch and panfish in Pineview Reservoir is more mixed; tiger muskie predation on black bullhead and black crappie (*Poxomis nigromaculatus*) has resulted in decreased density and increased size of these prey species but effects on yellow perch, other than possible stabilization of the boom-bust population cycle, have not been apparent (Schaugaard 1999; Drew Cushing, UDWR, personal communication).

Washington introduced tiger muskies into Mayfield Lake in an attempt to reduce northern pikeminnow (*Ptychocheilus oregonensis*) densities (Tipping 1992). It was felt that the slow growth of the pikeminnow and their tendency to be shoreline-oriented would maximize their availability to tiger muskies (Tipping 1992). Tiger muskies were also introduced into Evergreen Lake in Washington to control yellow perch, but did not appear to have exerted a control on the population at the time of the last warmwater fish survey (Peterson and Osborne 2006). However, due to the lack of adequate baseline data on pikeminnow and yellow perch densities in Mayfield and Evergreen Lakes, respectively, and the absence of a rigorous monitoring plan at Mayfield Lake, it is impossible to judge the effect of tiger muskie on the target "rough" fish populations

(Bruce Bolding, WDFW, personal communication). On the other hand, tiger muskie introductions into Curlew and Silver Lakes in Washington have successfully reduced northern pikeminnow and sucker densities from pre-muskie introduction levels (Bruce Bolding, WDFW, personal communication).

In summary, tiger muskie show promise as an effective biological control, but results have varied. Evidence is supportive enough to warrant a pilot project, given that the risk to native species is low as described in Section III.

II. PRESENT STATUS OF RECEIVING WATER

A. Overview

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 from 1965-68 for the purposes of irrigation, recreation and flood control. 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.

Mason Dam impounds the Powder River at approximately RM 131 creating Phillips Reservoir. The watershed upstream of the reservoir is 105,345 acres in size 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 over 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 in 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.

La Grande District

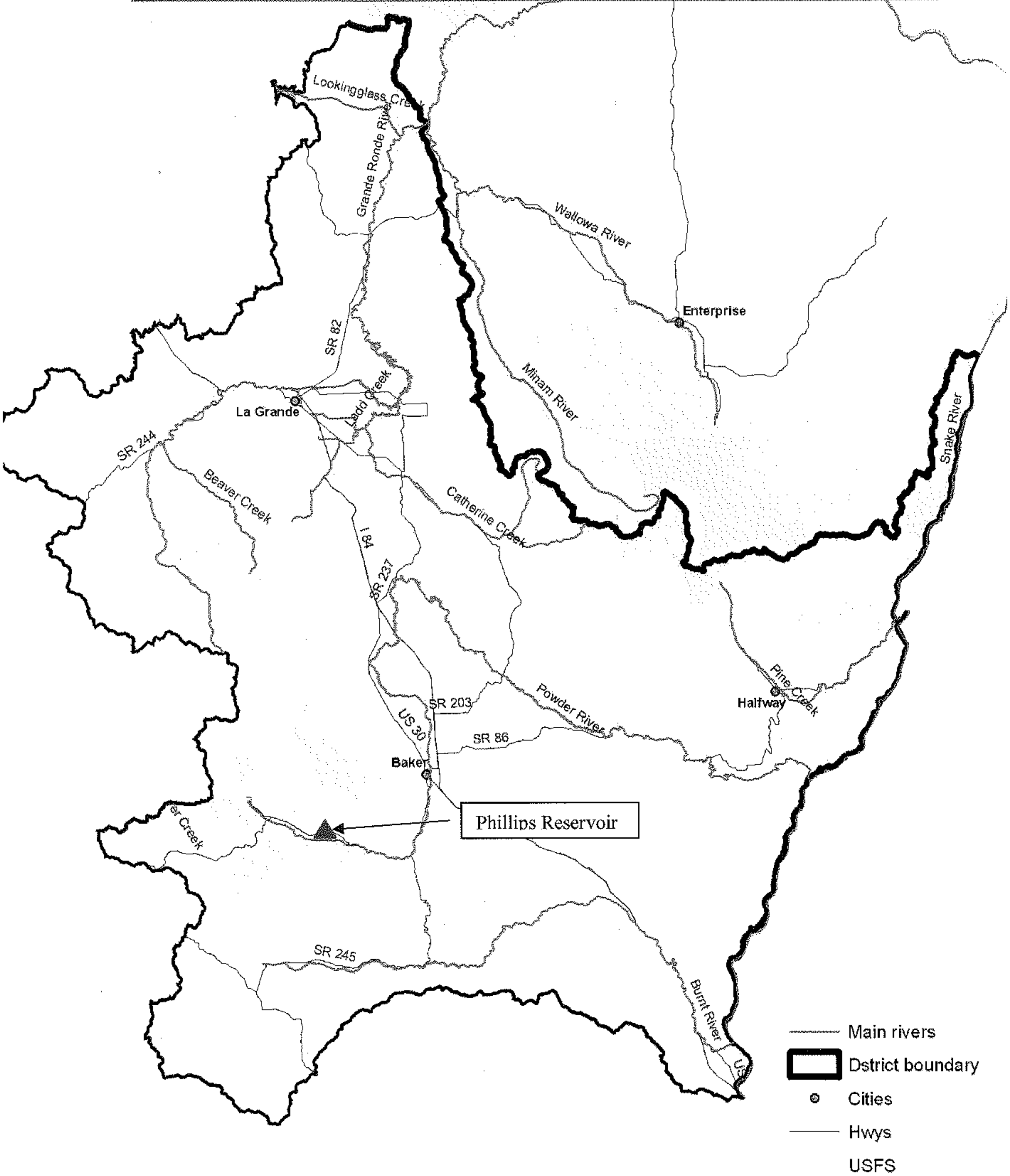

Figure 1. Map

Stream habitat and water quality upstream of the reservoir have been degraded by extensive gold mining activities. 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. 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 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 impacted 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 poor (RM 115 to the mouth).

B. 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*)), redside shiner (*Richardsonius balteatus*), dace (*Rhinichthys sp.*), sculpins (*Cottus sp.*) and northern pikeminnow 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. Known 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 13th and a 234 mm bull trout on April 18th. 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 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 present in the reservoir in relatively small numbers. Black crappie were first found in gillnet

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

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

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

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

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.

The stocking of hatchery rainbow trout (Oak Springs Stock), began in 1968, the year the reservoir was first filled, and continues presently. The program 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 program was terminated because, in the presence of over abundant yellow perch, they were not recruiting into the fishery. The fingerling program was replaced with a put and take program of legal-sized rainbows and experimental release of fall sub-legals (put-grow-take).

The current trout stocking program consists of 33,600 legal sized rainbows (Cape Cod Stock) spread out over the months of April through July and 24,600 sub-legals (Cape Cod Stock) released in mid-September. This program 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).

The release of sub-legal rainbow trout in the fall is an experimental release to determine if they can successfully grow and recruit into the fishery the next spring. If this strategy were successful, then a portion of the trout program could utilize the reservoir to grow to legal size, reducing program cost. Additionally, anglers prefer the quality of a fish that grows-out in natural habitat. The effectiveness of the release will provide a measure of the overall effectiveness of fishery restoration efforts.

Results to date indicate that the fall sub-legal rainbow trout releases do survive, grow, and recruit into the fishery the next spring at a reasonable size. Gillnet data from 2005 and 2006 and Merwin trap data from 2009 show, that on average, they reach approximately 9 inches in length their first April and a year later they are about 11.5 inches. Data from 2011 indicates that the sublegals grew better, averaging 12.9 inches in their second spring. Their size the first spring seems reasonable, but growth through the second spring is disappointing most years. In comparison, fall sub-legal rainbows stocked in Thief Valley Reservoir (a highly productive reservoir North of Baker City) in early November at a similar size are approximately 9 inches by late March and 15 inches a year after release. The condition factor of the Thief Valley trout is considerably higher than those in Phillips Reservoir.

While no direct estimates have been made of sub-legal rainbow abundance and survival in the reservoir, collections resulting from the perch removal project provide some insight. Of 264 rainbow trout captured in the Merwin traps in April 2009, 28% were unmarked naturally produced fish, 55% were stocked as legals and 17% were stocked sub-legals (adipose fin-clipped). Of just hatchery origin trout, 77% were legals and 23% sub-legals. The proportion of number of hatchery fish released is 58% legals and 42% sub-legals. Sub-legals were poorly represented in the 2009 sample, indicating that their performance has not been as good as the legals.

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 black crappie, smallmouth bass and rainbow trout (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 epilimnotic 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.

C. 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 largescale and bridgelip 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 regions 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. 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, but the length of fish caught are smaller than those caught in the past (Figure 2).

In 2004 and 2005, the Idaho Department of Fish and Game (IDFG) deployed Merwin trap nets in the reservoir in an attempt to capture perch for restocking Cascade Lake in Idaho. The project proved successful at capturing large numbers of yellow perch; 100,000 in 2004 and 200,000 in 2005. The traps were set on the reservoir in the spring immediately after ice-out for a period of approximately three weeks.

As a result of IDFG's successful perch capture efforts, ODFW and Baker County began implementation of a pilot project in 2009 to remove yellow perch from the reservoir. The objectives are to reduce the number of perch in the reservoir to increase the growth and survival of stocked rainbow trout and increase the average size of perch. Increased growth and survival of trout would then lead to more trout of a larger size available to anglers, thus assisting in achievement of fishery objectives. The combined catch of perch in 2009-2011 was 766,829. The estimated abundance of perch in 2011 at the time of removal was 1,636,575, meaning that 21.7% of the yellow perch population in the reservoir was removed. Plans are to continue the project in 2012 and 2013 to provide adequate data to determine effectiveness.

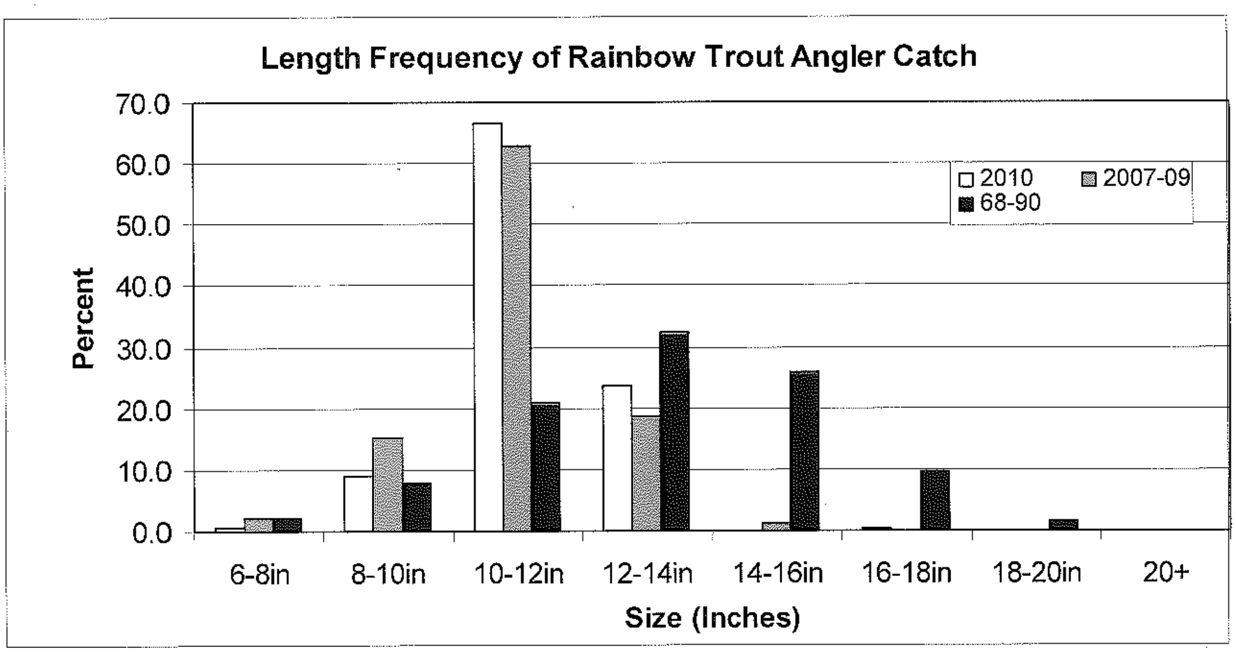

Figure 2. Length frequency of rainbow trout caught at Phillips Reservoir.

Stocking of tiger trout, a sterile hybrid resulting from the cross of brown and brook trout, is planned as an interim approach for providing quality and trophy-sized trout. The first stocking was implemented in September 2011 with 1,600 fingerlings released. Plans are to stock 10,000 annually at a size of approximately 6 inches. The goal of the tiger trout introduction is to provide anglers with a product that will be embraced as a "trophy", one that will arise the excitement as did the rainbows in this reservoir in the 1970's and 1980's. The objectives of the tiger trout introduction are to: provide a trophy quality fish (defined as a trout over 18 inches with good condition factor) and for these fish to return well to the creel.

Introductions of tiger trout into waters of Washington, Utah and Wyoming over widely ranging conditions indicate that they could meet our intent for them at Phillips Reservoir. The abundant population of yellow perch in the reservoir could serve as a forage base to augment their growth to "trophy" size.

D. 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, we 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 (ODFW 2009) documents that anglers are unsatisfied with the trout fishery, which is what the majority of anglers would like ODFW to manage for.

III. RISK ASSESSMENT

A. Overview

All species of pikes, pickerel and muskellunge (Family Esocidae) are prohibited from importation into Oregon per ODFW's Wildlife Integrity Rules (OAR 635-056-0050). In order for ODFW to introduce tiger muskie into Phillips Reservoir the Fish and Wildlife Commission must reclassify tiger muskie as a controlled species (OAR 635-056-0130), further specifying a set of conditions to establish this classification for introduction into Phillips Reservoir only.

The wildlife integrity rules provide the following list of factors that the Commission may consider in reviewing a classification request (OAR 635-056-0130):

- Potential to introduce disease or parasites to native wildlife populations;
- Potential for interbreeding or hybridizing with native wildlife;
- Possible competition with native wildlife for habitat, food, water, etc.;
- Impacts on the habitat of native wildlife;
- Potential predation on native wildlife;
- Feasibility and cost of capturing or eradicating escaped animals; or
- Any other factor or consideration the commission considers necessary to protect and maintain native wildlife.

Because reclassification of tiger muskie as a controlled species will be required, should the commission decide the introduction is appropriate; the following risk assessment addresses each of the factors listed above.

The primary ODFW policy guidance regardinmg the conservation of native fish is the Native Fish Conservation Policy (NFCP) (OAR 635-007-0502). Therefore, assessment of the risks addressed below is done so using the goals of the NFCP (shown below) as the measure of conservation risk.

> OAR 635-007-0503(1). Prevent the serious depletion of any native fish species by protecting natural ecological communities, conserving genetic resources, managing consumptive and non consumptive fisheries, and using hatcheries responsibly so that naturally produced native fish are sustainable.
>
> OAR 635-007-0503(2). Maintain and restore naturally produced native fish species, taking full advantage of the productive capacity of natural habitats, in order to provide substantial ecological, economic, and cultural benefits to the citizens of Oregon.

B. Potential to introduce disease or parasites to native wildlife populations

Because they are currently prohibited in the state, ODFW does not have a propagation program for tiger muskie. Thus, introduction of tiger muskie, and ongoing releases as proposed, would have to come from sources outside of Oregon. Transportation and release of fish from facilities outside of Oregon poses the potential risk of importing disease or parasites that do not currently exist in the state or destination water. However, under the existing Fish Health Management Policy (635-007-0960) ODFW has in place a process for preventing such importation. All of ODFW's policies and protocols will be followed to insure that diseases and parasites to native wildlife are not imported.

ODFW currently has an opportunity to acquire fingerling tiger muskie from the Utah Division of Wildlife Resources. Per OAR 635-007-0960 ODFW's Fish Pathologist must first approve importation of fish from this site. There are also numerous private hatcheries across the country that could be sources for tiger muskie releases into Phillips Reservoir. These facilities would have to undergo the same certification process.

Given the policies and protocols currently in place, the risk importing of diseases or parasites to native wildlife is very low. Thus, the proposed introduction would be consistent with the NFCP with respect to this risk category.

C. Potential for interbreeding or hybridizing with native wildlife

Tiger muskie are a cross between northern pike and muskellunge; males are sterile and although Scott and Crossman (1973) reported that females are often fertile, fertile females have not been observed in over 30 years in the long-term production program in Pennsylvania (Tom Pekarski and Mike Kaufmann, PFBC, personal communications). The risk of reproduction in an introduced population in Phillips Reservoir would be non-existent as fertile females would have to backcross with northern pike or muskellunge (Jim Gleim, NGPC, personal communication) and even in its native range, muskellunge recruitment is so low that many populations are in danger of vanishing (Mike Kaufmann, PFBC, personal communication; Dombeck et al. 1986). This is a major advantage to fisheries managers because they can more carefully control predator numbers and reduce the risk if individuals escaping from the intended waterbody.

Interbreeding of tiger muskie with either introduced or native species that currently inhabit the Powder Basin has not been documented, and presents a very low risk. Thus, the proposed introduction would be consistent with the NFCP with respect to this risk category.

D. Possible competition with native wildlife for habitat, food, water, etc.

Four top-line predators currently exist in Phillips Reservoir: northern pikeminnow, largemouth bass, smallmouth bass and tiger trout (introduced in 2011). All of these species are assumed to prey, to an unknown extent, on yellow perch and other native and introduced fish in the reservoir. Thus, there would be some level of competition for prey between tiger muskie and the aforementioned species. This risk assessment will focus on impacts to the native predator, northern pikeminnow.

It is obvious that the current predators have not exerted sufficient predatory pressure on the yellow perch population to achieve a desired level of control. Thus at this time, the availability of yellow perch as prey for predatory fish is not likely a limiting factor, recognizing that the food web in the reservoir is likely complex and that other species of prey may play an important role in the diet of predators and bioenergetics of these populations. However, the proposed introduction is intended to reduce the abundance of yellow perch.

Jeppson and Platts (1959) in a study of northern pikeminnow in three northern Idaho lakes found they are predominantly piscivorous as adults and compete with bull trout and rainbow trout. In these lakes, adult pikeminnow foraged primarily on yellow perch, kokanee (*Oncorhychus nerka*), trout and suckers. Zimmerman (1999) found that diets of northern pikeminnow, within impounded and free-flowing sections of the lower Columbia and Snake rivers, fed primarily on juvenile salmonids, 84 % by weight. McIntyre et al. (2006) also found that adult pikeminnow inhabiting Lake Washington in Washington State, fed primarily on fish. The proportion of fish in the diet was highest during winter months and shifted to include benthic invertebrates in the summer. The predominant energy pathway was from pelagic sources.

Obviously, tiger muskie will forage on prey sought by northern pikeminnow, but the degree of overlap both temporally and spatially is unknown. Northern pikeminnow being more of a pelagic feeder would suggest that while there may be substantial overlap in prey species, this could be separated at least spatially.

Phillips Reservoir is an artificial habitat created by the construction of Mason Dam. While there are no data available on the abundance of northern pikeminnow in the Powder River prior to construction of Mason Dam, it is likely that their abundance in the upper Powder Basin increased dramatically (probably by magnitudes) upon impoundment of Phillips Reservoir. The reservoir has increased volume of available habitat and very likely the abundance of prey available. Whatever the negative impact may be on northern pikeminnow by competing with tiger muskie for prey, it seems highly unlikely that the impact would be greater than the population expansion that occurred when the reservoir was constructed.

In general, northern pikeminnow in the Columbia Basin are not a species of conservation concern. They occupy a wide range of habitats and are generally abundant. In fact, they are so abundant in the mainstem Columbia River reservoirs bordering Oregon and Washington, that the Bonneville Power Administration has funded a long-term effort to control the abundance of northern pikeminnow as they prey heavily on ESA listed salmonids.

A critical component of managing tiger muskies to accomplish conservation mandates and fishery management goals and objectives will be monitoring of species biomass and resultant adaptive management. Fish 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, CDOW, personal communications). For example, other managers have found that trout fisheries can coexist with tiger muskie, given the tiger muskie don't overrun the managers preferred prey base (Greg Policky and Paul Winkle, CDOW; Bruce Bolding, WDFW; Mike Ruggles, MFWP; personal communications). When the desired level of control is achieved, stocking levels can then be reduced to maintain the tiger muskie density needed to achieve this (Greg Policky and Doug Krieger, CDOW, personal communications), but not exceed it, leading to unwanted levels of predation on or competition with other native and management species.

In addition, the intended management outcome is increased abundance and size of rainbow trout in the reservoir, which is supported by case studies throughout the west (Doug Krieger and Greg Policky, Aquatic Biologists, Colorado Division of Wildlife (CDOW); Mike Ruggles, Fisheries Biologist, MFWP; Bruce Bolding, WDFW; personal communications). There is sufficient evidence from other introductions that tiger muskie can achieve this end. Given that salmonids make up a large part of the diet of northern pikeminnow (Jeppson and Platts 1959; Zimmerman 1999), the net effect on northern pikeminnow could be positive.

Given that the abundance of tiger muskie in the reservoir can and be managed, northern pikeminnow abundance is likely artificially increased due to expansion of habitat and the prey base resulting from reservoir construction, and the potential benefit to northern pikeminnow primary prey species (rainbow trout/interior redband trout), the risk to the northern pikeminnow population resulting from competition with tiger muskie in the upper Powder Basin are considered to be low. Thus, the proposed introduction would be consistent with the NFCP with respect to this risk category.

E. Impacts on the habitat of native wildlife

It is not anticipated that tiger muskie will have any direct or indirect effects on the habitat of native wildlife. Thus, the proposed introduction would be consistent with the NFCP with respect to this risk category.

F. Potential predation on native wildlife

While it is very likely that tiger muskie would prey heavily on perch in Phillips Reservoir as they are so much more numerous than other fish species, they will also likely prey, to an unknown extent, on other native and introduced fish in the reservoir. A review of the spatial and temporal habitat usage of these species is provided (Section III. G.) in order to provide supporting information for the following assessment.

1. Catostomids and Cyprinids

It would appear from understanding the prey preferences of tiger muskie, and habitat utilization of native fish in the reservoir, that all would be susceptible to predation by tiger muskie, but catostomids would likely be most vulnerable followed by the cyprinids (Engstom-Heg et al. 1986; Tipping 1992; Kohler and Kelly 1991; Drew Cushing, Warmwater Sport Fisheries Coordinator, Utah Division of Wildlife Resources (UDWR); Bruce Bolding, Warmwater Fish Program Manager, Washington Department of Fish and Wildlife (WDFW); Mike Hensler, Regional Fisheries Manager, Montana Department of Fish, Wildlife, and Parks (MFWP); Rick Castell, Fisheries Manager, and Richard Hansen, Cold Water Fisheries Biologist, New Mexico Game and Fish (NMGF); personal communications). Catostomids present in Phillips Reservoir include largescale sucker and bridgelip sucker and cyprinids include northern pikeminnow and redside shiner (Table 2). These species are widespread and abundant in the reservoir and throughout the watershed upstream. The reservoir is an artificial habitat that has likely allowed catostomids and cyprinids to increase their abundance in the upper Powder Basin. Rapid recolonization of the reservoir by largescale sucker and northern pikeminnow after chemical treatments in the 1970's (ODFW unpublished reports and data) suggests individuals residing in adjacent stream habitats immigrated to the reservoir providing a source for recolonization and that they are highly productive in the reservoir habitat. There is no indication that the reservoir serves as a sink to the stream dwelling populations of these species and other catostomids and cyprinids. Thus, it is not anticipated that predation on these species within the reservoir will impact stream dwelling populations.

As previously discussed, control of the abundance of suckers and northern pikeminnow provided benefits to the trout fishery in the 1970's. Unfortunately, non-selective chemical treatments were used that removed all species form the waters treated. As in the past, some level of control of the abundance of these species in the reservoir could be beneficial to the fishery. Introduction of a biological control would provide ODFW with a tool to manage numbers of these prey species in addition to yellow perch, in a manner that would not impact stream dwelling populations and maintain relatively large numbers of individuals in the reservoir. Monitoring of species abundance in the reservoir and concurrent management of tiger muskie density, would be required in order to maintain a balance of game and non-game species in the reservoir.

Understanding that catostomids will be a primary prey species of tiger muskie, we believe the proposed introduction will pose a low conservation risk because the construction of Phillips Reservoir (an artificial habitat) has likely led to significant increase in the abundance of native catostomids and cyprinids in the upper Powder Basin, and the abundance of tiger muskie can be managed to achieve the desired level of predation. Thus, the proposed introduction would be consistent with the NFCP with respect to this risk category.

2. Interior Redband trout (*Oncorhynchus mykiss gibbsi)*

Interior redband trout (IRT) are of particular concern with respect to the proposed introduction due to their status as an Oregon Sensitive Species.

The presence of naturally produced rainbow/redband trout has been documented recently in Phillips Reservoir by the presence of <150 mm trout collected in Merwin trap nets used for perch removal in the spring of 2009 - 2011. These fish could be positively identified as naturally produced as they were considerably smaller than the legal sized trout (unmarked) stocked the previous summer, and had intact adipose fins that differentiated them from sub-legal trout stocked the previous fall. IRT abundance and spatial and temporal utilization of the reservoir have not been studied. They also occupy most of the headwater streams above the reservoir. No studies have been undertaken to understand the abundance or productivity of redband trout in stream habitats upstream of the reservoir. In general in northeast Oregon, redband trout have a wide distribution, are abundant and productive, where good habitat exists.

As with catostomids and cyprinids, the construction of Phillips reservoir has likely substantially increased the available habitat for IRT in the upper Powder Basin, and increased abundance, at least prior to yellow perch introduction.

Diet Studies of tiger muskie in Mayfield Reservoir in Washington State show that tiger muskie consume primarily round bodied, "soft rayed" non salmonid fish. Percent by number of fish species in a sample of 61 tiger muskie was northern pikeminnow (49%), largescale sucker (29%), rainbow trout (8%), coho salmon (6%) and other species (8%). So in this case, tiger muskie consumed salmonids, but they were a minor part of the tiger muskie diet.

Tipping (2001) found tiger muskie in shallow water macrophytes in summer and fall which reduces their opportunity to prey on salmonids that are generally more pelagic. While Tipping (2001) also found extensive movements of tiger muskie in winter and spring, he suggested that movements in relatively cold open water in winter and spring occur at a temp (<10 deg C) at which metabolism is greatly reduced (Meade and Lemm 1986), thereby reducing predation potential on trout. As previously discussed, these findings regarding spatial and temporal habitat use are supported by others (Scott and Crossman 1973; Miller and Menzel 1986; Bruce Bolding, WDFW, personal communication) and there are many instances where agencies have been able to maintain or improve hatchery trout programs while simultaneously introducing tiger muskie (Bruce Bolding, WDFW; Drew Cushing, UDWR; Mike Ruggles, MFWP; Doug Krieger and Greg Policky, MDOW; personal communications).

While tiger muskie may negatively impact IRT in Phillips Reservoir directly through predation, they may also benefit IRT by reducing yellow perch abundance and in-turn leading to increased abundance of key IRT Prey items (*Daphnia*). Given the case studies from other western reservoirs where fishery managers have utilized tiger muskie to restore trout fisheries (Doug Krieger and Greg Policky, Aquatic Biologists, Colorado Division of Wildlife (CDOW); Mike Ruggles, Fisheries Biologist, MFWP; Bruce Bolding, WDFW; personal communications), if managed appropriately, tiger muskie introduction could potentially lead to increased abundance and productivity of redband trout in Phillips Reservoir. The worst case scenario would be that tiger muskie would reduce abundance of IRT within Phillips Reservoir. However, considering again that the reservoir is an artificial habitat likely leading to increased abundance of IRT in the upper Powder Basin, a net negative impact on stream dwelling IRT in the upper Powder Basin is not expected. Thus, the net effect of the proposed introduction would be low risk, meeting the goals of the NFCP.

3. Bull Trout (*Salvelinus confluentus*)

Bull trout are the species of greatest concern with respect to the proposed introduction due to their status as Threatened under the federal Endangered Species Act. The U.S Fish and Wildlife Service has listed Phillips Reservoir as Critical Habitat (http://www.fws.gov/pacific/bulltrout/CriticalHabitat.html).

Oregon bull trout populations exhibit three of the distinct life history patterns known for this species – resident, fluvial, and adfluvial (Rieman and McIntyre 1993; Buchanan et al. 1997). Multiple life history types may be expressed in the same population (Rieman and McIntyre 1993). In evaluating the risk of tiger muskie to bull trout in Phillips Reservoir, it is important to consider whether the life history pattern of Upper Powder River Subbasin bull trout is resident in nature, contains a migratory component, or has developed an adfluvial pattern as each life history pattern represents a different frequency and length of interaction.

Bull trout with an adfluvial life history pattern in Phillips Reservoir would maximize exposure to tiger muskie; however, there is substantial evidence that bull trout do not inhabit the reservoir year-round. Reservoir conditions deteriorate in the summer to the point where temperature and dissolved oxygen levels are beyond tolerable limits for bull trout, and would be lethal if they didn't leave the reservoir. Hillman and Essig (1998) reviewed the available literature and suggested the optimal temperature for bull trout growth was 12-14°C, while Selong et al. (2001) suggested that the upper range of maximum growth temperatures (10.9° – 15.4°C) probably represents the upper limit of suitable habitat for bull trout. Although bull trout are found in waters above 20°C, temperatures above 15-16°C can result in reduced growth, feeding, competitive ability, disease resistance and increased mortality and are not suitable for long term survival (Selong et al. 2001). Summer epilimnotic temperatures in Phillips Reservoir exceed 20°C (21.8°C and 20.2°C in July and August, 2007, respectively; Eco West Consulting 2009). The upper incipient lethal temperature (UILT) for bull trout, the temperature that 50% of the fish can tolerate for ~1 day (Brett 1952, Armour 1990) is 20.9°C (Selong et al. 2001). While hypolimnetic temperatures were adequately cool enough for bull trout during this period (11.5-10.4°C; Eco West Consulting 2009), hypolimnetic dissolved oxygen levels are often close to zero during the summer and early fall (Eco West Consulting 2009; ODFW LaGrande Fish District 1968, 1969, and 1972 Annual Reports, unpublished) thus precluding use of these areas by bull trout. Conditions in the metalimnion at Phillips Reservoir are also too extreme to provide the refuge often found in other lakes; maximum temperatures are marginal – 15.8 and 14.2°C in July and August, 2007, respectively – but dissolved oxygen levels in August and September, ranging from a low of 0.1 mg/L to a high of 1.1 mg/L (Eco West Consulting 2009), are much lower than the 8.0 mg/L required by bull trout (Valiela et al. 1987). As a result, it is highly unlikely that bull trout are able to persist in the reservoir during the summer. Rainbow trout, on the other hand, with their higher thermal tolerances (UILT is 24.2°C, Bear et al. 2007; 25°C, Raleigh et al. 1984, Bjornn and Reiser 1991; or 26.2°C, Sonski 1984) and greater growth capacity at warmer temperature (Bear et al. 2007) are able to find conditions in the thermocline (depths ≤ 18°C with dissolved oxygen levels > 3 mg/L; May 1973) that, although suboptimal, are not lethal.

There is additional empirical evidence that Upper Powder Subbasin bull trout have not established an adfluvial life history pattern in Phillips Reservoir - the lack of capture of bull trout during ongoing ODFW fish sampling activities and fisheries monitoring of fisheries in Phillips Reservoir. Fall gillnet samples were done annually from 1968 to 1987, sporadically through the 1990's, and spring gillnet sets have been done consistently since 2005. Gillnet sets made in this manner and during this time period have been shown elsewhere to effectively capture bull trout where they occur (Donald and Alger 1993; Tim Porter, Fisheries Biologist, ODFW; Rick Castell NMGF, personal communications). Significant creel survey effort was also applied from 1968-1987 and then 2007-2010 with no observed or reported captures of bull trout in the reservoir. Additionally, shoreline areas have been sampled using boat electrofishing in the spring sporadically (10 times) since 1985 with no bull trout captured even though water temperatures were still cold enough for bull trout to be encountered. Additionally, perch removal through April Merwin netting conducted in 2004, 2005 and 2009-11 removed in excess of 1,000,000 perch and resulted in the only documentation of bull trout in the reservoir – two fish were captured during April Merwin trapping in 2011. Bull trout use of the reservoir is at such low numbers or low frequency that, in conjunction with evidence of lethal summer limnological conditions, it is almost impossible to conclude that they utilize the reservoir in an adfluvial pattern.

Although consideration of an adfluvial life history pattern by bull trout in Phillips Reservoir can be discounted, determination of whether or not a component of bull trout in the Upper Powder Basin possess a fluvial life history pattern in addition to a resident population could affect their exposure to tiger muskie predation by the frequency with which they enter the reservoir. Resident and migratory forms of bull trout are known to live together (Carnefix et al. 2001) and resident forms of other salmonids have been known to retain migratory phenotypes (Rieman and McIntyre 1993). The reported capture of a 12-inch bull trout in Brownlee Reservoir in 1959 suggests that a segment of bull trout in the North Powder Subbasin had a fluvial life history pattern (Buchanan et al. 1997), however there is no information suggesting that Upper Powder Subbasin fish also possess this trait. Indeed if they historically did have a fluvial life history pattern, construction of Thief Valley and Mason Dams in 1932 and 1968, respectively, isolated these populations from the rest of the basin and the Snake River (Buchanan et al. 1997). Additionally, historic and current mining activities in the Upper Powder River have adversely affected bull trout habitat above Phillips Reservoir (Buchanan et al. 1997) and has likely reduced the incentive for fish to inhabit these sections for prolonged periods. The combination of both these factors, population isolation and habitat degradation/fragmentation, has likely co-opted the advantages of any fluvial life history pattern and reinforced the resident life history form.

If any part of the populations in the Upper Powder Subbasin populations maintained a fluvial life history pattern, they might be expected to undergo annual migrations to the reservoir from tributary streams. Resident forms, however, might only enter the reservoir during years when hydrologic factors "flush" them into the reservoir. Juvenile bull trout have been shown to be particularly vulnerable to flooding and scouring in streams with unstable channels (Rieman and McIntyre 1993), such as those in Powder River mainstem above Phillips Reservoir. Downs et al. (2006) found that springtime emigration of juvenile bull trout in Trestle Creek, Idaho was associated with snowmelt runoff. In 2011, just prior to the Merwin trapping effort in which the only two bull trout were recovered in the reservoir, the Powder River rose to 427 cfs from a base flow of 65cfs (data source – US Bureau of Reclamation Hydromet System). During prior Merwin trapping efforts (2004, 2005, 2009, 2010), there was no freshet prior to the trapping and no bull trout recovered during the netting. Additionally, field studies have demonstrated that bull trout are unlikely to occur in streams with temperatures in excess of 14°C (Rieman and Chandler 1999); examination of temperature and flow records for the Powder River (data source – US Bureau of Reclamation Hydromet System) demonstrate that in only 3 of the last 11 years (with 2011 being one of those years) has such a rise in flow occurred when temperatures were cold enough to have had bull trout inhabiting the river above the reservoir. Therefore, if the bull trout captured in the Merwin traps in 2011 were resident fish flushed into the reservoir from the river above, the likelihood in any given year of those conditions occurring would be ~3:11. This is significantly less than if the any part of the populations in the Upper Powder Subbasin maintained a fluvial life history pattern. If this was the case, then it would be expected that juvenile bull trout could enter the reservoir on an annual basis.

As discussed above, the period of habitat overlap between tiger muskie and bull trout in Phillips Reservoir would likely be limited to the period from when bull trout either move volitionally or are flushed into the reservoir in the spring - April or May – to the point where reservoir conditions are no longer habitable (July). Ultimately, however, the risk of predation by tiger muskie while in reservoir is affected by a variety of factors including: 1) the feeding rate of tiger muskie and 2) the degree of habitat overlap, 3) the relative availability of bull trout as forage. During the spring, water temperatures in Phillips Reservoir are such that there could be considerable spatial overlap of muskie and bull trout habitat but that tiger muskie metabolism this time of year would be greatly reduced by water temperatures (<10°C; Meade and Lemm 1986). Laboratory investigation of tiger muskie food consumption at various temperatures bear this out; Bevelhimer et al. (1985) determined that tiger muskie food consumption at 5°C (0.017 grams of food/gram of predator/day) was 21% of the rate measured at 15°C and that the maximum consumption rate (0.134 grams of food/gram of predator/day) occurred at 22.5°C. Reservoir temperatures typically don't exceed 5°C until the end of April/first part of May, so the risk of predation occurring during April would be almost non-existent.

Once water temperatures rise and tiger muskie begin actively feeding, the predation risk for bull trout is limited due to the spatial and temporal overlap of habitat by the two species. During the majority of the growing season, tiger muskie prefer shallow water, generally less than 3.05m deep (Hanson and Margenau 1992), preferably in association with macrophytes (Scott and Crossman 1979; Miller and Menzel 1986; Strand 1986; Cook and Solomon 1987; Tipping 2001; Murray and Farrell 2007). This typically reduces their opportunity to prey on salmonids that are generally more pelagic especially as lake temperatures rise. However, although muskellunge have a reputation as a sedentary ambush predator (Engstrom-Heg et al. 1986) that feeds little after dark (Carlander 1969), they can adjust their feeding strategy seasonally to optimize prey encounters (Miller and Menzel 1986) particularly if prey is scarce (Becker 1983). During the spring and early summer, as water temperatures increase to 16°C, muskie often vacate shallow, vegetated areas and adopt a "searching predator" strategy characterized by extensive movement, utilization of a variety of water depths, and pronounced crepuscular activity (Miller and Menzel

1986; Hanson and Margenau 1992; Tipping 2001; Beck and Brooks 2011). This change in behavior from a passive to active predator would likely increase the chances of a tiger muskie encountering prey, including bull trout.

Tiger muskie have been shown to prefer fusiform, soft-rayed prey over deep-bodied or spiney-rayed ones (Wahl and Stein 1988; Szendrey and Wahl 1996), however, their actual consumption often reflects the abundance of available prey (Szendrey and Wahl 1996). The sheer mathematical predominance of other prey species (yellow perch, bridgelip suckers, largescale suckers and hatchery rainbow trout) in Phillips Reservoir suggest that the likelihood of the limited number of tiger muskie encountering and preying on bull trout during the brief period they are actually in the reservoir is extremely low. Considering the five years of Merwin trapping alone, of the over one million fish captured during this effort, only 2 were bull trout, suggesting the odds that they would be consumed by tiger muskie are miniscule.

The extremely low numeric probability of tiger muskie encountering bull trout would be reduced even further by temperature-mediated habitat selection. Temperature preference and avoidance are important components of habitat selection for poikilothermic organisms (Magnuson et al. 1979). During the spring when bull trout and tiger muskie would be sympatric, microhabitat utilization will reduce the degree of habitat overlap; bull trout would show a clear preference for cooler water while tiger muskie seek much warmer water and can tolerate much lower dissolved oxygen levels (<3mg/L; Beck and Brooks 2011) than bull trout. Muskellunge typically seek water temperatures at 25.6°C although their preferred temperature declines with age and size (McCauley and Huggins 1979). Tiger muskie exhibit maximum growth and food conversion efficiency, which has been found to be directly correlated with preferred water temperature (Magnuson et al. 1979, Wagner and Wahl 2007), at around 23°C (Meade et al. 1983, Bevelhimer et al. 1985) and optimum feeding at 26°C (Schoenebeck et al. 2008). The distribution of bull trout in lakes and reservoirs, on the other hand, appears to be temperature mediated, with fish generally avoiding temperatures greater than 15°C (Kahler et al. 2000, Carnefix 2002), and preferring temperatures less than 10°C (Kahler et al. 2000). When given a choice of temperatures from 8 to 15°C in a large plunge pool, juvenile bull trout showed a clear preference for the coldest water available (8-9°C; Bonneau and Scarnecchia 1996). In a survey of mountain lakes, Donald and Alger (1993) found bull trout in waters where the mid-summer water temperatures ranged from 5.4 to15.8°C. Following stratification of lakes Washington and Sammamish, Washington, avoidance of temperatures in excess of 15°C confines bull trout remaining in the lake to areas below the thermocline from mid-June to Mid-October (Kahler et al. 2000).

Although temperature preferences and avoidance are significant drivers of habitat selection and would act to separate tiger muskie and bull trout in Phillips Reservoir, both species must balance their pursuit of optimal water temperatures with responses to other factors such as light, prey density and availability, structural habitat selection, availability of adequate oxygen and social behavior (Reynolds 1977; Wagner and Wahl 2007). Bull trout tend to be nocturnal in nature (Jakober et al. 2000, Diana et al. 2004), moving from deeper water habitats during the day to shallower habitats at night (Polacek and James 2003, Goetz et al. 2003; Muhlfeld et al. 2003). The presence of warm-water prey species, such as yellow perch (*Perca flavescens*), in the diet of bull trout indicates that they make occasional forays into warmer (17-20°C) nearshore waters to exploit these prey during winter and spring (Leathe and Graham 1982; Kahler et al. 2000). In mountain lakes during the late spring and summer, using over-night gill net sets, Donald and

Alger (1993) typically caught bull trout near shore at depths less than 10m and often in water less than 3 m and rarely in water greater than 10m. However, given that trout and char are generally crepuscular feeders (Douglas 1982; Kreivi et al. 1999) and that muskellunge feed primarily during the day (Carlander 1969; Becker 1983), let alone the sheer numbers of other fish species, these feeding forays by trout do not increase their predation risk significantly.

Based on what is currently known about bull trout use of the reservoir it is highly unlikely that tiger muskie will interact with bull trout to the point of negative impact. Bull trout have obviously not established an adfluvial life history pattern utilizing Phillips Reservoir as evidenced by their absence in the reservoir year round. They apparently enter the reservoir in the spring and then either leave when reservoir water conditions deteriorate in June or remain in the reservoir and die as a result of lethal conditions. As a result, the only possible impact on bull trout by the introduction of tiger muskie would be predation occurring from the period when bull trout enter the reservoir until their exit to escape sub-optimal to lethal water conditions, basically April through June. Water temperatures during April essentially reduce predation risk to zero as tiger muskie do not feed actively at temperatures that occur during this period. This leaves the period of maximum predation risk as May and June, which is reduced by temperature and depth preferences and the mathematical odds of encounter.

While considering potential impact to bull trout by predation on them by tiger muskie, potential benefits to the productivity of bull trout using the reservoir, through reduced abundance of yellow perch, must also be taken into account. The primary purpose of the tiger muskie introduction is to reduce the abundance of yellow perch, thereby increasing the abundance of primary prey items of rainbow trout (Daphnia), thus increasing the growth and survival of rainbow trout. This has proven to be an effective strategy in some western reservoirs where tiger muskie have been introduced ((Doug Krieger and Greg Policky, Aquatic Biologists, Colorado Division of Wildlife (CDOW); Mike Ruggles, Fisheries Biologist, MFWP; Bruce Bolding, WDFW; personal communications). Bull trout of the size found in Phillips Reservoir in 2011 (215 and 234 mm) have similar diets to rainbow trout (Beauchamp and Van Tassell 2001; Beauchamp 1990). Thus, younger bull trout could suffer similar issues with growth and survival as rainbow trout. However, there is significant plasticity in the diets of these species seasonally in response to prey availability and other factors. We are only speculating here that there is, based on understanding the biology of these fish, that biological control of perch has the potential to also benefit bull trout, as predation has the potential, although slight, to impact bull trout.

For the reasons outlined above, the introduction of tiger muskie into Phillips Reservoir would be consistent with conservation of bull trout in the upper Powder River drainage.

4. Other Wildlife Species

While esocids are known to eat about anything living that is of the appropriate size (Scott and Crossman 1973), negative impacts to native aquatic/terrestrial wildlife is not expected. Impacts to mammals and birds would be insignificant due to the low level of expected predation by tiger muskie. Tipping (2000) prepared an annotated bibliography of food habit studies for 54,204 esocids. The bibliography included 49,908 northern pike stomachs, 2,860 muskellunge stomachs, and 1,436 tiger muskie stomachs. Roughly one-third to one-half of esocid stomachs are usually empty. Most stomachs with food items included fish and aquatic invertebrates (insects, crayfish, etc.). Other food items from more than 54,000 esocid stomachs were:

1 Redwing blackbird (baby)
1 muskrat (baby)
22 mice/voles
6 mammals (mice/voles?)
44 frogs, several mudpuppies, tadpoles
1 snake
45 waterfowl – mostly coots, one wood duck

- 45% of ducks were less than 1 week old.
- 10 days for complete digestion.
- One study in a waterfowl refuge observed 5,535 duckling minutes (1 duckling for 1 minute) with no attacks; one duckling was tethered in a pool with pike, with no attacks.

Impacts to native amphibians is expected to be low due to three primary factors: 1) irrigation reservoirs with large summer drawdown do not provide good habitat for amphibians, 2) existing introduced fish (largemouth bass, smallmouth bass, black crappie, yellow perch and exotic rainbow trout) and native northern pikeminnow in the reservoir already provide a large potential predator base on amphibians. Addition of tiger muskie at a relatively low density will not likely be additive to the current level of predation impact, and 3) there is abundant habitat for amphibians in the local area including 250 acres of dredge tailing ponds (will not be occupied by tiger muskie), wet meadows and natural streams with good floodplain/wetland habitats.

G. Habitat use of native and introduced fish inhabiting Phillips Reservoir

Yellow Perch (*Perca flavescens*)

Although there are a wide range of temperatures (41° to 57°F) reported for initiation of yellow perch spawning (Coots 1956, Collete et al. 1977, Nelson 1977, Herman et al. 1982, and Krieger et al. 1983), it is generally thought to be related to ice breakup in those lakes that freeze (Weber and Les 1982). Larger, older perch are the first to migrate into shallow bays and shoreline areas, preferring those areas with moderate amounts of vegetation (Nelson 1977; Krieger et al. 1983).

Semi-demersal eggs are emitted in gelatinous ribbons around plants or debris (Collette et al. 1977, Nelson 1977; Krieger et al. 1983) or rocks, sand, or gravel if submerged vegetation is not available (Herman et al. 1982; Krieger et al. 1983) in water generally less than 10 feet deep (Coots 1956; Herman et al. 1982), although spawning has been reported as deep as 25 feet (Thorpe 1977). This relatively unspecialized requirement for spawning strata and depth allows perch to utilize a wide variety of habitats and must partially account for their success in Phillips Reservoir.

Perch fry often move to open water for the first two months of their life and remain pelagic in nature until they reach approximately 0.8 inches in length (Krieger et al. 1983; Fisher et al. 1999). At approximately 0.8 inches, they often move back into the littoral area, adopt a demersal character, and form mixed schools with other fry of spring-spawning species (Scott and Crossman 1973; Fisher et al. 1999). When water temperatures begin to drop in the fall, they often move to deeper, offshore waters.

The following information was gathered from Scott and Crossman (1973). Perch are most abundant in the open water of lakes. They are usually considered shallow water fishes and are not usually taken below 30 feet but have been taken as deep as 150 feet. Adults and young are gregarious, moving around in groups of 50-200 individuals, segregated by size. Discrete schools of adults are close together in summer and more separated in winter.

There are migratory movements of yellow perch in the spring, movements inshore and out, up and down over the day and seasonal movements out and into deeper water in response to temperature and food supply.

Feeding takes place in the morning and evening with little to none at night when they are inactive and lie on the bottom.

Northern Pikeminnow*(Ptychochelius oregonensis)*

Pikeminnow are demersal and fairly well distributed to depths of 60 feet in northern Idaho lakes, occupying basically the same habitat as trout, except during spawning where they tend to congregate in large numbers (Jeppson and Platts 1957). They spawn along lake shores with gravelly substrate (Scott And Crossman 1973) from May – July (Carl et al. 1967). The young inhabit inshore waters in summer months and move offshore into deeper waters in the fall and the larger fish tend to remain offshore (Scott and Crossman 1973).

Largescale Sucker *(Catostomus macrocheilus)*

The following summary of habitat usage for large scale suckers is from Scott and Crossman (1973). They spawn in deeper sandy areas of streams or sandy gravelly shoals of lakes late April through late June. Juveniles are pelagic until 18mm in length and then move toward the bottom in deeper water as they grow larger. Adults are usually found at depths of a few feet up to 80 feet. They are often found in large numbers in weedy shore areas of lakes and in stream mouths. Fry move into inshore areas to feed in daylight hours and off into deeper water at night (McPhail and Lindsey 1970).

Bridgelip Sucker*(Catostomus columbianus)*

The bridgelip sucker is known as more of a stream dwelling fish and habitat usage by them in lake/reservoir habitat is not well described in the literature, although there is one study focused on their life history in the Columbia River (Dauble 1980). They are frequently captured while doing nighttime shoreline electrofishing for warmwater gamefish in northeast Oregon reservoirs.

The study by Dauble (1980) documents the following regarding their habitat use in the Columbia River. Newly emergent sucker were seen inshore and by late July through August, 0+ suckers were found in shallow pools. Sub adult and adult suckers were common in tailouts of pools during the day and shoreline at night. They spawn mid April through mid June. Periphyton was the dominant food for all age classes.

Bull Trout ***(Salvelinus confluentus)***

Bull trout are known to exhibit an adfluvial life history pattern of rearing for 2-3 years in their natal stream and then migrating downstream to reservoir habitat (Ratliff et al. 1996; Buchanan et al. 1997; Stelfox 1997). In the Metolious River these fish then returned to their natal stream to spawn and then returned to the reservoir to continue an annual cycle of foraging, migration and spawning. While there are known populations of bull trout in the headwaters of the Powder River upstream of Phillips Reservoir, they are believed to be primarily of a resident life history type. Like other species of trout they are generally pelagic in nature.

Redband Trout ***(Oncorhynchus mykiss)***

The presence of naturally produced rainbow/redband trout has been documented recently by the presence of <150 mm trout collected in Merwin trap nets used for perch removal in the spring of 2009 and 2010. These fish could be positively identified as naturally produced as they were considerably smaller than the legal sized trout (unmarked) stocked the previous summer and had intact adipose fins that differentiated them from sub-legal trout stocked the previous fall. The life history of these fish is unknown although it is suspected that they spawn in tributary streams and at least some move downstream into the reservoir for rearing.

According to McAfee (1966) rainbow trout are usually near the surface when water temps are below 70 Deg F, but move downward when temps exceed this. They are generally limnetic in reservoirs when most food is on the open water or on the surface and frequently forage near rocks and weeds close to the bottom in natural lakes.

Redside Shiner ***(Richardsonius balteatus)***

The following information on the redside shiner was gathered from Scott and Crossman (1973). Spawning is by large groups in lakes or streams, May to July. In summer during daylight hours they are found only inshore over shoals that have heavy growths of food producing, rooted vegetation. They are rarely seen more than 25 feet beyond these shoals, except at night when they move out into the top layer of deeper water, often to the center of the lake. There is generally vertical and horizontal stratification by size, the smallest are highest and closest to shore. Other than spawning migration, there appears to be little directed movement except a seasonal movement on and off shoals in response to water temps. They can exhibit schooling behavior in lakes (thousands).

Chiselmouth (Acrocheilus alutaceus)

Little information was found on this species. They are known to spawn in streams, and their feeding method is specialized, scraping the lower jaw along bottom substrate (Scott and Crossman 1973). While they are present in Phillips Reservoir, per collections in gillnet samples, they appear to be present in low densities because very few have been collected.

H. Summary of Risks

In summary, tiger muskie are effective top-line predators that if over-stocked can over-run the prey base and potentially negatively impact both the gamefish intended for improvement, sensitive fish species and native non-game fish. Because tiger muskie are sterile hybrids ODFW could control the abundance of tiger muskie, by adjusting stocking numbers, to achieve the desired outcome of achieving improved fisheries while minimizing impacts to native species, particularly those of sensitive status.

However, effective management of the fish community could only be achieved through implementation of a monitoring program with an established long-term funding commitment. Failure to provide adequate resources to monitor and manage the Phillips Reservoir fish community, post tiger muskie introduction, could lead to unintended consequences if stocking were continued under this scenario. The advantage of utilizing a sterile hybrid is that simply ceasing stocking of tiger muskie, in the event that adequate resources are not available to continue monitoring and management, would allow the fish community to return to pre-introduction conditions over the course of several years. The predation of tiger muskie on fish in the reservoir could essentially be "turned off" by discontinuation of stocking, and thus the risk associated with loss of funding and/or personnel support can be effectively managed simply by eliminating the stocking programs when resources for management are not adequate.

Given the risks described in the sections above are low categorically, and that the proposed action is, in effect, is reversible, we find that the overall risk to native fish is low and consistent with the goals of the NFCP.

IV. OTHER EFFECTS

A. Possible conflicts with other programs in watershed (Management, Research, Cultural-Planning-Zoning, etc).

Impacts of tiger muskie outside of Phillips Reservoir are not anticipated because it is highly unlikely that tiger muskie will leave the reservoir. While UDWR has reported volitional upstream movement of tiger muskie from Johnson Reservoir to Fish Lake via the very low velocity Johnson River, they have never seen movement, upstream or downstream, out of Pineview or Joes Valley reservoirs via the high-gradient, cold tributaries and outlets (Drew Cushing, UDWR, personal communication). Likewise, the limited upstream migration (< 0.5 mile) of juvenile tiger muskie out of Quemado Reservoir occurs during a short period in the spring when there is sufficient water (~ 2cfs) in the low gradient inlet (Richard Hansen, NMGF, personal communication). Tiger muskie preferred habitat is not high gradient coldwater streams, which characterize the Powder River and tributaries above Phillips Reservoir.

Although there have been reports of tiger muskie emigrating downstream of their stocking locations (Kerr and Lasenby 2001), most have been in free-flowing systems. Where tiger muskie have passed below dams, they did so over the spillway when the reservoir was spilling and not through the outlet near the bottom of the reservoir (Bruce Bolding, WDFW; Rick Castell NMGF). Phillips Reservoir has been in operation since 1968 and has never spilled; the design of the reservoir is such that there is 21,930 acre-feet of flood storage on top of the management level storage (73,570 acre feet). The most the reservoir has stored at any one time was 86,235 acre-feet in June 1983 (data source – US Bureau of Reclamation Hydromet System). The intake structure at Mason Dam is 98 ft below the normal high water elevation of Phillips Reservoir (GeoSense 2011) making it extremely unlikely that tiger muskie would be entrained.

It is not anticipated that tiger muskie introduction would conflict with other programs, jurisdictions, etc. It is intended that the introduction will improve the fishery, leading to improvements in the local economy.

B. Effects on existing fisheries

The primary purpose behind this introduction is to improve the trout and yellow perch fisheries in the reservoir. However, this will need to be carefully monitored and managed to achieve the appropriate density of tiger muskie to adequately control perch, yet not overly abundant to the point that they excessively forage on stocked trout and other managed gamefish (large and smallmouth bass). Experience from other states indicates that tiger muskie are compatible with a rainbow trout fishery as long as the fishery is monitored and tiger muskie density is appropriately managed (Bruce Bolding, WDFW; Drew Cushing, UDWR; Mike Ruggles, MFWP; Doug Krieger and Greg Policky, MDOW; personal communications).

C. Potential utilization or contribution of introduced species to fisheries.

In addition to their potential to control forage fish abundance, tiger muskie can provide for a trophy catch and release fishery (Storck and Newman 1992). In western states tiger muskie have been introduced into numerous lakes and reservoirs to provide both forage species control and trophy fisheries (Tipping 2001; Osborne et al. 2004; Peterson and Osborne 2006; Drew Cushing, UDWR; Bruce Bolding, WDFW; Greg Policky, Doug Kreiger, and Paul Winkle, CDOW; Mike Hensler and Mike Ruggles, MFWP; Jim Fredricks, IDFG, personal communications). The state of Washington currently releases tiger muskie into seven lakes totaling 11,700 surface acres. These fisheries represent 56,000 angler-days annually with an associated economic value of $7,560,000 to the local economy ($135/angler day) (WDFW 2009). Scaling this to the size of Phillips Reservoir, a successful tiger muskie fishery could result in 8,622 angler days with an economic value of $1,162,800.

D. Social considerations

Humans could respond to the proposed introduction in a number of ways that could pose risks to native fish. Following is a list of such responses and assessment of the risks involved: illegal transportation and unauthorized introduction of tiger muskie to new waters (public or private), additional illegal introductions into Phillips Reservoir, and public demand for tiger muskie introduction into additional waters.

Illegal transportation/introduction of tiger muskie from Phillips Reservoir

The history of the public's will to introduce non-native fish is well established and is an important concern regarding fish conservation and management. Local examples of this phenomena are numerous: walleye, yellow perch, white crappie and black crappie in Phillips Reservoir; black crappie and brown bullhead in Pilcher Creek Reservoir, black crappie in Wolf Creek Reservoir, smallmouth bass and black crappie in Balm Creek Reservoir; goldfish, catfish and warmwater species in numerous area ponds.

There is potential that the public could capture, transport and introduce tiger muskie into surrounding waters. At the present time, the only significant obstacle to this occurring is the nature of the fish it's self. Tiger muskie, particularly large ones, are difficult to catch and handle, thus making successful capture, transportation and introduction of them more difficult than the warmwater fish that are the usual target of illegal introductions. Enforcement of administrative rules, as evidenced by the problem its self, has not been effective in preventing illegal introductions.

If illegal transportation and introduction of tiger muskie were to occur, what would be the risks to native fish and wildlife populations? First, these fish are reproductively sterile so they do not have the ability to establish naturally reproducing populations in the absence of the parent species. The impact would be restricted to competition and predation realized from the released individuals. Considering the low density that tiger muskie will be in the reservoir, the low catch rates that anglers experience and the increased likelihood for detection of an on-going illegal effort, introduction of numbers great enough to be of conservation concern is highly unlikely. Finally, habitat of the hybrid and parent species being lakes, reservoirs and slow moving rivers, restricts the potential introduction sites. Tiger muskie are not inhabitants of fast moving coldwater streams where many of the native fish species of concern exist.

The Northeast Region believes that the illegal transport and introduction of tiger muskie into additional waters poses a very low risk to native fish and wildlife populations. Should this occur, which would likely be only a few individuals, a targeted recovery effort could be implemented, or wait for natural mortality to occur. Casselman and Crossman (1986) report the average age of indigenous hybrids was 7.2 years and the oldest was 18 years.

Additional illegal introductions into Phillips Reservoir

It is possible that sanctioned introduction of a exotic fish into the reservoir could lead some to believe that the illegal introductions that have occurred here and elsewhere are supportable because a fishery management agency has introduced non-native fish. Alternatively, those inclined to transport and introduce fish could potentially see an opportunity to introduce a forage fish to augment the growth of tiger muskie. There are probably many other ways the public could interpret a sanctioned management action, to support a self-serving illegal or undesirable activity.

The best way to counteract future illegal fish introductions at Phillips Reservoir, and/or anywhere else in the state is to implement an aggressive public outreach and education program. A plan for educating the public regarding ongoing and planned fishery management actions should be developed and implemented both at the reservoir, and throughout the region.

Public demand for tiger muskie introduction into additional waters

If the introduction of tiger muskie is approved and becomes successful, there could be a response by some members of the public to see tiger muskie or other prohibited species introduced into additional Oregon waters. And this response will increase should the introduction accomplish the dual objectives of perch control and a trophy fishery. The best response to this situation is to have a well formulated justification for this introduction (this proposal) and a completed fishery management plan for the reservoir that justifies the need in this case. Rulemaking required to implement the proposed introduction should be worded specifically for introduction to Phillips Reservoir, requiring additional rule making to allow tiger muskie introduction into other waters.

E. Economics

1. Cost of introduction

Assessment of costs is made for Phase I, the strictly experimental phase of on-going and proposed management actions, including tiger muskie introduction.

The UDWR has indicated that they can provide ODFW with disease-free tiger muskie fingerlings for the foreseeable future at no cost. Thus, the only cost of the introduction and ongoing stocking program would be limited to the cost of annually transporting the fish from the UDWR hatchery to Phillips Reservoir. Estimated annual cost of transportation is $1,000 which will be incurred by existing programs. It is likely that this source of tiger muskie will meet our needs at least through the Phase I.

Monitoring activities will involve implementation of fish sampling spring and fall, creel surveys implemented at least biannually, fish marking, data summary and analysis, and report writing. Annual costs of monitoring activities including annual creel survey, current staff apportioned to the work elements and additional staff needed, services and supplies and equipment is $80,000 or $400,000 over five years. It is important to note that this monitoring effort would not be specific to the tiger muskie introduction. Many aspects of the monitoring program are on-going and will continue without tiger muskie introduction.

2. Benefits

During the 1970's and 80's, the Phillips Reservoir fishery provided a significant value to the local economy. The estimated economic value of the fishery in 1981 was approximately $770,000. In 2007 dollars this would equate to a value of approximately $1.5 million. More recently, the fishery in 2010 had an estimated value of $138,300, in 2007 dollars.

It is unknown to what degree the fishery at Phillips Reservoir can be restored relative to past angler participation. The data presented above indicates that the fishery has the potential to increase dramatically, far outweighing the projected costs of the proposed management actions, tiger muskie introduction included.

3. Method of financing introduction and evaluation

A significant portion of the proposed monitoring work could be accomplished by existing staff (La Grande Fish District staff and Eastern Oregon Warmwater Biologist). However, the workload created by foreseeable management and monitoring activities will over tax these programs. Thus, additional staffing will be needed in order to effectively implement and monitor the suite of on-going and proposed management actions at Phillips Reservoir, including tiger muskie introduction. A full time EBA will be needed to avoid shifting of work priorities of current staff.

During early implementation and evaluation of management actions, it is reasonable to expect financial support for equipment and personnel from the ODFW Restoration and Enhancement Program. However, the R & E Program is unlikely to fund on-going personnel needs.

Baker County sees restoration of the Phillips Reservoir fishery as an important part of the County economy. As such, there are financially supporting, the current perch removal project. It is anticipated that this support will continue, and that the County will seek means of supporting future efforts.

Baseline monitoring of on-going and proposed (tiger muskie introduction) can be accomplished by existing programs and staff, augmented by readily available funding sources (R & E Program and Baker County) to implement specific elements (creel survey). However, it would be valuable to seek funding from other sources to ease workload issues of existing staff and enhance quality of the evaluation.

V. FEASIBILITY AND COST OF CAPTURING OR ERADICATING ESCAPED ANIMALS

The possibility of tiger muskie of volitionally leaving the reservoir is low as described in section IV, A., however, detecting escaped tiger muskie would be unlikely as there are no particular facilities in-place to detect emigration of fish from the reservoir, and none are proposed. Thus, the only method in place for detecting escapement of tiger muskie from the reservoir would be by random sightings.

The success of capturing and eradicating escaped individuals would be highly variable, given the conditions at the time and the size of the fish. General fish collection methods could be used to capture tiger muskie such as electrofishing, seining or gillnetting.

The cost of periodically capturing a few escaped individuals would be minimal, in cases where conditions provide a feasible opportunity to do so. However, capturing hundreds or thousands of individuals, the product of a chronic problem, could be quite costly and beyond the capability of the Grande Ronde Watershed District Fish Management Program.

Because tiger muskie are a sterile hybrid, and not able to reproduce with native or introduced fish currently known to exist in the Powder Basin, attempted capture of reported tiger muskie would only be pursued when circumstances indicated a high likelihood for successful capture. A chronic problem of tiger muskie emigration from the reservoir would best be addressed by terminating releases of juvenile fish.

VI. MONITORING AND EVALUATION

The following section provides a general description of a monitoring approach to assess the effectiveness of the proposed tiger muskie introduction in attaining fisheries objectives and assessing impacts to native fish. A more detailed, comprehensive monitoring and evaluation plan will be included in the Phillips Reservoir Fishery Management Plan currently under development.

The NE Region foresees the implementation of restoration actions at Phillips Reservoir occurring in three general phases as listed below:

- Phase I: Short-term, experimental implementation supported by monitoring and evaluation (0-5 years
- Phase II: Mid-term implementation of promising management actions supported by monitoring and evaluation (5-10 years)
- Phase III: Long-term implementation of effective (supported by monitoring and evaluation results) management actions supported by a reduced level of monitoring.

1. Description of Fishery Evaluation

Monitoring will focus on the performance (growth and survival) of stocked sub-legal rainbow trout, abundance of yellow perch and contribution of these fish to the recreational fishery (catch, catch rate and size). While the trout fishery is now largely supported by stocking of legal-sized rainbows throughout the summer (put and take program), an experimental put-grow-and take program is underway (stocking of rainbow sub-legals in the fall). Under current reservoir conditions the sub-legal stocking program is not providing anglers with the desired product. The NE Region envisions that successful restoration would involve creating a reservoir environment that would support a put-grow-and take trout program to provide the kind of product anglers desire (ODFW 2009) and to reduce overall program cost.

To gain estimates of trout growth and survival and yellow perch abundance and size, annual sampling of these populations will be required. Mark-recapture techniques would be used to estimate abundance and survival. A critical uncertainty currently exists regarding the type of sampling gear that would best provide adequate samples of fish, in an efficient manner. The current standard fish sampling technique at the reservoir, gillnets, has proven to be an ineffective method for adequately sampling species other than perch. Because of their high relative abundance, perch make up approximately 95% of these samples. More fish need to be handled to get adequate samples of species other than yellow perch. Merwin trap nets are currently being used to remove perch from the reservoir in the spring. While not intended as a monitoring activity, this effort has shown that this gear has the potential to provide better samples than gillnets, should the perch removal not continue. If initiated, early monitoring activities would test a variety of sampling gears including gillnets (floating and sinking), Merwin trap nets and other trap net designs (South Dakota) to determine the efficacy of each gear type. It is possible, as perch abundance is decreased in the reservoir, gillnets will become a more viable sampling gear.

An on-going dataset of catch-per-unit-effort derived from boat electrofishing to monitor warmwater fish species should be continued. Continuation of this dataset would provide a measure of abundance through the phases of pre-perch introduction, perch population expansion, and management actions taken to reduce perch abundance. These inventories have been typically done in the spring. This dataset can also be used to monitor trends in abundance of native species, particularly northern pikeminnow, largescale sucker and bridgelip sucker.

Creel surveys will need to be implemented in order to directly monitor the fishery (effort, catch, catch rate, size of catch for all gamefish species). This will need to be an on-going activity through phases I and II. Creel surveys should be implemented at least bi-annually. The angling season at Phillips Reservoir is open all year, which is problematic for conducting a creel survey that accurately reflects total effort and catch at a reasonable monetary cost. Observationally, most of the fishing effort occurs during the spring and summer at the present time, with significant effort occurring during the winter (ice fishing).

2. Description of Native Species Impact Assessment

The abundance of native species will be measured indirectly by collecting statistics of catch per unit effort and/or biomass from the proposed annual fish sampling activities. Monitoring of the abundance of native species in this way will conserve limited financial resources, while providing an indicator of the effect tiger muskie may be having on these populations and the need to adjust stocking numbers. Northern pikeminnow, largescale sucker, bridgelip sucker and naturally produced redband trout are currently captured in good numbers. Therefore, this method should provide a reasonable measure of their abundance.

Chiselmouth and redside shiner are infrequently caught in samples and it is anticipated that they will not be in great enough numbers in future samples to detect changes in their abundance. The abundance of the aforementioned native species will need to be used as an indicator for their abundance.

Because only two bull trout have been captured in over 40 years of on-going fish sampling at Phillips Reservoir, it is not anticipated that the proposed fish sampling actions will provide a measure of impacts. Thus, monitoring of bull trout abundance will have to be accomplished by implementing redd surveys on tributary streams.

Diet of tiger muskie will be studied as a direct measure of impact to native species in Phillips reservoir. Stomach samples will be collected from tiger muskie captured as part of the ongoing fish sampling activities. It is not anticipated that tiger muskie will be captured in great enough numbers to provide a quantitative description of their diet, but will provide us with a general understanding of the species consumed during spring and fall. WDFW has developed a technique to successfully collect stomach contents from tiger muskie collected in gillnets with minimal impact on the tiger muskie (Bruce Bolding, WDFW, personal communication).

Should the proposed sampling above indicate a potential impact on sensitive species, bull trout and redband trout, then monitoring activities directed at estimating the abundance of these will be explored. Activities to estimate abundance of these species would be costly thus are not proposed at this time, due to the expected low risk.

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