Swan River Valley Bull Trout Recovery Project

Draft Environmental Assessment

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U.S. Department of the Interior

Fish and Wildlife Service

Montana Ecological Services Office

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Contents

Chapter 1 – Purpose and Need for Project

Introduction

The United States Fish and Wildlife Service (the Service) has prepared an Environmental Assessment (EA) under the National Environmental Policy Act of 1969 (NEPA) as amended, the Council on Environmental Quality NEPA regulations (40 CFR 1500-1508), and the Department of the Interior NEPA regulations (43 CFR Part 46). The Service intends to decide on recovery actions to increase Bull Trout (*Salvelinus confluentus*) for the Swan Lake, Lindbergh Lake, and Holland Lake core areas. These Bull Trout populations are threatened by nonnative Lake Trout. Lake Trout proliferation has been determined to be the most significant threat to Bull Trout recovery in the three core areas of the Swan River watershed. The purpose of this project is to directly alleviate the threat by reducing Lake Trout numbers to a tolerable abundance level, such that Lake Trout do not outcompete Bull Trout. The Proposed Action is to implement Lake Trout suppression by means of an adaptive management strategy that incorporates the best available scientific information as it unfolds. This Environmental Assessment describes the Proposed Action and adaptive management strategy and analyzes potential effects on fish, wildlife, recreation, and water quality.

Background

The Swan River Valley has historically supported three Bull Trout core areas: Swan Lake, Lindbergh Lake, and Holland Lake. The three core areas include 11 local populations. The largest of the three core areas is the Swan Lake core area. Bull Trout in Swan Lake exhibit an adfluvial life history form, meaning adults migrate from the lake to the tributaries to spawn, then back to the lake to feed and grow. The adfluvial population within the Swan Lake core area consists of fish that hatch in one of twelve tributary streams in the Swan River Valley and reside there for 1-3 years. The fish then migrate to Swan Lake to mature and return to their natal streams to spawn when they are 5-6 years old. The Swan Lake core area was until recently regarded as healthy and stable. A series of population status reviews compiled in the late 1990s noted that Swan Lake was one of the most vital core areas remaining in Montana (Montana Bull Trout Scientific Group 1996). Furthermore, although recreational fishing for Bull Trout has been restricted for decades elsewhere, the Swan Lake population was still considered robust enough to support limited recreational harvest until 2012 (it is currently a catch-and-release Bull Trout fishery). Lindbergh Lake is the second largest core area. This adfluvial population behaves similarly but has just a single inlet stream for spawning habitat. The third and smallest core area uses Holland Lake for rearing habitat and likewise has a single inlet stream for spawning habitat. Recreational fishing for Bull Trout is prohibited in Lindbergh and Holland Lakes. All three lakes, plus the Swan River, and their spawning tributaries, are designated as Bull Trout critical habitat (Figure 1).

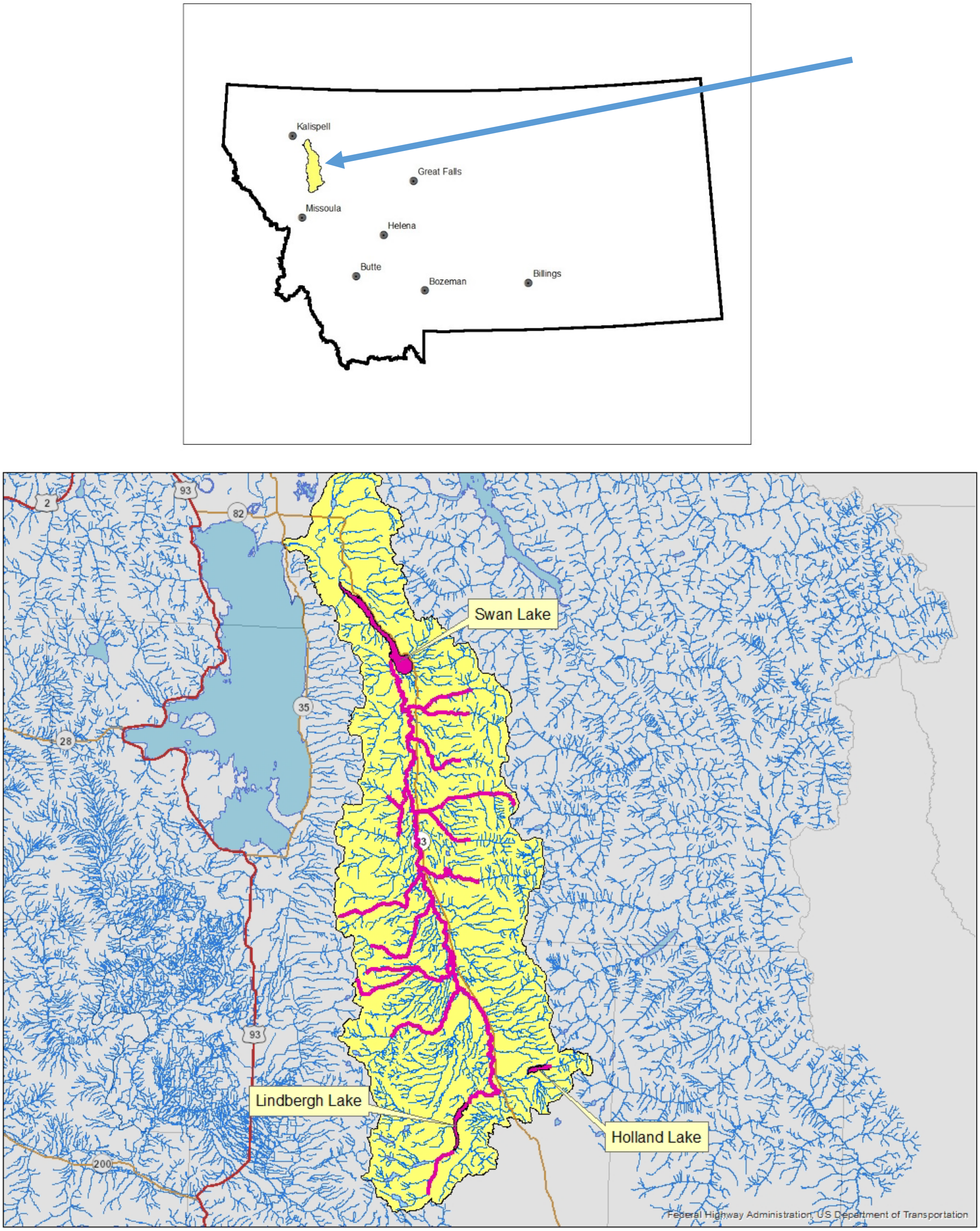


Figure 1. Swan River Valley with core area lakes. Critical habitat is shown in purple lines and polygons. The approximate position in state of Montana is shown above.

In 1998, nonnative Lake Trout were first discovered in the Swan River Valley. Their origin is unknown, but presumably, they came from nearby Flathead Lake. The fish arrived by either unauthorized introduction or migration through a now-closed fish ladder into the Swan River Valley. Lake Trout are a significant threat to many Bull Trout core areas (Martinez et al. 2009). Lake Trout have a strong habitat and niche overlap with Bull Trout, resulting in competition for resources and predation. In 1998, an angler caught the first documented Lake Trout in the Swan Basin. Then, in 2003, biologists with Montana Fish, Wildlife & Parks (MFWP) documented juvenile Lake Trout in Swan Lake, thus confirming that wild reproduction had occurred. Additional data in subsequent years confirmed that the Lake Trout population within Swan Lake was established and growing.

A collaborative group called the "Swan Valley Bull Trout Working Group" (SVBTWG) was formed in 2005 to address the situation and pool resources. Members of the SVBTWG included the Service, MFWP, Flathead National Forest, Montana State Cooperative Fisheries Research Unit, Montana Trout Unlimited, the Confederated Salish and Kootenai Tribes, and the Montana Department of Natural Resources and Conservation. The members of the SVBTWG entered into a Memorandum of Understanding to identify specific objectives and to collaboratively work toward those objectives to meet the overall purpose of conserving Bull Trout within the Swan River Basin. This MOU and coordination between the parties has been valuable to date. The Service intends to maintain and coordinate involvement by the parties and to include them in any decision-making process going forward. However, authority to initiate or terminate any action stemming from this EA will be at the discretion of the Service.

Montana FWP authorized the SVBTWG to conduct a 2009-2011 pilot study that utilized gill nets to remove Lake Trout. From 2009-2011, over 20,000 Lake Trout were removed, and the SVBTWG unanimously decided to extend the efforts. Therefore, in 2012, Montana FWP authorized an extension of the pilot study through 2016. Gillnetting from 2009 to 2016 was done in a consistent, systematic fashion to study the efficacy of the program (Fredenberg and Rosenthal 2017). During the suppression efforts, three specific objectives were used to evaluate the Lake Trout removal program. The three objectives were: 1) to maintain a minimum Lake Trout population mortality rate of 50%; 2) to provide evidence of a reduction in the Lake Trout density; and 3) to avoid further Bull Trout and Kokanee *(Oncorhynchus nerka)* declines while maintaining the density of *Mysis diluviana* (an abundant, nonnative zooplankton).

From 2009-2016, over 59,700 Lake Trout were removed at an average annual project cost of $150,000, including contract labor, agency labor, equipment and supplies, and funding from the SVBTWG pooled resources. Rosenthal and Fredenberg (2017) summarized the results of the 8-year project, including the program's ability to meet the three defined objectives. The authors noted mixed success in meeting the three 2012 evaluation criteria. Total Lake Trout mortality hovered around the 50% objective, but did not consistently achieve it; therefore, the first objective was not met. Similarly, the second objective was not clearly met as evidenced by a failure to show a decline in Lake Trout catch-per-unit-effort and relative weight. Finally, the third objective was partially achieved in that Kokanee redd counts and Mysis densities remained stable throughout the 8-year span. However, Bull Trout redd counts continued to decline.

The Rosenthal and Fredenberg (2017) findings suggest that the 2009-2016 effort failed to achieve a declining trend in the Lake Trout population. Although not elaborated by Rosenthal and Fredenberg (2017), several constraints limited the program's efficacy. Limited resources, funding, and contractual opportunities may have been too restrictive. Concern over excessive Bull Trout bycatch also constrained flexibility and dampened willingness to increase the program's effort. Also, the discovery of additional Lake Trout spawning areas in 2014 (Rosenthal, Fredenberg and Steed 2016) reinforced the notion that spawning areas may change over time and that successful suppression would require routine monitoring to ensure that all spawning areas are exploited. The 2009-2016 project was intentionally designed to have consistent annual effort. To ensure consistent efforts, a contract was awarded to an independent gillnetting company, the Hickey Brothers. Fishery workers did somewhat modify net locations and the amount of time the gill nets remained in the water after each set (soak time), but otherwise, the project design may have been too inflexible to react to new findings.

Because the 2009-2016 project failed to meet all three evaluation criteria and funding the Hickey Brothers contract and the Montana Environmental Policy Act (MEPA) coverage expired, the project was suspended indefinitely. Meanwhile, Lake Trout have been reported in Holland and Lindbergh Lakes, presumably due to emigration from Swan Lake up the Swan River, and Bull Trout redd counts in the Swan drainage have continued to decline. Insufficient information exists about those populations to describe their status.

Proposed Action

This project aims to support the recovery of Bull Trout in three Bull Trout core areas of the Swan River Valley by addressing the most significant threat: the proliferation of nonnative Lake Trout. Success is defined as a stable or increasing trend of Bull Trout redds for each core area, by successfully reducing and managing the primary threat which is the presence of nonnative Lake Trout. Due to the high annual variation in Bull Trout redds, a more accurate description of success is to have a stable or increasing trend in redd counts, and suppress Lake Trout to a level of tolerable abundance, which will be informed by MFWP's SPIN netting.

Purpose and Need of the Project

In 2015, the Service released a recovery plan for Bull Trout (USFWS 2015a). The recovery plan delineated six Recovery Units; this project is located within the Columbia Headwaters Recovery Unit. Each Recovery Unit has a Recovery Unit Implementation Plan (RUIP) that describes the primary threats affecting the Bull Trout core areas and local populations therein and identifies management actions that would lead to the recovery of Bull Trout (USFWS 2015b).

The Columbia Headwaters Recovery Unit has 35 Bull Trout core areas, some of which are considered "simple" (with just one spawning population) and others are "complex" (having multiple spawning areas). Recovery for the Columbia Headwaters Recovery Unit will be considered complete when the primary threats are effectively managed on at least 15 simple core areas and 12 complex core areas. Swan Lake is a complex core area, while Holland Lake and Lindbergh Lake are each simple core areas.

As described in the Columbia Headwaters RUIP, the primary threat to the Swan, Holland, and Lindbergh Lake core areas is the presence and uncontrolled proliferation of Lake Trout (USFWS 2015b). The Columbia Headwater RUIP identifies actions needed to address nonnatives within the Swan drainage by stating, "Develop and implement a long-term management strategy for Swan Lake that seeks to minimize Lake Trout impacts by whatever means possible," and further "Fully implement experimental Lake Trout suppression in Swan Lake while maximizing survival of non-target Kokanee and minimizing Bull Trout bycatch." Therefore, the purpose and need of this project is to suppress Lake Trout to a level that does not threaten maintaining a healthy Bull Trout population that meets recovery goals. Accomplishing this would effectively manage the primary threat to the three core areas and facilitate the successful implementation of the Bull Trout Recovery Plan.

Since the cessation of Lake Trout suppression efforts, the Lake Trout population in Swan Lake has likely grown and may be approaching carrying capacity. Similarly, Lake Trout numbers are presumably increasing in Holland and Lindbergh Lakes. The increase in Lake Trout in the three core areas threatens the long-term persistence of Bull Trout in the Swan River Valley. The proliferation of Lake Trout and the subsequent decline of vulnerable native species is not unique to the Swan drainage, as shown by Martinez et al. (2009). Expansion of the Lake Trout's range and population is considered the primary cause for Bull Trout decline in multiple Montana lakes: Flathead Lake (Confederated Salish and Kootenai Tribes 2014); Lake McDonald, Logging Lake, Bowman Lake, Kintla Lake, Harrison Lake (Fredenberg 2000; Downs and McCubbins 2018); Idaho lakes: Lake Pend Oreille (Hansen et al. 2019); Priest Lake (Ng et al. 2015); Upper Priest Lake (Ryan 2016); and Alberta, Canada lakes: Bow Lake, Hector Lake, Spray Lake (Donald and Alger 1993); and probable cause for bull trout decline in Upper Waterton Lake, Middle Waterton Lake and Glacier Lake (Donald and Alger 1993). Bull Trout extirpation in Lake Chelan was not due to Lake Trout but their presence prevents any meaningful consideration for reintroducing Bull Trout (Martinez et al 2009). There is no reason to believe that Swan River Valley lakes would be different and that these Bull Trout would somehow be immune to the consequences of Lake Trout invasion.

This is not a unique or novel proposal. Lake Trout suppression is currently underway in other Columbia Headwaters Recovery Unit core areas, namely Quartz Lake, Logging Lake, Lake Pend Oreille, Upper Priest Lake, and Flathead Lake, and in other states for the benefit of other native salmonid species (Wyoming). The ongoing work in Lake Pend Oreille (Idaho) is probably the closest comparison to this project as Lake Pend Oreille has a similar species composition, and fisheries managers were faced with a rapidly expanding Lake Trout population. From 2006-2016, gill net suppression of Lake Trout in Lake Pend Oreille resulted in a 60% Lake Trout population decline that is now approaching the desired density (Dux et al. 2019; Hansen et al. 2019). Therefore, the Service is considering the proposed action to fulfill our authority under the ESA to recover Bull Trout.

Chapter 2. Alternatives

Alternatives Considered

The NEPA and associated regulations require Federal agencies to analyze and publicly disclose the social, economic, and environmental effects of major Federal actions. This requires Federal agencies to study, develop, and describe appropriate alternatives to recommended courses of action in any proposal that involves unresolved conflicts concerning alternative uses of available resources (42 USC § 4332). This EA analyzes and compares the effects of the "no action" alternative and the proposed action of various methods of suppressing Lake Trout numbers, which will be informed by a structured decision process in an adaptive management framework to facilitate the recovery of Bull Trout.

A. Alternative 1-No Action Alternative

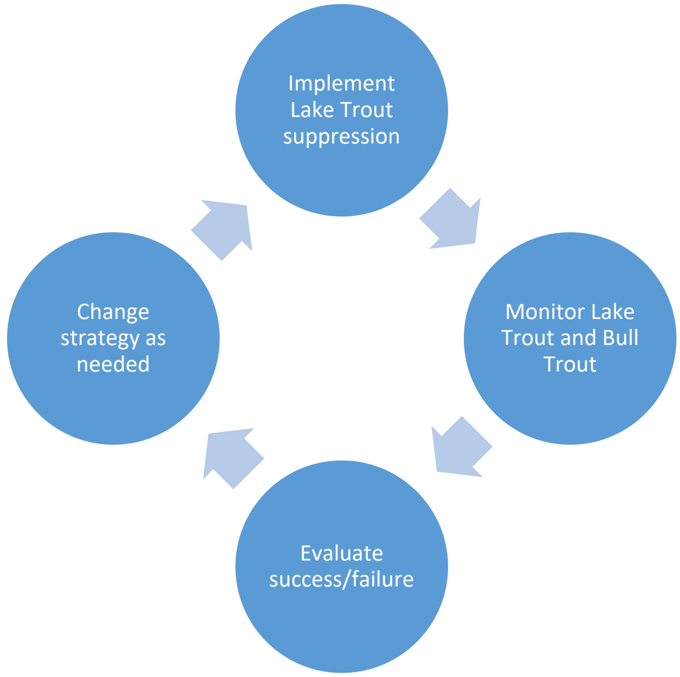
Alternative one is the No Action Alternative. The No Action Alternative assumes that no implementation of any Proposed Action elements would occur within the Swan Lake project area. The No Action Alternative provides a baseline for evaluating the changes and related environmental impacts that would occur under the action alternatives.

Under the No Action Alternative, the Service would not conduct Lake Trout suppression and Bull Trout conservation in the Swan Lake drainage. In Swan Lake, Holland Lake and Lindbergh Lake the Lake Trout populations would expand to the point where they reach equilibrium with the environment. Lake Trout would likely replace Bull Trout as the Swan system's top-level aquatic predator over the next 25 years, as observed in other lake systems within the Flathead drainage. Eventually, Swan, Lindbergh, and Holland lakes Kokanee populations would likely become functionally extinct. Under this alternative, bull trout would not be conserved in Swan, Holland, or Lindbergh lakes.

B. Alternative 2-Proposed Action Alternative

Alternative two is the Proposed Action. The Proposed Action allows for variable techniques to achieve the two primary objectives described below. There are no unresolved conflicts about the Proposed Action with respect to the alternative uses of available resources, because, based upon input from interested parties, there is agreement that the Proposed Action is sufficient. Therefore, the Service does not need to consider additional alternatives (43 CFR 46.310).

The Proposed Action involves the suppression of Lake Trout using various methods including removal of adult and juvenile Lake Trout using gill nets, smothering Lake Trout embryos at the spawning locations, and use of trap nets, or all three. The exact details of the action (duration and timing of nets, etc.) are flexible and will be revised annually under the "Adaptive Management" principle. Adaptive Management is a process where the Service implements the Proposed Action, monitors the results, and then adjusts future implementation as needed. Future adjustments would be analyzed before implementation to ensure impacts of the actions remain at or below those analyzed within this Environmental Assessment. Knowledge gained from the 2009-2016 project is a starting point. Adaptive management allows the Service to utilize the best available science as it becomes available, learn from previous efforts, increase efficiency and ultimately either achieve the goal or abandon the project. The concept is illustrated below.



The timeframe for each cycle is one year. The Service would implement projects and monitor results in that year. Most adjustments would take place the following year. The duration of this project may extend several decades until there is a sustainable change of condition.

The scope of this Proposed Action encompasses a variety of techniques and strategies to reduce Lake Trout abundance. Because of the adaptive management approach to Lake Trout reduction, plans with specific details (i.e. numbers of nets set, soak times, areas to be netted, etc.) do not currently exist. The Service, in collaboration with MFWP, will provide a detailed plan for Lake Trout removal actions to partner agencies before initiating any management alternative. Additionally, the Service and MFWP partners will periodically hold "open house" meetings to update the public on the ongoing action. While these actions were not detailed at the time this EA was created, they will continue to be evaluated such that they: (1) result in a level of Lake Trout harvest greater than what was conducted from 2009-2016, and (2) result in Bull Trout bycatch mortality preferably less than what occurred from 2009-2016; but within limits that are less consequential than no action.

Swan Lake contains the largest Bull Trout population of the three core areas in the Swan River Valley. Therefore, the Service shall prioritize work on Swan Lake first. After a period of time (likely 6-10 years) the Service will consider feasibility of expanding work to the other lakes. Expansion would depend on successful trends as learned from Adaptive Management and financial capability. Lindbergh Lake contains the next largest population of Bull Trout and thus would be the next focus area. Holland Lake has the smallest population and would be the lowest priority.

Key to this Proposed Action are the twin objectives described below. Both are equally important components of the Proposed Action. Both must be obtained to achieve the goal. If monitoring determines that either objective failed, then with the adaptive management principle the Service would modify their technique the following year (Table 1).

Objective 1. Reduce Lake Trout numbers adequately to cause a decline in population density to achieve tolerable abundance. The project would remove Lake Trout adults, juveniles, or embryos at sufficient levels to cause a decline in the Lake Trout population. This will take a sustained effort over many years. Ultimately, the Lake Trout population will be reduced to a level where the threat to Bull Trout is ameliorated. Once at this level, called "tolerable abundance," further reductions may not be necessary. The objective would then change to long-term maintenance to keep Lake Trout at or below tolerable abundance. The number of Lake Trout considered tolerable is not currently known but should become clearer through the adaptive management strategy. It may take 10-15 years before Lake Trout are at a tolerable abundance. Similar work on Lake Pend Oreille (a significantly larger lake) required 10 years to confirm significant reduction of Lake Trout (Dux et al. 2019).

To evaluate progress on Objective 1, the Service will rely on annual monitoring conducted by MFWP. Montana FWP monitors the average density of Lake Trout by deploying gill nets set at random locations, following the summer profundal index netting (SPIN) protocol used by the Ontario Ministry of Natural Resources in native Lake Trout populations (Sandstrom and Lester 2009). This program results in a defendable, quantitative density of Lake Trout that allows an evaluation of population trends. Objective 1 requires a statistically significant declining trend over at least a 6-year period. This lag time is necessary due to Lake Trout ecology. Lake Trout can have naturally variable recruitment, and juvenile Lake Trout are challenging to capture until they are about 3-4 years old. Therefore, a decline may not be visible initially, but an effort must be sustained over several year classes before it can be considered genuine. Once Lake Trout is at tolerable abundance, SPIN monitoring will be used to confirm static trends.

Montana FWP began SPIN monitoring for Lake Trout in Swan Lake in 2017. Similar monitoring efforts will be needed if the project expands to Lindbergh and Holland Lake.

Objective 2. Minimize negative impacts to Bull Trout to a level less than what would occur under the No Action. If left unmanaged, the Lake Trout population would continue to expand, resulting in the continued decline and possible loss of Bull Trout and Kokanee. To achieve Objective 2, the Service will use adaptive management techniques to minimize Bull Trout bycatch, such as adjusting the location of nets or improving recovery techniques for captured Bull Trout on board the boat. Even with best practices, based on previous experience, it is likely that actions will result in some Bull Trout mortality from bycatch. It is also assumed, however, that if Lake Trout suppression does not occur, the Bull Trout population will continue to decline due to predation and competition on Bull Trout by Lake Trout. Therefore, Lake Trout suppression activities could allow some Bull Trout bycatch so long as Bull Trout bycatch does not exceed what would have occurred in the absence of suppression and the bycatch remains below an agreed upon maximum number set by the Service and MFWP and Objective 1 is met; or if an Adaptive Management response addresses the cost:benefit.

To evaluate Objective 2, the Service will tally all Bull Trout mortality from this project and monitor it relative to a predetermined annual limit. The tally will include all observed or estimated Bull Trout mortality from suppression work and SPIN monitoring. The predetermined annual limit is based on a computation of the Bull Trout population size and the best available science regarding Lake Trout impacts. The best available science comes from a study of 29 Bull Trout lakes in Canada (Donald and Alger 1993). Of these, 13 lakes experienced Lake Trout invasion and 16 did not. The authors found that the mean annual Bull Trout mortality increased by 0.12 when Lake Trout invaded. Therefore, using the model in Appendix C, the Service will annually estimate the total abundance of Bull Trout in lakes and multiply it by 0.12 to estimate how many Bull Trout would perish if this project did not take place.

This predetermined estimate of Lake Trout-associated Bull Trout mortality will be used to estimate the maximum Bull Trout bycatch limit the population is expected to withstand. Bull Trout mortality associated with Lake Trout presence, and bycatch from gillnetting is, to some degree, additive (mortality that is additional to what would have occurred under natural conditions, or natural mortality). However, as the Lake Trout population declines, Lake Trout-induced Bull Trout mortality should decrease as well, but as long as Lake Trout occupy Swan Lake, some level of associated mortality to Bull Trout will remain. However, because this project is focused on Bull Trout recovery, the Service and MFWP are committed to reducing Bull Trout bycatch to the greatest extent possible. Therefore, the Service and MFWP will identify conservative Bull Trout bycatch limits within the detailed action plan that are less than the predetermined estimate. This will ensure the project meets Objective 2.

The following table presents four possible scenarios of how these twin objectives shape adaptive management.

Table 1. Adaptive Management Response to monitoring results.

Scenarios	Objective 1 – Reduce Lake Trout	Objective 2 – Minimize Bull Trout bycatch	Adaptive Management Response
Monitoring finds Lake Trout numbers are declining and Bull Trout bycatch is below annual limit set by USFWS, MFWP	Meets objective	Meets objective	**Continue**
Monitoring finds insignificant change in	Does not meet objective	Meets objective	**Increase effort and/or efficiency**

Scenarios	Objective 1 – Reduce Lake Trout	Objective 2 – Minimize Bull Trout bycatch	Adaptive Management Response
Lake Trout but Bull Trout bycatch is below annual limit set by USFWS, MFWP			
Monitoring finds Lake Trout numbers are declining but Bull Trout bycatch excessive	Meets objective	Does not meet objective	**Reduce effort and/or modify technique**
Monitoring finds little change in Lake Trout and Bull Trout bycatch excessive	Does not meet objective	Does not meet objective	**Modify technique or abandon effort**

The Service may use one or multiple Lake Trout suppression techniques simultaneously. As of this writing, the only proven technique is to utilize sinking gill nets that entangle fish and allow biologists to remove them from the lakes. These nets may target juvenile or adult Lake Trout or both. The nets' locations, depth, and timing will vary based on adaptive management feedback. They will likely resemble the 2009-2016 project as a starting point. All Lake Trout captured will be killed except for any need for monitoring or research. As many Lake Trout fillets as possible will be salvaged for the Confederated Salish and Kootenai Tribal Fisheries Program or local food banks (with limitations on feasibility, food bank need, and maximum size for safe human consumption based on mercury guidelines). Non-salvageable fish will be disposed of at offsite waste management facilities and will have no further impacts.

The Service intends to use other techniques as evaluated by the best available science. However, before implementing these other techniques, more rigorous environmental analysis will occur to ensure that they do not exceed the potential environmental impacts analyzed within this EA. One promising but experimental technique is to smother Lake Trout embryos where they are deposited in order to suffocate them. Lake Trout are broadcast spawners and they congregate in October to broadcast eggs over rocky, shallow substrates. A negatively buoyant, smothering agent is being developed in Yellowstone National Park for their Lake Trout suppression efforts (Thomas et al. 2019). If this technique proves effective and feasible, it could be applied in Swan River Valley lakes. Additionally, the use of large trap nets may be employed. Trap netting has been shown to be effective for both monitoring and suppression of nonnative Lake Trout in Lake Pend Oreille (Dux et al. 2019). One advantage of these passive suppression techniques is the elimination of Bull Trout bycatch. These methods are described further in the Proposed Action effects section.

At present, angling is not being proposed as a suppression tool. However, angling may be explored later collaboratively with MFWP for data collection, such as a mark-recapture survey where anglers return tagged fish. Future yet-unknown techniques that will incur similar or less impact to the surrounding environment and the species involved may be utilized to meet objectives as they become available; each of these potential activities will be evaluated by the agencies, should they emerge as a viable means to reduce the Lake Trout abundance. If a future contemplated technique proves effective and does not result in a significant effect, then this technique may be utilized following a favorable inter-agency work group approval.

Lake Trout suppression may cost between $75,000 to $250,000 annually (including in-kind contributions of time and equipment), depending on techniques and scope of work. The Service has acquired a gillnetting boat and already possesses the equipment needed to carry out suppression efforts. All costs associated with the effort will be in the form of gill net repairs, spawner analog pellets, gas for the operation of the boat, field technician salaries, contractor costs and incidental equipment and supplies. The Service does not currently have dedicated funding to implement these strategies and will continue to rely on the pooled resources of the SVBTWG. This working group can assist with labor, supplies, and equipment such as nets. When the detailed action plan is available, the Service and MFWP will use the plan to seek further long-term funding from partnering agencies and stakeholders.

The Service does not propose any new or additional monitoring of Bull Trout in the Swan River Valley. Montana FWP has been the lead agency that monitors juvenile Bull Trout densities in spawning streams and spawner escapement with redd counts. Bull Trout redd counts will be used to evaluate Bull Trout trends. However, annual Bull Trout redd counts are highly variable, and it will likely take at least six years of targeted Lake Trout suppression before benefits to the Bull Trout spawner population may be realized.

Mitigation Measures to Avoid Conflicts

- To minimize any potential impact on common loon (*Gavia immer*), gill nets will not be deployed within a quarter mile of any active nest locations from May 15 to June 30. Entanglement of loons in gill nets has not happened in the past and is not anticipated, but if any should occur, additional mitigation measures will be developed in consultation with wildlife biologists. Further details on loon mitigation measures are found in Appendix B.
- To minimize the chance that increased boating traffic may cause nest failure for bald eagles (*Haliaeetus leucocephalus*) and western osprey (*Pandion haliaetus)* due to abandonment, the work boat will maintain a distance of ¼ of a mile from any reported nesting locations during the nesting season whenever practicable.
- To minimize the impact of work boat traffic or gill net entangling to recreational fishing, Lake Trout suppression will not take place during peak recreational boating times. Peak recreational boating times are defined as Memorial Day weekend, July 4, Labor Day weekend, and every Saturday and Sunday from Memorial Day to Labor Day. Furthermore, a map showing gill net locations, and description of buoys and gear, will be posted each day of operations on a sign board at the public boat ramps where work will be conducted. The sign boards are found at Swan Lake Day Use Site, Lindbergh Lake campground and Holland Lake Day Use Site.

Chapter 3 Affected Environment and Environmental Consequences

Affected Environment

The affected environment includes the human environment within the geographic scope of the area analyzed. An analysis of the human environment includes "the natural and physical environment and the relationship of people with that environment" (40 CFR § 1508.14). The boundaries for this EA include the entirety of the Swan River drainage. The Swan River drainage in its entirety was chosen because Lake Trout have now invaded all accessible lakes from Swan Lake to Holland and Lindbergh lakes, and as such presents an equal threat to those populations of Bull Trout upstream of Swan Lake. The Swan River drainage and the associated resources affected by this action include:

A. Fish
B. Wildlife
C. Recreation
D. Water Quality

A. Fish

The fisheries resource of the Swan River Valley to be analyzed include Bull Trout, Lake Trout, Kokanee, and Westslope Cutthroat Trout. Effects to species other than Lake Trout, Bull Trout and Kokanee are anticipated to be minimal and are briefly described below.

Bull Trout

Three core populations of Bull Trout occur in the Swan River Valley, namely Swan Lake, Holland Lake and Lindbergh Lake.

Swan Lake. Swan Lake is a complex core area with nine local populations spawning within twelve streams. Spawner escapement estimates have been conducted by redd counts since 1982. Bull Trout redd counts on four of the highest use streams have been counted consistently, and they are called "index streams". Since 1995 redd counts have been conducted for nearly the entire basin. Total redds counted since 1982 for index streams and comprehensive surveys are shown in Figure 2.

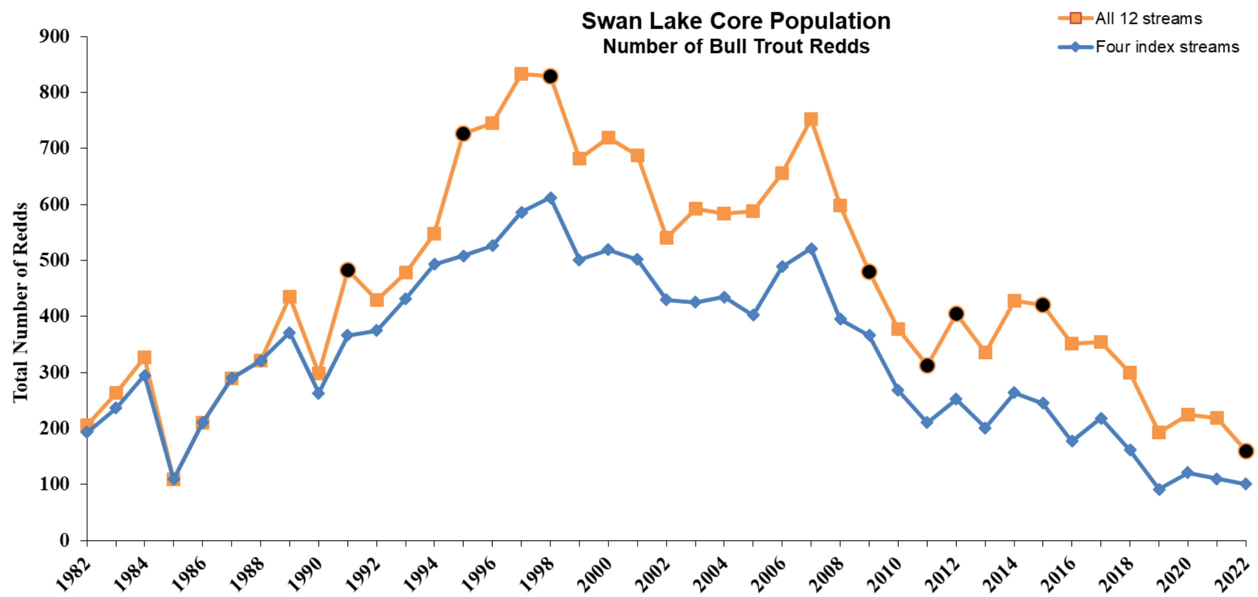


Figure 2. Trend of Bull Trout redd counts in the Swan Lake Core Area over time. Blue line represents consistent effort on four index streams. Prior to 1995 other streams were sparsely inventoried. After 1995, effort typically focused on about 10 streams and deferred one or two minor ones. Solid black dots indicate comprehensive inventories where all 12 streams were surveyed.

Lindbergh and Holland Lakes. Lindbergh Lake and Holland Lake core areas are considered "simple" because they only have one spawning stream. These populations have been traditionally considered isolated due to warm water conditions in their outlet streams (Montana Bull Trout Scientific Group 1996) but this theory has never been fully tested. Redd counts have been conducted annually on Holland Lake since 1991 but only intermittently for Lindbergh Lake. Figure 3 illustrates the trend over time.

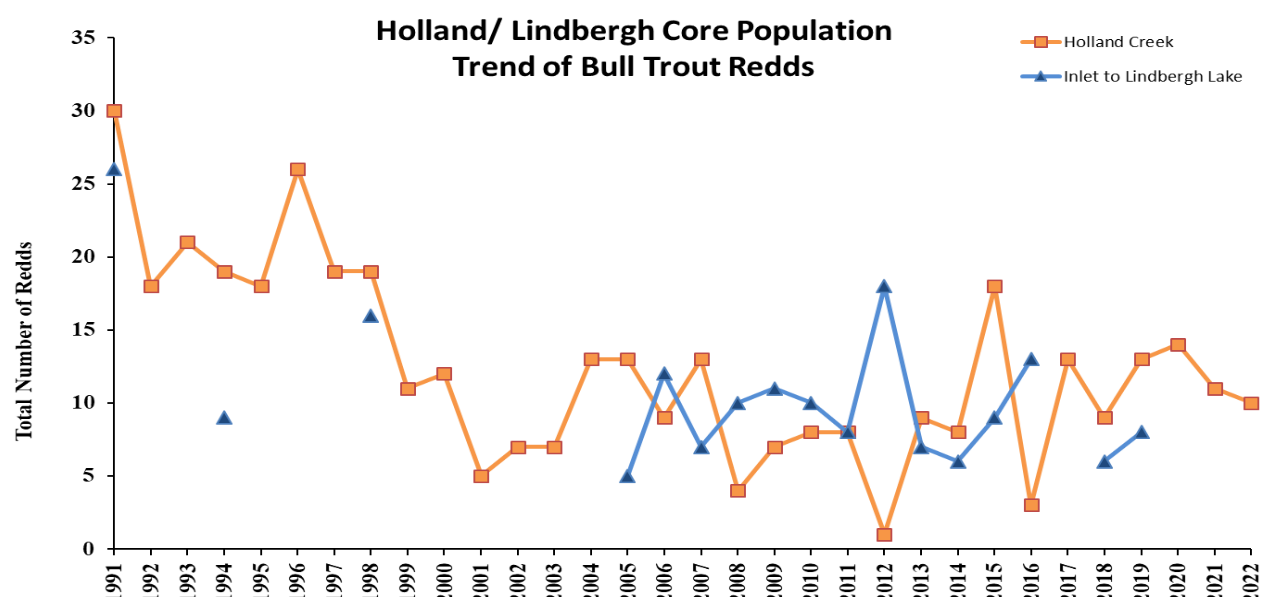


Figure 3. Trend of Bull Trout redd counts in Holland and Lindbergh core areas over time.

Lake Trout

Lake Trout are not native west of the continental divide or to the Swan River Valley. Lake Trout were first documented by a recreational angler within the Swan River in 1998. It is unknown if Lake Trout were illegally introduced to Swan Lake or if they emigrated from the Flathead system via a simple fish ladder installed near the Bigfork Dam. The Bigfork Dam fish ladder was of relatively simple design and was not considered functional by biologists, therefore, it was removed in the early 1990's. It is possible Lake Trout ascended the ladder prior to its removal.

The first juvenile Lake Trout captured in Swan Lake by MFWP within their monitoring gill nets was caught in 2003. This juvenile Lake Trout provided evidence that the Lake Trout population had become established and was reproducing within Swan Lake. Following the initial introduction, the Lake Trout population grew rapidly.

In 2006, Ben Cox, a Montana State University graduate student, conducted a 6-week study and captured a ratio of 1.7:1 Lake Trout:Bull Trout. By 2008, the population of Lake Trout between 6.5" and 35" was estimated to be about 8,800 fish (Cox 2010). An interesting comparison can be made with nearby Flathead Lake, where the Lake Trout population was at or near carrying capacity as of 2014 (Confederated Salish and Kootenai Tribes 2014). Within 10 years of the initial discovery of Lake Trout in Swan Lake, the population of age 4+ Lake Trout in Swan Lake was approximately half of the Lake Trout density of Flathead Lake. A 2007 report notes that the relative weight (a measure of the condition of individual fish) of adult Lake Trout in Swan Lake exceeded those of Yellowstone Lake, Lake McDonald, and Flathead Lake (Swan Valley Bull Trout Working Group 2007). Data from 2006-2007 suggested the Lake Trout population in Swan Lake had not yet reached carrying capacity. From 2009-2016, annual population estimates were derived from the same depletion models used to calculate the initial estimate in 2008 (Cox 2010). Although the catch rate of age 4+ Lake Trout exhibited a depletion over the 3-week juvenile netting period each year, exploitation and catch rates remained consistent from year to year (Rosenthal and Fredenberg 2017), suggesting the level of harvest was inadequate to cause a decline in the overall Lake Trout population.

Recognizing the need for improved Lake Trout population data, MFWP began the previously mentioned Lake Trout sampling strategy called SPIN (Sandstrom and Lester 2009). SPIN systematically divides the lake surface area into cells, each of which have a standardized effort with a suite of gill net mesh sizes. While some information on Lake Trout density was collected in the 2017 pilot year, the 2018 data is considered the first comprehensive assessment of Lake Trout density in Swan Lake. In 2018 biologists found an average of 6.7 Lake Trout per net lift as compared to 0.9 Bull Trout per net lift (data provided by Leo Rosenthal, fisheries biologist, personal communication).

Lake Trout are also present in Holland Lake and Lindbergh Lake. They were first detected in Lindbergh Lake in 2009 and Holland Lake in 2012. Lake Trout presumably invaded these lakes by emigrating from Swan Lake, traveling up the Swan River. Anglers reported catching juvenile Lake Trout in the Swan River during that era, which suggests that the Swan Lake population had expanded enough to foster emigration to Flathead, Lindbergh, and Holland lakes. Although, little is known about the status and size of the Lake Trout populations in Holland and Lindbergh Lakes, Lake Trout varying in age and reproductive maturity have been captured during gill net monitoring. Adult Lake Trout telemetry studies and SCUBA diver observations, identified probable spawning locations in both Holland and Lindbergh lakes, indicating some Lake Trout reproduction occurs. It is also likely that these populations are at least intermittently bolstered by emigrants from Swan Lake. Similarly, the emigration of Lake Trout from Swan Lake to Flathead Lake (where suppression is ongoing) has been documented.

Kokanee Salmon

Kokanee are not native to the Swan River Valley and have been introduced by the state of Montana to provide a recreational fishery. In Swan Lake, current management is for a wild (self-sustaining) population, though historically, Kokanee were also stocked. Montana FWP stocked about 50,000 to 80,000 fingerlings annually (range 36,720 to 105,600) to replace lost production from their egg-taking operations on Swan Lake for many years. Stocking was halted beginning in 2005 because egg collection had ceased and because of concerns from the increasing Lake Trout population. Kokanee redds (wild recruitment) have been monitored annually along the southeast shoreline of Swan Lake since 1987 (Figure 4). Although Kokanee redd counts varied annually prior to Lake Trout establishment (around 2001), the Kokanee population experienced a declining trend following the establishment of the Lake Trout population. Given that Kokanee were the most numerous prey species found in Lake Trout stomachs, the decline in the Kokanee population can likely be attributed to the proliferation of the Lake Trout population. In recent years, Kokanee redd numbers are approximately one third of their abundance before Lake Trout's proliferation.

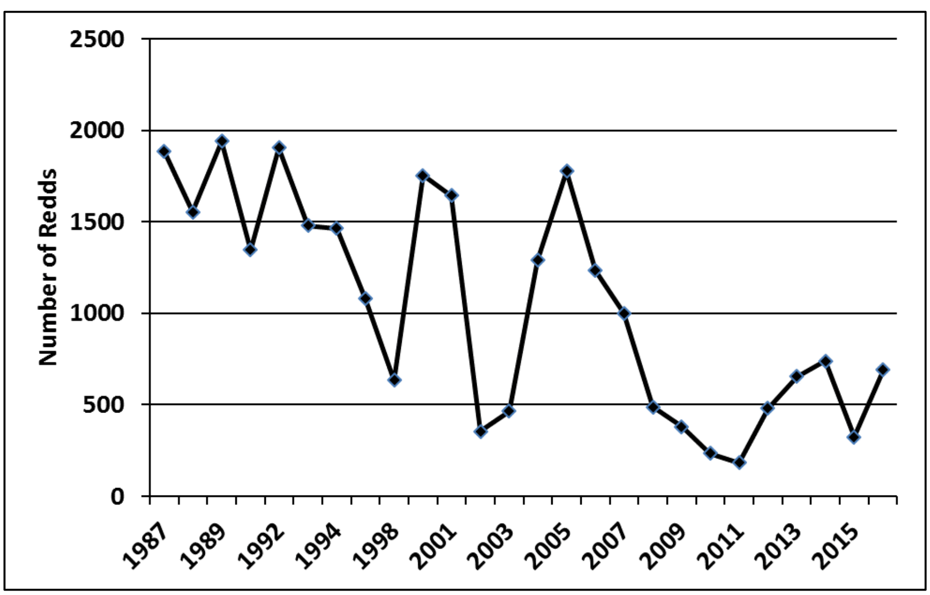


Figure 4. Trend of Kokanee redds in Swan Lake from 1987-2017. Figure provided by Rosenthal and Fredenberg (2017).

Kokanee are also found in Lindbergh Lake and Holland Lake. Between 30,000 and 50,000 fingerling Kokanee have been stocked in both lakes almost annually since 1944. No wild reproduction is known to occur in Holland or Lindbergh Lake, and Kokanee are caught infrequently in routine monitoring conducted on both lakes by MFWP. Since the routine monitoring is not well suited to sample Kokanee, information on the Kokanee population status and trend in Holland and Lindbergh lakes are not available.

Westslope Cutthroat Trout

Westslope Cutthroat Trout (*Oncorhynchus clarki lewisi,* alternatively *Oncorhynchus lewisi*) are native to the Swan River Valley. Historically, Westslope Cutthroat Trout (Cutthroat Trout) in the Swan drainage exhibited migratory and resident life forms, but it is unclear what proportions of the population exhibited adfluvial, fluvial or resident life history forms. The Cutthroat Trout population in the river and tributary streams of the Swan River Valley have declined in recent years. A collaborative assessment effort by multiple agencies and conservation groups have identified 22 remnant populations in tributary streams that were genetically pure or nearly-pure and there is uncertainty if any significant migratory stocks remain (Flathead National Forest et al. 2010). Cutthroat Trout are infrequently captured during MFWP monitoring in Swan Lake and are not commonly reported by anglers, thus, Cutthroat Trout are assumed to be uncommon or rare in Swan Lake. Cutthroat Trout have not been stocked in Swan Lake since 2007. Roughly 3,000-5,000 Cutthroat Trout are stocked almost annually in both Holland Lake and Lindbergh Lake. Holland Lake has little or no spawning habitat for Cutthroat Trout, thus the Cutthroat Trout population is assumed to be primarily artificially maintained. The inlet river to Lindbergh Lake supports a remnant Cutthroat Trout population and some exchange between lake and river is possible.

Other Fish Species

Other fish species in the Swan River Valley lakes include native Mountain Whitefish (*Prosopium williamsoni*), Pygmy Whitefish (*Prosopium coulterii*), Sculpin (undetermined *Cottus* species), Northern Pikeminnow (*Ptychocheilus oregonensis*), Peamouth (*Mylocheilus caurinus*), Longnose Sucker (*Catostomus catostomus*) and Largescale Sucker (*Catostomus macrocheilus*). Nonnative species include Northern Pike (*Esox lucius*), Brook Trout (*Salvelinus fontinalis*), Rainbow Trout (*Oncorhynchus mykiss*), Yellow Perch (*Perca flavens*), Largemouth Bass (*Micropterus salmoides*), Brook Stickleback (*Culaea inconstans*), Central Mudminnow (*Umbra limi*) and Pumpkinseed Sunfish (*Lepomis gibbosus*). Monitoring data for these other fish species are limited. Montana FWP has conducted annual routine springtime gillnetting in Swan, Lindbergh, and Holland Lakes, periodic boat electrofishing in the Swan River, and annual tributary electrofishing. None of these surveys target any of the aforementioned species individually, which limits future trend information.

B. Wildlife

The Swan River Valley hosts numerous wildlife species, including terrestrial and riparian-dependent species. Two terrestrial species present within the Swan ecosystem are protected by the Endangered Species Act: the grizzly bear (*Ursus arctos*) and Canada lynx (*Lynx canadensis*).

Neither of these species dwells in lakes; implementation of this project, or not, would have no consequences on them, and therefore they are not considered further.

Waterfowl are commonly observed on Swan Lake, Holland Lake, and Lindbergh Lake. Most species are dabbling birds that only swim under a few feet of water in search of plants, mollusks or insects, such as the lesser scaup (*Aythya affinis*) and the ring-necked duck (*Aythya collaris*). Gill nets will not be set shallow enough to entangle these species and therefore implementation of this project, or not, would have no consequences on them, and therefore they are not considered further.

Common loons (*Gavia immer*) are a species of concern that are routinely observed on all three lakes. These fish-eating birds normally dive 10-30 feet but have been recorded to dive up to 200 feet. Common loons have been monitored by wildlife biologists and volunteers since the mid 1990's, and successful nesting has not occurred on Swan, Holland or Lindbergh lakes since approximately 2000.

Bald eagles and western osprey are common on all three lakes. Both birds of prey rely on fish species that reside near the surface of lakes or rivers as part of their diet. Fish species that occupy the deeper waters of lakes are unavailable prey items, as neither bird species are known to dive greater than one meter in depth. For this reason, the reduction in Lake Trout numbers and subsequent increased abundance of Bull Trout and other Lake Trout forage species will likely benefit both bird species. Bald eagles have been monitored in the Swan Valley, and direct evidence of breeding has been observed at the inlet to Swan Lake. Direct evidence of breeding has not been documented at Lindbergh or Holland lakes.

C. Recreation

Swan Lake is popular for recreational boating and fishing. The lake has a single public boat ramp and receives relatively high use on summer weekends. Due to the immediate access from the highway, public boat launch, floating dock, and ample parking, this lake accommodates a wide range of boating traffic. While roughly a third of the shoreline is on National Forest system lands or the Swan River National Wildlife Refuge, several hundred private residences line the shore in two large clusters.

Swan Lake creel data has been collected periodically by MFWP; the most recent creel survey was conducted in 2009. As of 2009, the primary recreational fisheries in Swan Lake (in descending order) were Kokanee, Northern Pike and Bull Trout. Historically, Bull Trout harvest was allowed in Swan Lake, however, in 2012 harvest was discontinued in favor of a catch-and-release fishery. Periodic ice-fishing surveys conducted by MFWP resulted in anglers reporting high catch rates of Kokanee and Bull Trout. Since the 2009 creel survey, Lake Trout numbers have increased and it is likely that some anglers are successful in targeting Lake Trout (Leo Rosenthal, fisheries biologist, personal communication).

Lindbergh Lake receives moderate recreational boating and fishing use. The lake is accessed by a 6-mile gravel road and has a small boat ramp with limited parking. A small campground is located on the northeast shoreline. Approximately 75 percent of the shoreline is on National Forest system lands and the remaining portion has approximately 70 small privately-owned parcels. Creel data is unavailable for Lindbergh Lake but the MFWP management biologist suggests most of the angling targets Kokanee and Cutthroat Trout (Leo Rosenthal, fisheries biologist, personal communication).

Holland Lake receives moderate to high recreational use. The lake is accessed by a 4-mile gravel road, and has a small, shallow public boat launch. The Public boat launch is not suited for larger boats with deep drafts. A large campground exists on the northwest shoreline. The entire lake is on National Forest system lands but 17 recreational residences (cabins) are present on the south shoreline with special use permits. One commercial facility with a special use permit offers lodging and food accommodations on the north shoreline. Creel data is unavailable for Holland Lake, however, the MFWP management biologist suggests most anglers target Kokanee, Cutthroat Trout and Yellow Perch (Leo Rosenthal, fisheries biologist, personal communication).

D. Water Quality

Swan Lake is a 1,327-hectare (3280 acre) lake that is naturally regulated and Swan River flows in and out of the lake at opposite ends. Swan Lake has two deep basins each, about 38 meters (120 feet) deep. The lake is generally characterized by excellent water quality and clarity and comparatively low nutrient levels that are typical of oligotrophic lakes. However, a 1990 sample (the oldest on record) found normal conditions in the North basin and low dissolved oxygen concentration and percent saturation in the deeper waters of the South basin. The situation is uncharacteristic of oligotrophic lakes. Since 1996 the Montana Department of Environmental Quality (DEQ) has listed the lake as a “threatened” water body on their list of impaired waters.

In 2004 Montana DEQ prepared a Total Maximum Daily Load (TMDL) and protection plan for Swan Lake. The Montana DEQ outlined several primary targets of: (a) no further decrease in dissolved oxygen saturation, (b) no increase in the spatial extent of the low dissolved oxygen area, (c) no increasing trend of nutrient concentration and (d) no increasing trend of chlorophyll *a* concentration (Land & Water Consulting Inc. et al. 2004). Additional monitoring from 2004-2011 found no apparent trend in most of the primary targets but information is unavailable regarding the spatial extent of the low dissolved oxygen (Whitefish Lake Institute 2012). However, further volunteer monitoring data has found a deteriorating trend of dissolved oxygen. In October 2016 and October 2017, anoxic conditions were documented on the bottom 2 meters of the South basin (Swan Lakers Water Quality Monitoring Program 2017). The spatial extent of this anoxic zone remains unknown.

While acknowledging the uncertainty of whether Swan Lake is naturally predisposed to low dissolved oxygen levels, the TMDL plan listed several probable causes including erosion from forest roads, timber harvest in riparian areas, loss of woody debris in stream channels, historic log drives and private development around the lake (Land & Water Consulting Inc. et al. 2004). In order to achieve restoration, the plan recommended a 40 percent reduction in road erosion, a 10 percent improvement in riparian canopy density, no increase in nutrients from timber harvest-associated actions such as mass wasting and culvert failures, no increase in nutrient loading from septic systems near the lake, and an undefined reduction in airborne nutrient loading. The road erosion allocation has been met (Atkin 2012) but the status of other allocations is unknown.

Although not listed in the 2004 TMDL plan, the Service also considers the modified wetland hydraulics in the Swan River Wildlife Refuge may be a contributing factor as well.

Lindbergh Lake is a 330 hectare (817 acre) natural lake, it is located upstream of Swan Lake and is fed by the Swan River which flows in and out of the lake at opposite ends. The lake has a U-shaped profile and the deepest location is about 38 meters (125 feet). Lindbergh Lake is considered oligotrophic due to low nutrient content, low chlorophyll *a* concentration and high water clarity (Ellis et al. 1998). Intermittent volunteer monitoring from 1998-2012 found no adverse trends but the 2006 dissolved oxygen concentration was unusually low at all depths (Whitefish Lake Institute 2013).

Holland Lake is a 167 hectare (414 acre) natural lake with Holland Creek flowing in and out at opposite ends. The lake has one deep basin with a maximum depth of 48 meters (156 feet). Intermittent monitoring of Holland Lake by volunteers from 1998-2012 found its water quality to be characteristic of oligotrophic lakes and shows no apparent trends over time (Whitefish Lake Institute 2013).

Environmental Consequences of the Alternatives

A. Fish

Alternative 1- No Action Alternative

The No Action Alternative will likely *harm* Bull Trout, Kokanee and Cutthroat Trout, *benefit* Lake Trout, and have an *indeterminable impact* on other species. Each species response is described separately below.

Alternative 2- Proposed Action Alternative

The Proposed Action would *benefit* Bull Trout, Kokanee and Cutthroat Trout, *harm* Lake Trout and have *indeterminable impact* to other species. Each species response is described separately below.

Bull Trout

Alternative 1- No Action Alternative

Bull Trout are anticipated to decline in the Swan Lake core area and may become essentially extirpated in Lindbergh Lake and Holland Lake core areas. In order for the Columbia Headwaters Recovery Unit to be delisted, primary threats need to be managed in 75 percent of simple core areas and 75 percent in complex core areas (USFWS 2015a). Should Bull Trout populations in Holland, Lindbergh, and Swan core areas continue to decline, two additional simple core areas and a complex core area would fail to meet recovery standards, further ensuring the Bull Trout's status remains listed or perhaps worsens at some point to endangered. Strong empirical data shows a pattern of Lake Trout displacing Bull Trout (Martinez et al 2009). Lake Trout invasion has been considered the primary reason for Bull Trout population decline in many lakes including Flathead Lake (Confederated Salish and Kootenai Tribes 2014), Lake McDonald, Logging Lake, Bowman Lake, Harrison Lake, Kintla Lake (Fredenberg 2000; Downs and McCubbins 2018), Priest Lake (NG et al. 2015), Upper Priest Lake (Martinez et al

2009), Bow Lake, Hector Lake, Spray Lake (Donald and Alger 1993) and the probable cause for Upper Waterton Lake, Middle Waterton Lake and Glacier Lake (Donald and Alger 1993).

The mechanism appears to combine niche overlap (competition) and direct predation. There is uncertainty about which factor is more important: competition or predation. Bull Trout were infrequently found in Lake Trout stomachs in a diet study in Swan Lake (Guy et al. 2011) and nearby Flathead Lake (Confederated Salish and Kootenai Tribes 2014). This may simply reflect the relative scarcity of Bull Trout as prey. However, the consequence of additional predation on a species with low abundance and few native predators is outsized. At the same time, evidence of competitive pressure is also challenging to document. Meeuwig's (2008) review of 7 sympatric lakes in Glacier National Park could not fully explain Bull Trout decline from competition and theorized that displacement only happens in food-limited situations. Swan Lake and Holland Lake support both *Mysis diluviana* (hereafter *Mysis* shrimp) and Kokanee. These lakes are relatively productive semi-oligotrophic valley bottom lakes, but still have the potential to be food limited for upper level piscivores. Lindbergh Lake, however, contains Kokanee but not *Mysis* shrimp. It is plausible that Lindbergh Lake is more food-limited for juvenile lake trout. Lake Trout may take longer to establish in Lindbergh Lake and their impact to Bull Trout may be more a consequence of competition rather than predation. Given these complex interactions, it is impossible to forecast the actual rate of Bull Trout decline.

Therefore, rather than forecasting precise Lake Trout and Bull Trout interactions, the Service models potential Bull Trout population trend in the Swan Lake core area (which has sufficient data) and compares Holland and Lindbergh Lake core areas (which have insufficient data) to similar lakes that experienced Lake Trout invasion. The analysis timeframe extends until year 2040, which is about 3-4 Bull Trout generations.

In developing the Swan Lake model, the Service utilizes the findings of Donald and Alger (1993) who studied numerous Bull Trout lakes before and after the invasion of Lake Trout. This study found the average annual mortality of Bull Trout increased 12 percent in lakes colonized by Lake Trout. Modeling results for this added mortality result in a slow, gradual decline in Bull Trout redds. This is illustrated as the No Action Alternative in Figure 5. The model is not intended to provide exact forecasts of trends, but rather to allow comparison of the No Action Alternative to the Proposed Action. This model is an estimate of Bull Trout trend for the best case (Proposed Action) and worst case (No Action Alternative) scenarios. Details of the model are in Appendix C. The findings are that the No Action Alternative would likely result in the Swan Lake core area population declining precipitously by year 2040, but not extirpated. This seems reasonable in that it parallels the experience with Flathead Lake core population. Although pre-Lake Trout (prior to stocking about 1905) data is sparse, the Flathead Lake core area has maintained itself at roughly 40 percent of its historic abundance for the past few decades (Confederated Salish and Kootenai Tribes 2014). Swan Lake is similar to Flathead Lake in that both had abundant adfluvial Bull Trout populations (Leathe and Enk 1985), *Mysis* shrimp, multiple spawning tributaries, and access to considerable riverine habitat. It should be noted, however, the Flathead Lake system is much larger and contains many more miles of large riverine habitat that vulnerable juvenile Bull Trout life stages may utilize to avoid the additive mortality associated with competition and predation by Lake Trout.

Lindbergh Lake and Holland Lake vary from Swan Lake in that they are characterized as having lower numbers of adfluvial Bull Trout, a single spawning tributary, and little or no riverine habitat; Holland Lake hosts nonnative *Mysis* shrimp, but Lindbergh Lake does not. Due to the numerous ecological, spatial, and Bull Trout population size differences between Swan Lake and these lakes, the model in Appendix C would not provide an informative forecast, and therefore it was not used here. However, the closest comparable lakes to Lindbergh and Holland lakes are Harrison Lake and Logging Lake in Glacier National Park.

Harrison and Logging lakes are similar to Holland and Lindbergh lakes in all characteristics except that Holland Lake hosts *Mysis* shrimp. Lake Trout were first observed in Logging Lake in 1984 and, while data are sparse in Harrison Lake, Lake Trout likely invaded between 1990 and 2000 (Fredenberg et al. 2007). By the year 2000, Lake Trout in Logging Lake outnumbered Bull Trout 12:7 in routine sampling (Fredenberg 2002). By 2005, the ratio of Lake Trout to Bull Trout in Logging Lake had increased to 25:7 (Meeuwig et al. 2008), and finally in 2010, the ratio of Lake Trout to Bull Trout was 25:0 (Downs et al. 2011). Within 30 years of Lake Trout invasion, Bull Trout redd counts in Logging and Harrison lakes declined precipitously and in recent surveys were undetected (Downs and McCubbins 2018). Thus it appears that Lake Trout replaced Bull Trout in just a few generations. While not entirely extirpated yet (a few Bull Trout have been captured in recent samples), Logging Lake is described as "facing functional extirpation in the near term" (USDI National Park Service 2013) and Harrison as "dangerously low" (Downs and McCubbins 2018).

While there is uncertainty regarding when Lake Trout first dispersed from Swan Lake to Holland and Lindbergh lakes, four Lake Trout varying in length from 16 to19 inches were first captured by MFWP in Lindbergh Lake sampling nets in June of 2009. Based on the 2009 date of discovery, it is reasonable to assume complete displacement of Bull Trout by Lake Trout will likely occur within a 30 year time frame. Therefore, the No Action Alternative is likely to result in extirpation or near extirpation of Bull Trout in Holland and Lindbergh Lakes by roughly 2040.

Alternative 2- Proposed Action Alternative

The Proposed Action will likely have negative effects on individual Bull Trout, although these effects would be less severe than the negative effects experienced should the No Action Alternative occur. Bull Trout are expected to experience short-term negative impacts in the form of bycatch to the individual, but removing a competing, long-lived top piscivore in Lake Trout will result in long-term stabilization and potential increases to the Bull Trout population. Although removing competing and predatory Lake Trout will immediately benefit Bull Trout on an individual basis, these benefits will not be realized at the population level until after a full generation of Bull Trout have successfully been recruited to the system and reach maturity. Successful suppression of Lake Trout will benefit Bull Trout throughout the Swan system. This will be true during implementation at each of the three lakes. Because Swan Lake will be implemented first and has the most available data it is the model for all three systems. The following discussion focuses on Swan Lake. The Bull Trout population responses in Holland and Lindbergh Lakes should follow a similar pattern to Swan Lake.

During the first seven years of implementation (2024 to 2030), the predicted Bull Trout redd counts for the Swan Lake core area may continue to decline from the current average. This is due, potentially, to a combination of effects from a pause in Lake Trout suppression from 2017-2024, the lag time benefit from the resumption of suppression, and the bycatch of Bull Trout associated with the Proposed Action. Because gill nets are size selective, the lapse of Lake Trout suppression from 2017-2023 presumably resulted in six large cohorts of Lake Trout. These cohorts are likely the largest yet in Swan Lake and will exert the greatest mortality to Bull Trout to date. As the Proposed Action begins in 2024, there is a lag time before any benefit is realized. It will take at least six years for biologists to detect improvements. Empirical data in the Swan Lake core area found some Bull Trout are sexually mature at age 5 but the majority by age 6 (Fraley and Shepard 1985). Thus, the benefit of reduced Lake Trout associated mortality is not expected to translate to more redds for at least six years, however, the removal of Lake Trout will benefit Bull Trout immediately by reducing natural mortality rates for individual bull trout (due to a decrease in predation and competition). Only after six years will Bull Trout recruitment begin to recover resulting in subsequent benefits to the bull trout population in Swan Lake. Finally, the Proposed Action itself will contribute to Bull Trout mortality due to unintended bycatch, although the mortality associated with bycatch would be less than what would have otherwise occurred under the No Action Alternative. Bull Trout bycatch mortality is described below.

During any gillnet suppression and SPIN monitoring by MFWP (which also uses gill nets), some Bull Trout entanglement is inevitable. If developing technology that smothers Lake Trout embryos proves successful, use of this suppression tactic would have no known negative side effects to Bull Trout. Trap nets were used in Swan Lake prior to the previous suppression efforts, when the Lake Trout population was small. Subsequently, trap nets were not an effective tool to capture Lake Trout and were expensive to deploy. Trap nets are routinely used in Lake Pend Oreille, it is estimated that only 6% of the overall Lake Trout removed were captured in trap nets (Dux et al. 2019). Although trap nets may not result in the highest catch per unit effort, catch results for both Bull Trout and Lake Trout can be used as another tool to assess the success of the suppression program. Therefore, trap nets may be used to complement the suppression work. Additionally, trap nets are non-lethal, therefore bycatch of Bull Trout would not be an issue. Using anglers to help achieve goals (via mark-recapture) would also likely have less Bull Trout bycatch, although some would occur due to incidental hooking mortality or mistaken identification. In order to err on the side of caution, this analysis assumes the continued use of gill nets, which has the greatest potential for Bull Trout bycatch.

Considerable experience regarding gillnetting bycatch has been gained from the 2009-2016 Lake Trout suppression effort in Swan Lake. The 2009-2016 effort resulted in a total bycatch of 2,331 Bull Trout over eight years. Based on their experience with direct observed mortality and subsequent computed delayed mortality, Rosenthal and Fredenberg (2014) empirically estimated that 53.6 percent of Swan Lake Bull Trout entangled in gill nets die. Techniques to minimize

Bull Trout bycatch improved over time. The 2016 year represents the culmination of experience and the bycatch was estimated to have caused mortality for 71 Bull Trout in that year. As detailed in Appendix A, the total Bull Trout population dwelling in Swan Lake in 2016 is estimated at 7,799 fish (ages 3-6). Therefore, the 2016 bycatch directly removed approximately 1 percent of the lake's population. Concurrently, the 2016 effort removed 7,044 Lake Trout, which would compete with, or predate directly upon, smaller Bull Trout, if left to flourish; so on balance, the effort was beneficial to bull trout. Another metric is to compare the impact of bycatch to mature adults. As detailed in Appendix C, approximately 965 Bull Trout spawned in 2016. Thus, the 2016 bycatch mortality removed approximately 6 percent of the total number of mature adults. The Proposed Action will likely have similar average soak time of gill nets in the lake as the 2016 effort, although it will undoubtedly experiment with different netting schedules. Although the Service intends to use the best available science to maximize Lake Trout harvest while minimizing Bull Trout bycatch, it is reasonable to assume that a similar bycatch rate of 1 percent of the population or 6 percent of the adult population of Bull Trout will be affected per year.

The Proposed Action is designed to prevent Bull Trout bycatch (mortality) from exceeding what would have otherwise occurred if no action were taken, and then limit it even further (Objective 2). These design criteria should ensure the Proposed Action remains a recovery action by limiting bycatch. A retrospective review of 2009-2016 project found that Swan Lake Bull Trout population decline is primarily due to a "survival bottleneck" of age 3-4 Bull Trout from Lake Trout, not solely from bycatch (Rosenthal and Fredenberg 2016). Despite the documented Bull Trout redd count decline in the recent decade, there has been no coinciding decrease in the juvenile Bull Trout abundance index. Hence, we surmise that the spawning and rearing habitat is fully seeded and the decline in adult Bull Trout has not yet reached a level where it affects productivity. The decline in Bull Trout is likely a symptom of in-lake mortality (and possibly some in the mainstem Swan River) and will correct itself once survival in the lake improves. Likewise, Lake Pend Oreille fishery managers report that Bull Trout bycatch has not overshadowed the benefits from Lake Trout suppression. Dux et al (2019) calculate that during ten years of Lake Trout suppression on Lake Pend Oreille, the Bull Trout bycatch removed 1.6 percent of the total Bull Trout population. The Lake Pend Oreille project is considered beneficial to Bull Trout conservation (Dux et al 2019). Given the similar Bull Trout bycatch rate in Swan Lake, the outcome of this Proposed Action would also be beneficial.

In order to estimate the trajectory of Bull Trout redds over time, the fate of each year's cohort is modeled (see Appendix C). The model relies on assumptions about recruitment to the lake, natural annual mortality rates, Lake Trout associated annual mortality rate, bycatch rates, spawner escapement, redd expansion, and potential recruitment recovery rate after Lake Trout are diminished. This model is useful to predict the "best and worst case" scenario for both the Proposed and No Action Alternative over time. Should the Proposed Action occur, redd counts would be expected to mimic the blue line in trend. Likewise, should the No Action Alternative occur, redd counts would be expected to mimic the orange line in trend and possibly stabilize at some reduced level. This model cannot factor overlapping generations, stochastic events (flood, fire, etc), or compensatory mortality and as such, is not intended as a precise estimate but rather a means to compare the consequence of the Proposed Action to what would otherwise happen with the No Action Alternative. Figure 5 below illustrates the findings. Details of the model assumptions and values are in Appendix C.

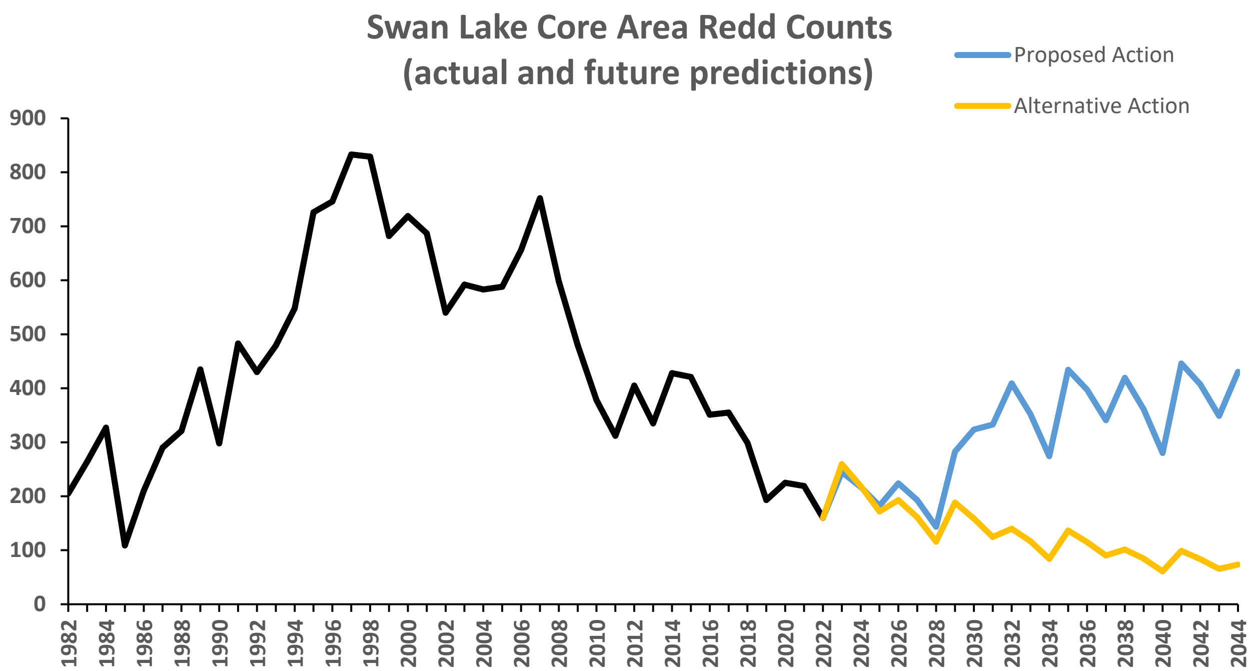


Figure 5. Past and future modeled projections of total redd counts for the Swan Lake core area depending on alternative. Historic redd counts are shown with black line.

Over the long-term, the Proposed Action is anticipated to compliment the Bull Trout recovery goal. Recovery of the Kokanee and Bull Trout populations in Lake Pend Oreille appears to be occurring after ten years of Lake Trout suppression (Hansen et al 2019). Once Lake Trout are suppressed, a rapid Bull Trout population recovery is expected, especially if the production of new recruits (age 2-3 Bull Trout juveniles) from the spawning and rearing streams remains stable. Swan Lake Bull Trout experienced a 30 percent population growth rate annually from 1992 to 1998, presumably due to the removal of prior threats from angler harvest and compromised habitat conditions. Since the Bull Trout population rebounded so rapidly before, it has demonstrated the capacity to do so again.

As defined in the project description, the project's goal is a stable or increasing trend of Bull Trout redds. The Service will continue to use annual redd counts to document population trend. Bull Trout redd counts tend to have high annual variation, which challenges the ability of managers to correctly identify trends (Maxell 1999). Therefore, it will take many years to confirm success. Maxell (1999) provides a power analysis of the ability of redd count monitoring to confirm trends, depending on coefficient of variation (CV). The Swan Lake core area has an observed CV of 0.49. Therefore the Service will have an 80 percent confidence to confirm there will not be a 50 percent decline in seven years but it will take 15 years to have a similar power of detection for a 20 percent decline (Maxell 1999, Figure 2, one-tailed test with 0.05 probability of type I error and observed CV 0.49 in Swan Lake core).

While Lake Trout suppression should be beneficial, results displayed by the model are not guaranteed. Other factors such as illegal harvest, habitat changes, climate change, Brook Trout hybridization, Northern Pike predation, and illegally introduced species (e.g., Walleye) will likely have some confounding effects (USFWS 2015). It is incorrect to assume that Lake Trout are the exclusive reason for recent Bull Trout decline and thus incorrect to assume Lake Trout suppression solely recovers the species. However, this project reasonably expects to result in a stable or increasing trend to Bull Trout because it addresses the primary threat that Lake Trout poses to Bull Trout.

Kokanee

Alternative 1-No Action Alternative

Kokanee populations will continue to decline and possibly collapse with the No Action Alternative. This species is a preferred food item and is especially vulnerable to predation by Lake Trout. The Kokanee population in Flathead Lake quickly collapsed following the proliferation of Lake Trout. In an attempt to reestablish the Kokanee population, MFWP, CSKT, and the Service reared and planted over 11 million Kokanee into Flathead Lake between 1989 and 1999. Despite best efforts to replenish the Kokanee population, managers concluded that "kokanee survival to adulthood is largely precluded, apparently due to Lake Trout predation" (Fredenberg et al. 1999). A decline in Kokanee abundance was also observed in Lake Pend Oreille prior to Lake Trout suppression, followed by a Kokanee rebound coinciding with successful Lake Trout suppression (Hansen et al. 2010, Dux et al. 2019). Without Lake Trout suppression, it is reasonable to conclude that Kokanee will decline and possibly disappear in Swan Lake, Holland Lake and Lindbergh Lake, even if biologists continue to stock this species.

Alternative 2-Proposed Action Alternative

The Kokanee population would benefit from the suppression of Lake Trout. It is likely that the Kokanee population would rebound from their current depressed state in the long term; however, in the short term, Kokanee would experience some short-term negative impacts. Some individuals would perish from entanglement in gill nets. During the 2009-2016 project, an average of 459 Kokanee were captured in gill nets annually (Rosenthal and Fredenberg 2017) and many perished.

However, over the long term, the suppression of Lake Trout is essential to maintain the Kokanee populations in Swan, Holland and Lindbergh lakes. Lake Trout prey preferentially upon Kokanee (Mesa et al. 2013). The continued existence of wild Kokanee redds in Swan Lake, albeit at reduced numbers, may be an important result of the 2009-2016 Lake Trout suppression effort. Likewise, Corsi et al (2019) noted that the Kokanee population in Lake Pend Oreille depends equally on *Mysis* forage availability and reduction of Lake Trout. Restoration stocking of Kokanee was not successful in Flathead Lake during the 1990's when Lake Trout population expanded and largely replaced Bull Trout. Given the inability to oversaturate Lake Trout consumption with excess Kokanee, it is unlikely that MFWP would attempt it, and the Kokanee population would likely collapse. Therefore, the Proposed Action is essential to maintaining Kokanee populations for the enjoyment of anglers, as Kokanee were identified as the most sought after species within Swan Lake in the 2009 Creel Survey. If Lake Trout suppression were successful, the Kokanee population and size structure would return to conditions prior to Lake Trout expansion (Circa 2001).

Lake Trout

Alternative 1-No Action Alternative

Lake Trout will benefit from the No Action Alternative. The populations in Swan, Lindbergh and Holland lakes will continue to grow until they reach carrying capacity. As Lake Trout reach carrying capacity, the average growth rate and size may decline and age of maturity may increase. The Lake Trout populations of Swan, Holland and Lindbergh Lakes could likely resemble the size structure of Whitefish Lake or Flathead Lake, which are presumed to be at carrying capacity (Montana Fish, Wildlife and Parks 2012, Confederated Salish and Kootenai Tribes 2014).

Alternative 2-Proposed Action Alternative

The Lake Trout populations would be negatively impacted by the Proposed Action. Objective 1 of this Proposed Action is a statistically significant decline in Lake Trout density over time. Similar suppression efforts using primarily gill nets have reduced Lake Trout populations in Lake Pend Oreille (Idaho), Upper Priest Lake (Idaho), Quartz Lake (Montana), and Yellowstone Lake (Wyoming). The ongoing work in Lake Pend Oreille (Idaho) is probably the closest comparison to this project. Lake Pend Oreille generally has similar species composition, including *Mysis* shrimp, but fisheries managers were faced with a rapidly expanding Lake Trout population. From 2006-2016, gillnet suppression of Lake Trout in Lake Pend Oreille resulted in a 60% Lake Trout population decline and is now approaching the desired density (Dux et al. 2019; Hansen et al. 2019). The Swan Lake Proposed Action, however, is not comparable to Lake Trout suppression in Flathead Lake. The Flathead Lake project intends slow, careful decline over 50 years.

It is highly unlikely that all Lake Trout will be extirpated in the Swan River Valley. At some point, Lake Trout numbers will decline enough to allow Bull Trout recovery, possibly when Lake Trout density is equal to or less than Bull Trout density. Lake Pend Oreille managers estimate this is when the Lake Trout population drops by 90 percent from project initiation (Hansen et al 2019). Providing a similar target is not possible in Swan Valley Lakes because the current Lake Trout population size is unknown. At the target point of Lake Trout “tolerable abundance”, suppression will cease, and the Service will then begin “maintenance” work which will be scaled back annual effort and/or intermittent effort. Montana FWP’s SPIN netting data will be used to monitor Lake Trout density and to assess the annual effort needed to achieve desired results. Low numbers of Lake Trout will persist. These remaining fish will not have competition for food resources and will continue to have above average growth rates.

Westslope Cutthroat Trout

<u>Alternative 1-No Action Alternative</u>

Cutthroat Trout would likely experience some negative effects from the No Action Alternative, although less profound than anticipated for Bull Trout and Kokanee, due to a partial fluvial life history that occurs entirely in streams. The adfluvial life history form of Cutthroat Trout, already at very low abundance, would experience increased predation as the Lake Trout population expands. Given that Bull Trout also prey upon Cutthroat Trout, the indirect effect is the replacement of one predator (Bull Trout) with another (Lake Trout). Lake Trout are likely to become more numerous when they reach carrying capacity than Bull Trout were historically. This assumption is based on the apparent reproductive advantage of spawning in a lake, as compared to a tributary stream, and observations of exponential growth rate of new invasions. Thus, the increased number of predators means an increased predation rate on Cutthroat Trout, especially in lakes.

Cutthroat Trout are already uncommon in Swan Lake. Lake Trout will consume more Kokanee than Cutthroat Trout. However, a collapse of Kokanee could also be catastrophic for adfluvial Cutthroat Trout. Any potential increase of predation on an uncommon species has disproportional consequences. The No Action Alternative adds additional stress to an already small adfluvial Cutthroat Trout population in Swan Lake. Holland and Lindbergh lake's Cutthroat Trout populations are partially or fully maintained by periodic stocking. It is uncertain if MFWP would continue to stock these lakes following Lake Trout expansion. If stocking continues, the No Action Alternative would have inconsequential effects as the stocked Cutthroat Trout would presumably replace those consumed by Lake Trout. If stocking ceases, the No Action Alternative would have indirectly resulted in reduced numbers of Cutthroat Trout in Swan Lake, Holland Lake and Lindbergh Lake.

<u>Alternative 2-Proposed Action Alternative</u>

Cutthroat Trout would be positively impacted by the Proposed Action, although not as substantial as the expected benefit to Bull Trout and Kokanee. There is less certainty that an adfluvial life history form of Westslope Cutthroat would reestablish since there may not be sufficient founders to do so. Suppression of Lake Trout would undoubtedly cause a decline in Lake Trout predation rate to Cutthroat Trout, but it would not altogether remove the threat. As Bull Trout populations recover, they will prey on Cutthroat Trout, albeit at a lower rate since Bull Trout carrying capacity is lower than that of Lake Trout, and they spend a portion of their life upstream in their natal tributaries and not in the lake. The Proposed Action would essentially maintain the Cutthroat Trout population at its' current depleted condition. There are no short-term consequences from the Proposed Action. Cutthroat Trout were not captured during the 2009-2016 suppression effort and similar results are anticipated with the Proposed Action.

Other Fish Species

<u>Alternative 1-No Action Alternative</u>

All other fish species would likely experience indeterminable impacts from the No Action Alternative. Lake Trout will probably shift their diet as the more preferred prey species decline; however, it is not currently known what level of impact predation from Lake Trout would have. Species that inhabit primarily shallow littoral zones, such as Northern Pike, Yellow Perch and Pumpkinseed Sunfish would largely escape predation by Lake Trout which tend to be more pelagic. Other species such as Northern Pikeminnow, Rainbow Trout, Largescale Suckers, Peamouth, Mountain Whitefish, and Pygmy Whitefish may experience increased predation following a Kokanee decline; however, in similar systems where Lake Trout have been introduced, these species remain abundant.

Alternative 2-Proposed Action Alternative

Other fish species would experience indeterminable effects, either from direct bycatch impacts from gill nets or indirect population effects. Direct effects from gillnetting would be inconsequential. During the 2009-2016 Lake Trout suppression project, gill nets were soaked for over 2,000 hours annually. Rosenthal and Fredenberg (2016) reported the total catch of all species during that work, provided in Table 2. Mortality from bycatch was not studied (except for Bull Trout) but most individuals of all species except Kokanee appeared vigorous and swam away after release from the nets. Bycatch of other fish species did not result in a known population loss. Given that the Proposed Action would likely have a similar amount of total soak time as past work, bycatch is not likely to have population effects.

Table 2. Total catch and bycatch from the 2009-2016 Lake Trout suppression effort in Swan Lake. Table reports only bycatch, not actual mortality. Species are listed in descending order of total catch.

Species	Total Catch from 2009-2016
Lake Trout	59,752
Kokanee	3,674
Bull Trout	2,331
Longnose Sucker	1,704
Largescale Sucker	955
Northern Pikeminnow	947
Mountain Whitefish	530
Pygmy Whitefish	358
Rainbow Trout	150
Northern Pike	33
Walleye	2
All other species (Yellow Perch, Cutthroat Trout, Pumpkinseed, Peamouth, Brook Sticklebacks, etc)	0

B. Wildlife

Alternative 1-No Action Alternative

The No Action Alternative would likely have no consequence for wildlife. The replacement of Bull Trout by Lake Trout is unlikely to affect any species, including common loons, bald eagles and western osprey. Although it is likely Kokanee populations would decline, or possibly disappear, the common loon, osprey and bald eagle would still be able to prey upon other species such as Peamouth, Rainbow Trout and Northern Pikeminnow.

Alternative 2-Proposed Action Alternative

The Proposed Action is not anticipated to affect wildlife, including diving birds, eagles, osprey, and loons. No birds were captured during the 2009-2016 suppression effort. The design criteria of avoiding boat travel and placement of nets near nesting locations of common loons appears to have been sufficient in the past and it is likely to remain so with this Proposed Action. Similarly, buffering eagle nesting locations has been proven effective at minimizing fledgling abandonment at Quartz Lake, Glacier National Park (Chris Downs, personal communication).

C. Recreation

Alternative 1-No Action Alternative

The No Action Alternative will not impact recreational boating but will affect recreational fishing. Recreational fishing for Kokanee will gradually decline and may disappear altogether. Some anglers will adjust and target Lake Trout instead. These anglers may enjoy a short period of quality size Lake Trout. They will be able to utilize Swan Lake and possibly Lindbergh Lake, but will find access at Holland Lake to be frustrating, as the boat launch is relatively shallow and the surrounding recreational parking is limited. Eventually, the Lake Trout population will reach carrying capacity, as described above, and the growth rates and average size will decline. Angler satisfaction may drop as large Lake Trout become increasingly scarce, such as the situation on Whitefish Lake (Montana Fish, Wildlife & Parks 2012). On the other hand, even with reduced average Lake Trout size, Flathead Lake continues to attract anglers and Swan Lake may provide the same amount of local angler use. Bull Trout fishing could dwindle and the catch and release fishery will likely be terminated within a few years. Northern Pike and Yellow Perch fisheries will remain largely unaffected. Northern Pike and Yellow Perch are infrequently preyed upon by Bull Trout or Lake Trout and thus any species shift will have no impact.

Alternative 2-Proposed Action Alternative

The Proposed Action would have minor direct and indirect effects on recreation on any of the lakes. During the 2009-2016 suppression effort, most boaters were unimpacted by project boat traffic or gill nets. Very few complaints were raised about disturbance from the large boat provided by contract fishermen, presumably because the contract workers avoided working on weekends, holidays, and docked their boat away from the single (often crowded) boat ramp. Conflicts with contract fishermen were infrequent, however, a few anglers did get fishing gear entangled in gill nets (Leo Rosenthal, Fisheries Biologist, personal communication). Design criteria to avoid work during peak boating season and also, to post net locations at the boat ramps should minimize direct recreation impacts.

Recreational fishing would be indirectly affected in that the Proposed Action would reduce the recreational harvest opportunity for Lake Trout. Ultimately, the goal of the project is to contribute to the recovery of bull trout and, in part, provide a recreational bull trout fishery that was historically enjoyed on Swan Lake. Past creel data and professional opinion by MFWP biologists indicate that the majority of anglers at Swan, Holland and Lindbergh Lakes target Kokanee, Northern Pike, Cutthroat Trout, Bull Trout or Yellow Perch (Leo Rosenthal, Fisheries Biologist, personal communication). Historically, anglers who targeted Lake Trout were less common, as Lake Trout numbers were low. However, in recent years Lake Trout angling has become part of the recreational fishery. Anglers who target Lake Trout will be negatively affected by the Proposed Action and will likely abandon these lakes for opportunities elsewhere unless a trophy Lake Trout component remains. However, most anglers would not notice any change since the Proposed Action would essentially conserve the aforementioned species.

D. Water Quality

Alternative 1-No Action Alternative

The No Action Alternative is unlikely to result in an impact on water quality. There are two primary considerations on the role of the No Action Alternative. First, the adfluvial Bull Trout numbers are likely to decline precipitously. The loss of adfluvial Yellowstone Cutthroat Trout in Yellowstone Lake due to Lake Trout apparently had substantial indirect impacts on changes in plankton assemblages, nutrient transport to stream and diet changes of bears, eagles and osprey upon establishment of Lake Trout (Koel et al 2019). This was a result of a new piscivorous trophic level that was previously unknown to the lake and the inaccessibility of Lake Trout to terrestrial predators. Swan Valley lakes, however, already have Bull Trout as the top piscivore and Lake Trout seem to occupy a very similar ecological niche. It is unlikely that the replacement of Bull Trout by Lake Trout would change nutrient transport, plankton assemblages or affect predatory species.

The second consideration is the complex role *Mysis* shrimp may have on nutrients in the water. Extensive monitoring of the microscopic food web in Flathead Lake suggests each level appears to be controlled by the abundance of predators above (e.g. “top down”) (Confederated Salish and Kootenai Tribes 2014). A change in *Mysis* shrimp abundance could change the population of zooplankton they prey upon, primarily *Daphnia* species. *Daphnia,* in turn, consumes plankton (such as algae). The plankton, in turn, utilize bacteria that process nitrogen and phosphorus. A change in the plankton community could result in undesirable availability of phosphorus which would then be consumed by blue-green algae and indicate poor water quality. Yet in both Flathead Lake and Swan Lake, long term monitoring of *Mysis* shrimp has found considerable annual variation and yet no corresponding change with water quality. Even if Bull Trout and Kokanee no longer predate upon *Mysis* shrimp, Lake Trout is expected to take over that role. Therefore, any indirect effect of predation on *Mysis* shrimp and their influence on water quality is dismissed.

Alternative 2- Proposed Action Alternative

The act of using gill nets to suppress Lake Trout would not affect water quality in any lake. All captured Lake Trout would be removed from the lake. Salvageable fish fillets may be donated to local food banks for human consumption or donated to the Confederated Salish and Kootenai Tribes. Unsalvageable fillets may be used for research, compost, bird rehabilitation or other uses. By removing dead fish entangled in gill nets from the lake, no decomposition would occur and water quality would not be impacted by the Proposed Action.

Additional consideration is given to the developing science of suppressing Lake Trout embryos. Research in Yellowstone National Park found that depositing Lake Trout carcasses on top of spawning areas killed 98 percent of the embryos buried in the substrate (Thomas et al. 2019). As Lake Trout carcasses decompose, dissolved oxygen concentrations decrease in the immediate surrounding waters, creating hypoxic conditions that result in Lake Trout embryo mortality (Thomas et al 2019). Dissolved oxygen levels returned to pre-treatment condition within 7-10 days as the carcasses disintegrated (Thomas et al. 2019). The study did not evaluate the broader implications of treatment on water quality elsewhere in the lake. Due to the challenges of anchoring the carcasses and avoiding attracting bears, Yellowstone National Park is now experimenting with negatively buoyant pellets of organic, plant-based material that could achieve the same temporary hypoxic condition (Todd Koel, Fisheries Biologist, personal communication). If this proves feasible, the Proposed Action may implement similar embryo suppression on Swan River Valley lakes.

Decomposition of the organic pellets would result in localized poor water quality (immediately at the spawning areas). It is not anticipated to result in measurable effects on the overall water quality of the lake for three reasons. First, the spatial extent of embryo suppression is limited. Professional judgment of the Flathead National Forest District Fisheries Biologist is that suitable Lake Trout spawning areas are less than 3 percent of the surface area of Swan Lake, Holland Lake or Lindbergh Lake. A temporary hypoxic condition in such a small area is not likely to affect overall dissolved oxygen concentrations elsewhere in the lake. Second, the embryo suppression would take place immediately after Lake Trout spawning, which is typically in October. This is normally right before lakes recover dissolved oxygen levels (“turning over”) and thus, any stress on dissolved oxygen levels would be of short duration. Finally, because the Proposed Action would remove Lake Trout biomass from the lake, this helps provide a neutral balance of total nutrients added to the lake. There is no anticipated enrichment of lake nutrients from the Proposed Action. However, before implementing this technique and any other techniques not yet identified, more rigorous environmental analysis will occur to ensure that they do not exceed the potential environmental impacts analyzed within this EA.

As described with the No Action Alternative, it is unlikely that Lake Trout suppression has any predictable impact on *Mysis* shrimp density. Given the lack of correlation between Lake Trout suppression and *Mysis* density, the Proposed Action would not have indirect consequences on plankton levels and nutrient assimilation in the lakes.

Cumulative Impacts

According to the Council of Environmental Quality's regulations for implementing NEPA (50 CFR 1508.7), a cumulative impact is an environmental impact that results in incremental impacts when added to other past, present, or reasonably foreseeable actions in the analysis area. Cumulative impacts can be individually minor but collectively significant when added over a period of time.

A. Fish

A potential cumulative impact is apparent in the form of some recreational fishing and associated regulations. Due to the increasing threat of Lake Trout and the additional bycatch mortality associated with the previous suppression effort, MFWP and the Service agreed to close the Swan Lake fishery to Bull Trout harvest in 2012. Although anglers can no longer harvest Bull Trout, Swan Lake still remains one of only three populations within Montana that allows anglers the opportunity to purposefully target Bull Trout (i.e., "catch-and-release"). As such, it is likely angler induced catch and release mortality affecting the Swan Lake Bull Trout population occurs. Although fishing regulations for Lindbergh and Holland lakes do not allow targeted angling for Bull Trout, incidental angler bycatch undoubtedly occurs.

Angling mortality on Bull Trout has not been estimated in Holland or Lindbergh lakes, and hasn't been estimated on Swan Lake since 1995 (Rumsey and Werner 1997). However, it is reasonable to assume angling mortality occurs within all three lakes. Polzin and Fredenberg (2005) estimated 46.3% of active anglers could not properly identify a Bull Trout when presented with visual representations of Brook Trout, Lake Trout, and Bull Trout. The inability of anglers to differentiate the three *Salvelinus* species suggests incidental harvest of Bull Trout by anglers is likely occurring. In addition to incidental harvest, there is likely additional mortality associated with the capture, handling and release of Bull Trout. Joubert et al. (2019) simulated the capture, handling, and release of 30 memorable size Bull Trout (60 cm average) in an Alberta Lake to estimate mortality associated with prolonged handling and air exposure. After simulating the capture and prolonged air exposure (112 seconds) associated with photographing and measuring the fish, 33% (10 of 30) of the memorable size Bull Trout succumbed within 24 hours of being released (Joubert et al. 2019).

Although converting Swan Lake to a catch and release Bull Trout fishery in 2012 undoubtedly reduced angling mortality, the inability of anglers to differentiate Bull Trout from the other *Salvelinus* species, resulting in incidental harvest, coupled with the mortality associated with a catch and release fishery, further increases the total annual mortality rate for Bull Trout in the system. Although recreational angling likely contributes to Swan Lake Bull Trout mortality, the Service views the Swan Lake Bull Trout fishery as an important recreational opportunity for anglers and wants to ensure fishing regulations allow anglers to purposefully fish for Bull Trout in Swan Lake for the foreseeable future. The incidence of Bull Trout mortality from recreational catch and release fishing could be reduced through information and education campaigns aimed at appropriate fish handling practices and species identification. However, if the threat imposed by Lake Trout is not managed immediately, and the Bull Trout population continues to decline, both MFWP and the Service's decision-making space pertaining to angling regulations may be narrowed, resulting in more strict regulations.

Apart from recreational angling, there are no similar present or reasonably foreseeable actions of Lake Trout suppression in the Swan River Valley analysis area. Based on a review of effects to fish, wildlife, recreation and water quality, the Proposed Action would not result in a significant adverse cumulative effect.

B. Wildlife

The considered alternatives are not anticipated to generate measurable effects either singly or when aggregated with existing or anticipated effects of other past, present, or reasonably foreseeable future projects to any wildlife species.

C. Recreation

The considered alternatives are not anticipated to generate measurable effects either singly or when aggregated with existing or anticipated effects of other past, present, or reasonably foreseeable future projects to recreational activities in the future.

D. Water Quality

The considered alternatives are not anticipated to generate measurable effects either singly or when aggregated with existing or anticipated effects of other past, present, or reasonably foreseeable future projects to water quality in the future.

List of Sources, Agencies and Persons Consulted

Leo Rosenthal, Fisheries Biologist with Montana Fish, Wildlife & Parks, was consulted for development of the Proposed Action and provided considerable data.

Barry Hanson, Fisheries Biologist with Confederated Salish & Kootenai Tribes, was consulted for development of the Proposed Action.

Wade Fredenberg, retired Fisheries Biologist, was consulted for development of the Proposed Action.

Mark Ruby, Wildlife Biologist with Flathead National Forest, was consulted in developing mitigation measures to minimize impacts to common loons.

Todd Koel, Fisheries Biologist with Yellowstone National Park, was consulted for effects analysis of Lake Trout embryo suppression techniques.

Chris Downs, Fisheries Biologist with Glacier National Park, was consulted for selection of lakes that best resemble Holland and Lindbergh Lakes.

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List of Preparers

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Public Outreach

This Environmental Assessment is available to public comment. The FWS also seeks input from other federal, state, tribal and local government entities. Input received will be used to modify the Assessment (if needed) and prepare the Finding of No Significant Impact.

Appendix A

Evaluating Objective 2 (the annual limit of acceptable Bull Trout bycatch mortality)

In development of this criteria, consideration was given to a similar exercise conducted in 2007 during the initial, experimental Lake Trout suppression effort on Swan Lake. Fredenberg and Rumsey (2007) estimated that various Lake Trout suppression efforts, along with angler harvest, would remove 6.7 to 9 percent of the adult Bull Trout population and subsequently MTFWP determined this adverse impact was acceptable. The Fredenberg and Rumsey (2007) calculations were not used in developing Objective 2 in that it had incorrect bycatch mortality estimates, outdated Bull Trout redd counts, outdated angler harvest metric and, most importantly, was not intended to contrast bycatch with Lake Trout associated mortality.

Based on information gained from the 2009-2016 project, this evaluation criteria is based on two computations. The tally of Bull Trout bycatch mortality is described as ϕ. The computation of the acceptable limit of Bull Trout bycatch mortality is described as β. Objective 2 requires:

$\phi < \beta$.

This report will first describe the method and then provide an example using most recent data from Swan Lake. If new science becomes available that improves these calculations, they will be used.

Step 1. Determining φ

During suppression work, the Service would keep tally of all Bull Trout captured in gill nets alive or dead, regardless of size. Montana FWP would likewise do the same during their SPIN monitoring work. If other suppression techniques are employed, any inadvertent Bull Trout mortality will likewise be tallied. All obviously dead Bull Trout are simply numerated. All living Bull Trout captured will be released but tallied into three condition classes (poor, fair, good) as described by Rosenthal and Fredenberg (2014). This study empirically derived delayed mortality by a mark/recapture study of Bull Trout in Swan Lake. Bull Trout released in poor condition had 0.7 delayed mortality, those released in fair condition had 0.3 delayed mortality and those released in good condition had 0.05 delayed mortality. Therefore the bycatch mortality consists of total number of dead Bull Trout plus the ratio of delayed mortality. Therefore ϕ and is computed as:

*Dead Bull Trout + (Poor condition *0.7) + (Fair condition *0.3) + Good condition * 0.05) =* ϕ.

Example: The 2016 suppression effort captured 132 Bull Trout, but the total bycatch mortality, ϕ, was 71 (Rosenthal and Fredenberg 2017).

Step 2. Calculating β

The Swan River Valley Bull Trout core populations all exhibit adfluvial life history. Adfluvial Bull Trout undergo three major life stages: 1) eggs, fry, and juveniles up to age 2 or sometimes 3 that dwell in the spawning and rearing streams, 2) immature subadult (typically ages 3, 4, and 5) fish that dwell in the lake and 3) sexually mature adults (typically age 5-6 and older) that dwell in the lake and migrate to streams to spawn. Since Lake Trout are generally not present in Bull Trout spawning and rearing tributary streams, population estimates of eggs, fry and juveniles up to age 3 are not subject to the effects of direct interaction with Lake Trout. Therefore β only comes from subadult and adult Bull Trout.

The first step is to estimate the number of adult Bull Trout. Adult Bull Trout will be derived from the total number of redds for each core area. If the annual census is incomplete, the Service will extrapolate those missing streams using a 10-year running average. There are two studies that examined the correlation of the number of redds to spawning adults. Al-Chokhachy et al (2005) compiled information from several Columbia River core populations and found a simple average of 2.68 spawning adults per redd. Similar research in the Flathead Basin (Fraley and Shepard 1989) used a conversion factor of 3.2 adults per redd. To err on the side of caution, the Service will utilize the lower expansion factor of 2.68 adults per red.

The next step is to estimate the number of subadults that dwell in the lake. This will be derived by back-calculating cohorts from the number of adults. Fraley and Sheppard (1989) provide age of spawning adults in a 1983 study from 57 individuals collected in the Swan River Valley. They found 33 percent of the spawning fish were age 5, 35 percent were age 6 and 34 percent were ages 7 through 9. The age at maturity is not known and thus it seems likely that some older fish (such as age 7) may have already spawned once. To err on the side of caution, the most conservative approach is to assume that 33 percent of age 5 fish in Swan Lake are sexually mature but 100 percent of fish age 6 and up are sexually mature.

The number of subadult Bull Trout (ages 3, 4, and some of 5) is now back-calculated using an annual survival rate. Donald and Alger (1993) study of 7 lakes with Bull Trout (and no Lake Trout) found a mean annual mortality rate of 0.28, which implies a 0.72 annual survival rate. Al-Chokhachy and Budy (2008) study of fluvial Bull Trout in Oregon found a range of 0.55 to 0.75 annual survival rate, depending on cohort and year. The Service will use 0.72 annual survival rate because Donald and Alger (1993) study is on adfluvial populations and yet it still falls within range of Al-Chokhachy and Budy (2008). Thus, the number of age 5 adults/0.72 = number of age 4 and number of age 4/0.72= number of age 3 and so forth.

The next step is to remove age 3 from calculation. While these Bull Trout are exposed to Lake Trout mortality, they are seldom captured in gill nets. Thus, unless suppression methods change and begin to catch age 3 Bull Trout, all age 3 fish are removed from β. This yields a lower, more conservative maximum allowable bycatch.

The final step is to compute the mortality associated with Lake Trout against the population estimate. Donald and Alger (1993) reported a 0.12 annual mortality increase over the baseline in control lakes without Lake Trout. These authors determined that because of diet overlap and lack of Bull Trout in Lake Trout stomachs, the primary source of mortality is due to competition between species. However, Meeuwig (2008) study of sympatric lakes in Glacier National Park did not find strong evidence of competition. Fishery biologists with Flathead Lake theorize the primary source of mortality is predation on subadult Bull Trout (Barry Hanson, Confederated

Salish and Kootenai Tribes, personal communication). Until best available science information determines otherwise, the Service will assume mortality is a combination of both. Subadult Bull Trout are assumed to be fully vulnerable to both competition and predation but, to err on the side of caution, adult Bull Trout are assumed not vulnerable. This yields a lower number and more conservative number of vulnerable fish. Therefore, this loss is expressed as:

*Age 4 and 5 Bull Trout in Year (x) * 0.12 = β in Year (x+1)*

Example: In 2015, 421 redds were observed in the Swan Lake core area tributaries. This year had a complete census and no correction for missing tributaries is needed. Employing the 2.68 expansion factor from 421 redds would equate to roughly 1,128 adults.

The 1,128 adults are then assumed to consist of 372 age-5 and 756 age 6-plus. Back calculating the subadults for both of these cohorts is done by dividing each year by 0.72. Table 1 below illustrates this.

Table 1. Estimation of Bull Trout dwelling in Swan Lake in 2015, based on that year's redd counts. All figures are rounded to whole numbers.

Cohort	Mature Adults	SubAdults		
		# of Age 3	# of Age 4	# of Age 5
Age 6	756	2025	1458	1050
Age 5	372	718	517	
Sum Population in Lake	***1,128***	***2,743***	***1,975***	***1,050***

Thus in 2015, if there were no Lake Trout, there would have been an estimated 5,768 subadult Bull Trout in Swan Lake (age 3-5). The 2016 gillnetting strategy was unlikely to capture any age 3 Bull Trout, so they are removed from the equation. All that is left to calculate β is to add in the Lake Trout associated mortality for ages 4 and 5.

3,025 age 4 and 5 Bull Trout in 2015 * 0.12 mortality rate = 363 = β for 2016

The 2016 Bull Trout bycatch mortality, ϕ, was 71. The 2016 maximum allowable limit of bycatch mortality, β, would have been 363. Thus, we conclude:

$\Phi < \beta$

And part of Objective 2 was met. The bycatch was less than what would have otherwise occurred due to Lake Trout associated mortality.

Appendix B

Mitigation Measures to minimize impacts to Common Loons.

The two main concerns for the Lake Trout suppression activities involve (a) disturbing active nest sites (activity close to nests may displace the birds causing the nest to fail) and (b) inadvertent mortality from bycatch of diving loons in the gill nets.

A. Disturbance to nesting sites:

Montana's Common Loon Conservation Plan (Hammond 2009) recommends avoiding human activity within ¼ mile of nesting loons. If loons are nesting during project implementation, every effort would be made to observe this buffer.

- Active nests would be identified as early in the spring as possible by the USFS. Floating nesting buoys would be deployed by USFS up to ¼ mile from the nest.

- Lake Trout suppression will not occur within the perimeter of the floating nest buoys from May 15 to June 30.

- Avoiding an active nest ¼ mile is recommended, however this is not practical on all lakes. If the ¼ mile active nest site buffer cannot be observed (due to narrow areas of the lake, for example), activities would occur in a manner that is as least disturbing to loons as possible. These may include travel at "flat wake" speed, maintaining the maximum distance possible while traveling through the area, or no netting within the ¼ mile buffer.

- If wildlife biologists determine loons are still occupying nesting sites after June 30, the Service will work closely with wildlife biologists to find alternatives such as extending the restriction, allowing limited work in high priority areas, or other plans.

B. Mortality in gill nets

If diving mortality occurs from bycatch in netting, collaborate with local wildlife staff and consider applying mitigations to reduce future mortality. It is noteworthy that no previous such incidents were recorded in Swan Lake despite nets being soaked for over 2,000 hours annually. Mitigations may include but aren't limited to:

- Applying colored net panel alerts to the gill nets to aid in net visibility near the float line
- Avoiding areas of high loon activity on the lakes
- Other site specific mitigations determined by the suppression team and wildlife staff

If a diving bird is caught and killed in a gill net the following information should be recorded and reported. Bird carcasses should be preserved and turned in to FWP:

- bird species
- presence of tags or bands - colors or serial numbers

- gillnet crew initials
- location of data sheet
- date set (and time if available)
- date pulled (and time if available)
- approximate location on the lake
- net length
- panel mesh size
- beginning lat/long of net
- ending lat/long of net
- shallow end depth/beginning depth
- deep end depth/end depth

Appendix C

Modeling future Bull Trout redds based on the Proposed Action

The objective of this exercise is to help understand and display the potential difference in anticipated Bull Trout population response between the No Action Alternative and the Proposed Action. Bull Trout populations are primarily monitored by redd counts. Therefore, the model's objective is to forecast how redd counts would change between the alternatives. The model is only intended to contrast alternatives. It is not purported to give an actual, precise forecast, but rather to give the reader an idea of the possible "best and worst case" scenarios. It is likely that the actual results from either the Proposed Action or the No Action Alternative would mimic the overall trends described here, but the numbers and magnitude of change may vary with either alternative. The model is incapable of factoring local (stream) population changes, compensatory mortality, stochastic effects such as drought or floods, or other factors not related to Lake Trout. So long as these factors are equal between alternatives, the model has value. The model is only capable of contrasting alternatives for Swan Lake. Insufficient information exists for Lindbergh and Holland Lakes.

The model is built on a Microsoft Excel spreadsheet. This appendix describes the assumptions and displays outputs in a table format.

Part One: Base construction of the model

The first step is to build a hypothetical number of Bull Trout age classes based on known redd counts, without any interactions from Lake Trout associated mortality or bycatch mortality. This model is only concerned with lake-dwelling age classes, which will be age 3+. As described earlier, the Service uses Donald and Alger (1993) study that denotes a 0.72 average annual survival rate in lakes without Lake Trout. Thus, the basic calculation to determine the number of age(x) individuals that will survive to age(x+1) is N (age x)*0.72 = N (age x+1).

The next part is to model the contribution of these age classes into spawner escapement. For simplicity, the model will track each cohort as one complete spawning group that spawns just once six years after they emerge as eggs. Fraley and Shepard (1989) found 33 percent of Swan River Valley Bull Trout spawning adults were age 5, 35 percent were age 6, 23 percent were age 7, 9 percent were age 8 and 1 percent were age 9. For simplicity, the model will remove age 9+ because they are rare. Because the age at maturity is not known, it is likely that older fish have already spawned once. Therefore, the model will assume that 33 percent of age 5 are mature spawners but 100 percent of age 6+ will spawn that year. The age 7 and 8 classes are more problematic to model. Bull Trout can spawn repeatedly over their lifespan but whether they do so annually or intermittently is largely a function of individual recovery and condition the following year (Johnston et al. 2007, Johnston and Post 2009). Furthermore, the sharp decline between age 7 and 8 observed by Fraley and Shepard (1989) does not reflect a reported 72 percent annual survival rate modeled by Donald and Alger (1993). Therefore, this model will estimate that 70 percent of age 7 successfully spawn but only 50 percent of age 8 spawn. Thus, the total spawner escapement is (age 5 * 0.33)+(age 6)+(age 7*0.7)+(age 8*0.5). As described earlier, the expansion factor of 2.68 adults per redds (Al-Chokhachy et al 2005) is then used to convert escapement to redds.

It is possible to then estimate a starting number of age 3 fish. There is no known model to estimate age 3 fish in a lake from spawner escapement three years prior. But with the constructed model, we can interject values until we find something that approximates a steady-state (in other words, the population remains stable) and the age 3 input equates the redd counts. Please note that the number of age 3 fish may not look like the calculations in Appendix A. That is because Appendix A needed to compute the number of fish in the lake while they are vulnerable to Lake Trout, while this exercise computes future redd counts. To test this, the cohort from year 2000 was compared to 2006 redds. These years were selected because they resemble the most stable period in the entire 1982-2018 redd count dataset in the Swan River Valley. In year 2000, there were 719 observed redds. Adding in streams that were missed that year (NF Lost and S Woodward) with a 10 year running average would expand that to 750 redds. In 2006, there were 656 (again missing NF Lost and S Woodward) and so that expands to 687 redds.

Using repeated process, if 2,300 was input to age 3, that yields 688 redds three years later. This is very close to the actual 2006 results. If input at 2,500, it yields 748 redds which is very close to 750 starting point. Therefore, a true steady-state value is redds/0.299. Henceforth, the number of age 3 fish is expressed as: Age 3 in Year x+3 = redds in year x/ 0.299

Cohort Year	Expand. Redds	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Spawning Adults	Predicted Redds	
2000	750	2300	1656	1192	858	618	445	1845	689	in year 2006
2000	750	2500	1800	1296	933	672	484	2006	748	in year 2006

Now that the model has a base steady-state equation, we can begin to experiment with the variables of Lake Trout associated mortality, bycatch mortality and recovery rate after Lake Trout are suppressed.

Part Two: The No Action Alternative

To build the No Action scenario, we only need to add in Lake Trout associated mortality. There would be no bycatch and no recovery in the No Action Alternative. As described earlier, Lake Trout associated mortality is assumed to be an added 0.12 annual mortality for age 3, 4 and 5 (Donald and Alger 1993). This added mortality is due to a combination of predation and competition. As the Bull

Trout grow into large sizes, it is assumed that they are no longer vulnerable to predation and probably have minimal competition. Therefore, Bull Trout that live beyond age 6+ are considered invulnerable. The table below shows the output of the model.

Year	Cohort	Actual Redds	Expanded Redd	Age 3	Age 3 Adjusted w LT Mortality	Age 4	Age 4 Adjusted w LT Mortality	Age 5	Age 5 Adjusted w LT Mortality	Age 6	Age 7	Age 8	Escapement	Predicted Redds
2019	2013	335	338	1130	995	716	630	454	399	288	207	149	657	245
2020	2014	428	433	1448	1274	918	807	581	512	368	265	191	841	314
2021	2015	421	421	1408	1239	892	785	565	497	358	258	186	818	305
2022	2016	351	354	1184	1042	750	660	475	418	301	217	156	688	257
2023	2017	355	358	1197	1054	759	668	481	423	305	219	158	696	260
2024	2018	299	302	1010	889	640	563	405	357	257	185	133	587	219
2025	2019	193	237	793	698	502	442	318	280	202	145	105	460	172
2026	2020	225	266	890	783	564	496	357	314	226	163	117	517	193
2027	2021	219	222	742	653	470	414	298	262	189	136	98	431	161
2028	2022	160	160	535	471	339	298	215	189	136	98	71	311	116
2029	2023		260	868	764	550	484	348	307	221	159	114	504	188
2030	2024		219	732	644	464	408	294	259	186	134	97	425	159
2031	2025		172	575	506	364	320	231	203	146	105	76	334	125
2032	2026		193	645	568	409	360	259	228	164	118	85	375	140
2033	2027		161	538	474	341	300	216	190	137	99	71	313	117
2034	2028		116	388	341	246	216	156	137	99	71	51	225	84
2035	2029		188	629	554	399	351	253	222	160	115	83	366	136
2036	2030		159	531	467	336	296	213	188	135	97	70	308	115
2037	2031		125	417	367	264	232	167	147	106	76	55	242	90
2038	2032		140	468	412	296	261	188	165	119	86	62	272	101
2039	2033		117	390	343	247	218	157	138	99	71	51	227	85
2040	2034		84	281	248	178	157	113	99	72	52	37	163	61
2041	2035		136	456	402	289	254	183	161	116	84	60	265	99
2042	2036		115	385	339	244	215	155	136	98	70	51	224	83
2043	2037		90	302	266	191	168	121	107	77	55	40	175	65
2044	2038		101	339	298	215	189	136	120	86	62	45	197	73

The first year of the No Action (2023) starts with the cohort that came from redds constructed in 2017. In 2017, the expanded number of redds (if there was a complete census) would have been 358. As described above, this yields 1,151 age 3 fish. But with the added Lake Trout associated mortality of 0.12, the number of age 3 fish are henceforth 1,197 as shown in the orange columns. The same reductions take place with age 4 and 5. Ages 6-8 retain the base 0.72 survival rate since they are assumed invulnerable. Escapement sums up all the potential spawning adults in year 2023 using the formula described earlier. This results in 245 redds in the fall of 2023, shown in the purple column. From 2023-2028, all the beginning cohort redd counts are known. Year 2029 is the first year where we estimate production. This comes from the purple column estimate from 2023. As shown on the table, the model simply inputs the redd counts estimated from six years prior and then runs the cohort.

Part 3: The Proposed Action Alternative

This alternative now adds bycatch mortality and gradual recovery. Learning from experiences from the 2009-2016 project, biologists have been able to minimize Bull Trout bycatch (but not eliminate) by adjusting net sizes, deployment locations, soak times, and improving handling procedures. The final year of the project, 2016, was arguably the best success and thus this rate would be used henceforth. In 2016, Bull Trout bycatch was 132, of which the mortality was assumed to be 71 (see Appendix A). But not all 71 fish would have been mature adults. The model needs to be able to estimate bycatch that inadvertently kills mature fish. Reviewing records of 1,865 Bull Trout captured in gill nets from 2007-2012, we find that 815 of these fish were greater than 400mm. Leathe and Enk (1985) observed that all spawning fish in the Swan Valley in their study were at least 400mm. Thus 815 fish out of the 1,865 fish captured would have been mature adults, a 43.9 percent rate. Thus, a 43.9 percent rate of 71 bycatch mortality in 2016 would have equated to 31 mature adults lost to bycatch mortality. The remaining 40 Bull Trout would have been juveniles from age 3-5. Some of these juveniles would have otherwise survived and eventually become adults. The model assumes that 60 percent of juveniles would have survived (the remainder lost to natural mortality). Adding 60 percent from the 40 juveniles along with the 31 adults yields an estimated 55 Bull Trout that perished in 2016 bycatch that would have otherwise spawned. In 2016, biologists observed 351 redds in an incomplete census. If that was fully expanded, it would have been 360 redds. Using the 2.68 ratio of adults to redds as described earlier, that equates to 965 adults. Thus the 2016 bycatch resulted in 55 adult mortalities out of 965 adults, a 5.9 percent ratio. The model now applies a 0.059 mortality to the estimated number of adults for each year of active suppression. This is shown in dark gray. The model assumes that suppression would cease around year 2034, when Lake Trout are at a tolerable abundance. Subsequent monitoring and maintenance work would yield about 10 Bull Trout bycatch mortality per year (shown in light gray).

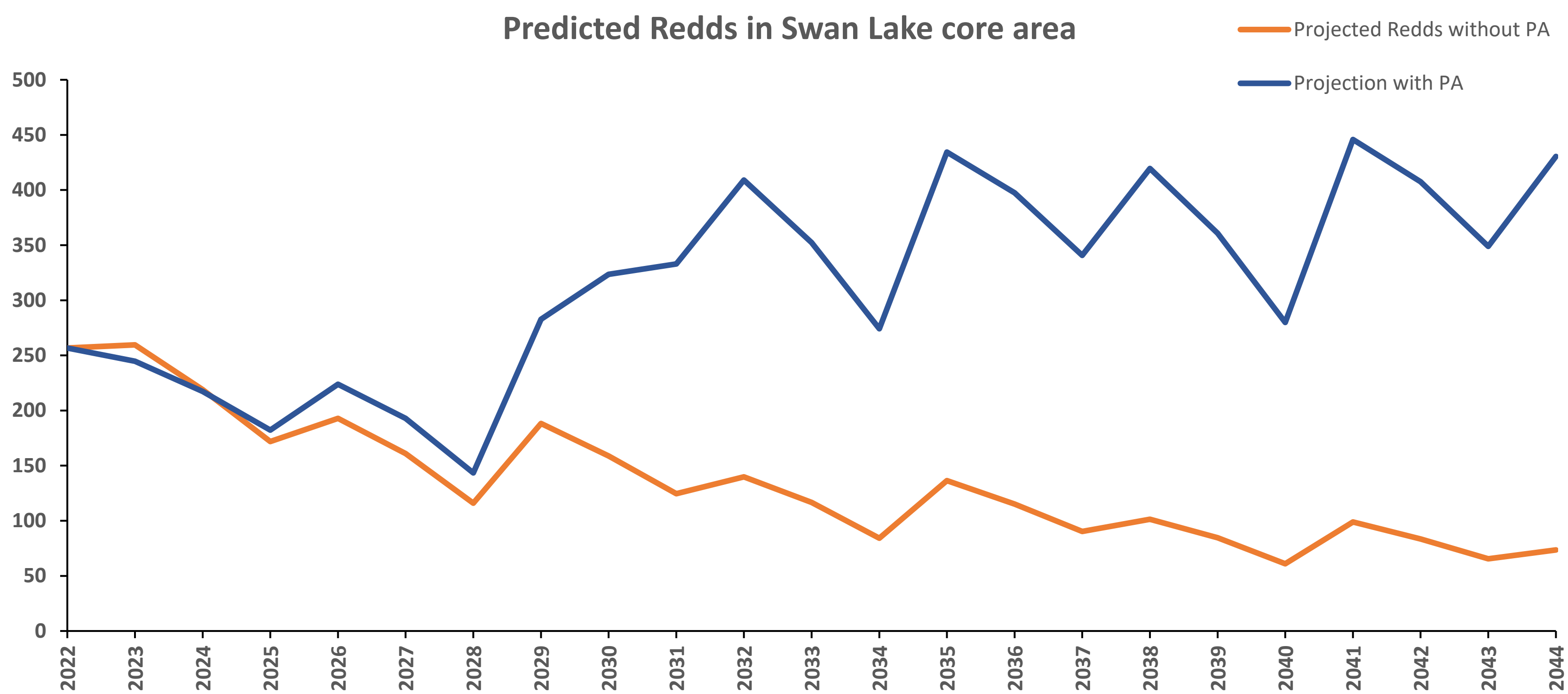
During the first year of suppression, the model assumes no immediate benefit. Age classes 3-5 would continue to experience the same 0.12 Lake Trout associated mortality. These are still shown in orange color as the No Action Alternative. However, beginning in 2024, the model assumes a gradual easement of Lake Trout associated mortality. The first benefit would be from age 5 classes. The model simply cuts the Lake Trout associated mortality in half to 0.06 annual mortality (shown in Yellow). The magnitude of this reduction is speculative in that we do not have a clear understanding at what level the Lake Trout associated mortality will decrease. However, this is an attempt to visualize the possible "best and worst case" scenarios of the Proposed Action and No Action Alternative, respectively, and it is not meant for purposes of precise modeling. The younger fish (age 3-4) would still be encumbered by the large Lake Trout cohort reproduced during the no action years of 2017-2023. By 2025, the age 4 cohort begins to experience some benefit and finally by 2026, age 3 benefits as well. The model assumes that the reduced Lake Trout mortality rate would then half again after two years. Thus by 2026, the age 5 fish now only experience 0.03 Lake Trout associated mortality (shown in Green) and this benefit gradually appears over time. By 2028, all age classes' benefit from reduced Lake Trout associated mortality. The year 2029 should be the first evidence of positive trend. Age 3 fish in year 2029 would have benefitted from six years of aggressive Lake Trout suppression and would have improved survival rates. The Swan Lake Bull Trout population has already demonstrated its ability to strongly recover. The population increased from 298 redds in 1990 to 833 redds in 1997, an average of 30 percent annual growth. Given that at least some Lake Trout will remain, the model conservatively estimates an annual growth of 20 percent for 7 years. These are factored into the blue color working stepwise through each cohort over time. After this the population growth would plateau. The model shifts to a steady-state mode where age 3-5 fish have neither Lake Trout associated mortality or further growth.

The following table reports the Proposed Action model. The formulas for the color cells are described above.

Year	Cohort	Actual Redds	Expanded Redd	Age 3	Age 3 after LT mortality or recovery	Age 4	Age 4 after LT mortality or recovery	Age 5	Age 5 after LT mortality or recovery	Age 6	Age 7	Age 8	Spawning Adults	Minus ByCatch of Adults	Escapement	Predicted Redds
2019	2013	335	338	1130	995	716	630	454	399	288	207	149	657	0.00	657	245
2020	2014	428	433	1448	1274	918	807	581	512	368	265	191	841	0.00	841	314
2021	2015	421	421	1408	1239	892	785	565	497	358	258	186	818	0.00	818	305
2022	2016	351	354	1184	1042	750	660	475	418	301	217	156	688	0.00	688	257
2023	2017	355	358	1197	1054	759	668	481	423	305	219	158	696	39.65	656	245
2024	2018	299	302	1010	889	640	563	405	381	274	198	142	618	35.21	582	217
2025	2019	193	237	793	698	502	472	340	320	230	166	119	518	29.51	488	182
2026	2020	225	266	890	836	602	566	408	395	285	205	148	636	36.27	600	224
2027	2021	219	222	742	698	503	487	351	340	245	176	127	548	31.23	517	193
2028	2022	160	160	535	519	374	363	261	253	182	131	94	408	23.23	384	143
2029	2023		245	819	1023	737	715	515	499	359	259	186	803	45.79	758	283
2030	2024		217	727	909	654	818	589	571	411	296	213	919	52.40	867	323

2031	2025		182	609	762	548	685	494	617	444	320	230	946	53.93	892	333
2032	2026		224	749	936	674	842	607	758	546	393	283	1163	66.27	1096	409
2033	2027		193	645	806	580	725	522	653	470	338	244	1001	57.07	944	352
2034	2028		143	480	600	432	540	388	486	350	252	181	745	10.00	735	274
2035	2029		283	945	945	681	851	613	766	551	397	286	1174	10.00	1164	434
2036	2030		323	1082	1082	779	779	561	701	505	363	262	1075	10.00	1065	397
2037	2031		333	1113	1113	802	802	577	577	416	299	215	923	10.00	913	341
2038	2032		409	1368	1368	985	985	709	709	511	368	265	1134	10.00	1124	420
2039	2033		352	1178	1178	848	848	611	611	440	317	228	977	10.00	967	361
2040	2034		274	917	917	660	660	475	475	342	246	177	760	10.00	750	280
2041	2035		434	1453	1453	1046	1046	753	753	542	390	281	1205	10.00	1195	446
2042	2036		397	1329	1329	957	957	689	689	496	357	257	1102	10.00	1092	408
2043	2037		341	1140	1140	821	821	591	591	425	306	221	945	10.00	935	349
2044	2038		420	1403	1403	1010	1010	727	727	524	377	272	1164	10.00	1154	430

The results of the estimated number of redds for both the No Action and the Proposed Action are in the right column (purple). These are then graphed to compare the differences between alternatives, below.


Predicted Redds in Swan Lake core area
Projected Redds without PA
Projection with PA
500
450
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