Chapter 2.0: Proposed Action and Alternatives

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This chapter describes the alternatives being considered to meet the need, summarizes how environmental consequences differ among alternatives, and compares each alternative's potential to satisfy BPA's purposes as outlined in Chapter 1. BPA is considering the following alternatives:

Alternative A: No Action—MFWP continues to manage westslope cutthroat populations as they are currently managed, including current fish stocking practices, angling regulations, and future fish stocking. BPA makes no effort to affect the westslope cutthroat population in the South Fork.

Alternative B: Proposed Action—Use motorized/mechanized and non-motorized/non-mechanized means to access all project sites and to apply fish toxins to remove hybrid trout from designated lakes and designated portions of outflow streams. These designated lakes and streams would then be restocked with genetically pure westslope cutthroat trout.

Alternative C: Use motorized/mechanized means to access all project sites and to apply fish toxins to remove hybrid trout from designated lakes and designated portions of the outflow streams. These designated lakes and streams would then be restocked with genetically pure westslope cutthroat trout.

Alternative D: Use gill netting or other mechanical means of fish removal to suppress hybrid trout populations in designated lakes and, where possible, in designated streams. An intensive "genetic swamping" program would then be implemented.

This chapter also describes other suggested alternatives that have been eliminated from detailed consideration for technical or economic reasons (see section 2.7, Alternatives Considered and Eliminated from Detailed Study). It concludes with a comparative analysis of BPA's alternatives. This analysis provides an overview and introduction to more detailed information presented in Chapter 3.

2.1 History

With the exception of Doctor Lake, most of the lakes in the higher elevations of South Fork drainage were likely fishless before settlers of European origin inhabited the area.

Over time, these lakes were stocked to provide food sources and angling opportunities. Comprehensive genetic testing of South Fork Flathead trout populations began in the mid 80's. A number of non-native trout populations were confirmed by these tests. In 1985, MFWP started a management concept that involved stocking these non-native populations with high densities of genetically pure westslope cutthroat trout on a frequent or annual basis in an effort to reduce non-native genes to a non-detectable level. This management concept later became known as genetic swamping. It was estimated that this management tool would take 40 years to be effective. This method of management *has* increased the percentage of westslope cutthroat genes in some populations; however, some lakes still contain fish with non-native genes. Therefore, a more decisive program to remove the non-native fish and support the genetically pure westslope cutthroat trout populations in the South Fork is being proposed.

2.2 Scope of Project

At the time of the preparation of this DEIS, 21 specific lakes and their designated stream segments are targeted for treatment. A table summarizing information about those lakes and streams is included below. Additional information about the sites including location, size, specifics about the methods of and procedures proposed for treatment can be found in appendix C. Although there is no specific information indicating other hybrid lakes and streams are present in the South Fork, if any other lakes and streams in the South Fork Flathead are discovered, at some time in the future to contain hybrid trout, these would also need to be treated. A list of lakes currently under consideration follows:

- Black
- Blackfoot
- Clayton
- George
- Handkerchief
- Koessler
- Lena
- Lick
- Lower Big Hawk
- Lower Three Eagles (genetic analysis pending)
- Margaret
- Necklace Chain of Lakes ("Smokey Creek Lakes")– total of four
- Pilgrim
- Pyramid
- Sunburst
- Upper Three Eagles
- Wildcat
- Woodward

The determination to treat lakes and streams other than the 21 listed above would be made only if hybridization was determined through genetic analysis. Once hybridization is confirmed, the proposed method of treatment and transportation method would be made based on the following criteria:

- The method of fish removal would include one of those listed in Alternatives B, C, or D; and would be determined by the size and complexity of the project, whether or not any stream segments would require hybrid trout removal, and whether or not sensitive fish species occur in the lake or stream.
- The transport method to the lake would be determined based on land management classification (i.e., wilderness, hiking area, national forest).

BPA would either supplement the existing EIS or prepare a tiered ROD. The public will be notified by utilizing BPA's mailing list for this project. FS would either utilize the supplement prepared to make the appropriate decision or develop a tiered ROD. Under the Administrative Rules of Montana, Title 12 (12.2.445[2]), MFWP would likely prepare a separate ROD. MFWP would utilize the media for announcing the availability of the additional environmental documentation.

2.2.1 Proposed Transportation Method

Conditions under which specific methods of transportation would be selected:

- In all cases, the allowable method of transportation that can be functionally used in a specific area with the least environmental impact would be selected.
- Hiking/Livestock would only be used in areas than can be accessed by system trails.
- Helicopter access would be used in wilderness and non-wilderness areas.
- SEAT aircraft would only be used in non wilderness areas, and would be used when needed to carry and apply large quantities of chemicals.
- The use of helicopters for the transportation of materials, personnel, and equipment would be determined by a lack of appropriate system trail access, and regulations prohibiting the use of livestock.

2.2.2 Proposed Treatment Method

Based on the project proposal, public scoping, analysis of comments, and recommendations contained in this document, fish toxins would be the preferred treatment method, as it is the most reliable and provides the shortest duration of environmental impacts. Although there are no other foreseeable conditions that would prevent implementing fish removal by toxins, it may be necessary to evaluate other possible lake and stream hybridization problems on a case by case basis. Reasons that another treatment method may be considered include:

- Sensitive fish species occur in the lake or stream.
- Any one method may produce too great of an environmental impact.
- The cost of treatment with fish toxins may be prohibitive due to the size of the lake.
- If unanticipated or unforeseen limitations occur with the fish toxin proposed, this may warrant consideration of using the other toxin. For example if **photolosis** of antimycin in large lakes is too rapid, rotenone would be considered to achieve the desired objective.

2.3 Alternative A: No Action or Status Quo Management

Of the 355 lakes in the South Fork drainage above Hungry Horse Dam, 50 are known to have fish. Only 28 of these lakes have genetically pure populations of native westslope cutthroat. The remainder either has hybrid populations (confirmed through the University of Montana's Wild Trout and Salmon Genetics Lab) or are still under investigation to determine their status.

The No Action alternative would maintain current management practices, providing no means to prevent hybrid trout from moving downstream to pioneer new areas. These hybrid trout would continue to compromise the genetic integrity of the genetically pure westslope cutthroat trout by interbreeding, and would likely create new hybrid populations in the South Fork Flathead drainage. If Alternative A: No Action is implemented, hybridization would continue to threaten the genetic purity of the westslope cutthroat populations and could also lead to future restrictions on angling, affect angling opportunities, and management of this species. The No Action alternative could also lead to a Westslope Cutthroat ESA listing and more severe restrictions for all activities affecting the species in the subbasin.

Currently, in general terms, management goals of fisheries in the South Fork focus on the following (MFWP 1991a):

- Maintaining self-sustaining fish populations
- Preventing hybridization of native species
- Maintaining and improving the genetic integrity of westslope cutthroat trout
- Emphasizing high quality fisheries over harvest size
- Managing fisheries consistent with wilderness management guidelines

To accomplish these management goals, MFWP stocks westslope cutthroat trout where needed. Most stocking occurs on a rotational basis, generally in one to five year intervals.

For the foreseeable future, stocking genetically pure fish on a “frequent or annual” basis would likely continue as a management practice, though management goals or administration may change.

2.4 Alternative B: (Proposed Action) Fish Toxins–Combined Delivery and Application Methods

Under the Proposed Action, all fish would be removed from selected lakes and designated portions of their outflow streams in the South Fork of the Flathead that harbor hybrid species that threaten to enter and genetically contaminate streams leading from those lakes, down into the Flathead River and Hungry Horse Reservoir. The piscicides rotenone and antimycin would be used to remove these fish.

The size and volume of these lakes and the quantity of the piscicide needed to treat them has already been measured and calculated. The downstream treatment distances and boundaries have been determined based on past genetic tests, natural barriers such as waterfalls, and the presence of bull trout populations. Calculating the amount of piscicide necessary to treat stream segments would be conducted prior to treatments, and would be based on up-to-date flow measurements and on-site assays. This amount would be small compared to the amount needed for each lake. The piscicides, equipment, and licensed applicators would be transported by livestock, or flown in by helicopter and/or by fixed-wing aircraft. After personnel and material transport is completed, the anticipated time to implement the application on each lake is one day, but may vary depending on unforeseen circumstances. Equipment, materials, and staff would be packed up and removed from the area beginning on the day after the lake treatment. Afterwards, additional personnel would evaluate the lake and collect and measure fish. Stream segments would be treated as necessary to accomplish the downstream goals, and is expected to require one day for setup of **drip stations**, caged fish monitoring stations, and **detoxification stations**; one day for treatment; and several days for detoxification and clean-up. All of these time estimates would vary based on the transport method used, the size and complexity of each project, and site conditions.

Before the re-stocking of fish occurs, MFWP would install sentinel fish cages in each lake to determine if water conditions are appropriate. If so, the lake and stream would be stocked in order to establish genetically pure cutthroat populations in sufficient quantities to ensure domination over any hybrid fish that might remain, and to re-establish the fishery. MFWP would determine future stocking amounts and frequency on a case-by-case basis.

Monitoring of the restocked fish would continue for several years to determine population viability and associated characteristics; to determine program success such as presence; and degree of natural reproduction, genetic purity, angling quality, and growth rates of fish. Lessons learned from these evaluations would be applied to succeeding applications on other lakes. Many of these lessons have already been learned on previous rotenone treatments in the Flathead Basin, contributing to the refinement of safety and technical procedures and the promotion of successful projects. Appendix D provides background detail on the application of rotenone and antimycin, along with their characteristics and historic uses. Table 2-1 below lists the lakes currently being considered for treatment, along with transportation and treatment strategies.

Table 2-1. Lakes proposed for treatment, length of designated outlet stream that would also be treated, and detoxification measures.

Lake	Land Use*	Proposed Treatment Method	Proposed Method of Transport for Personnel, Materials, and Equipment	Outlet Streams or Waters Proposed for Treatment	Detoxification Measures
Wildcat	JBHA	Antimycin	Helicopter	Unnamed pond directly downstream of lake and 1 mile of stream below it.	Use caged fish and potassium permanganate
Clayton	JBHA	Rotenone	SEAT, Helicopter	4.52 miles of stream between the lake barrier and waterfall.	Use caged fish and potassium permanganate
Blackfoot	JBHA	Rotenone	Helicopter	5.76 miles of Graves Creek flowing out of Blackfoot Lake to Handkerchief Lake.	Use caged fish and potassium permanganate

Black	JBHA	Rotenone	SEAT, Helicopter	6.09 miles of stream between Black and Handkerchief Lakes.	Use caged fish and potassium permanganate
Handkerchief	FNF	Antimycin	Truck (lake is accessible by road)	0.5 mile of Graves Creek upstream of lake, and 1.33 miles of stream between the lake and Hungry Horse Reservoir.	Use caged fish and potassium permanganate
Upper Three Eagles (Would be treated concurrent with Lower Three Eagles.)	JBHA	Rotenone	Helicopter	Treated lake water would be allowed to flow downstream, and hybrid trout in the stream would be removed between Upper & Lower Three Eagles Lakes.	Use caged fish and potassium permanganate
Lower Three Eagles	JBHA	Rotenone	Helicopter	2.23 miles of stream to the confluence of Graves Creek.	Use caged fish and potassium permanganate
Pilgrim	JBHA	Rotenone	SEAT & Helicopter	3.27 miles of stream between the lake and the Aeneas-Graves confluence.	Use caged fish and potassium permanganate
Lower Big Hawk	JBHA	Rotenone	Helicopter	2.97 miles of stream between the lake & Graves Creek confluence.	Use caged fish and potassium permanganate
Margaret	FNF	Rotenone	SEAT & helicopter	3.0 miles of stream between the lake & road 895 crossing.	Use caged fish and potassium permanganate

Sunburst	BMW	Antimycin	Livestock	6.1 miles of stream between the lake & the waterfall near Feather Creek.	Use caged fish and potassium permanganate
Woodward	BMW	Antimycin	Livestock	2.96 miles of stream between the lake & Cataract/Big Salmon Creek confluence.	Use caged fish and potassium permanganate
Necklace Chain of Lakes (Smokey Creek Lakes)	BMW	Antimycin	Livestock	Stream segments between the lakes; 2.1 miles of stream between Lower Necklace & Cataract/Big Salmon confluence.	Use caged fish and potassium permanganate
Lena	BMW	Antimycin	Livestock	4.25 miles of Big Salmon Creek between Lena & Cataract Creek confluence.	Use caged fish and potassium permanganate
Lick	BMW	Antimycin	Helicopter	3.7 miles of stream between the lake & rock waterfalls near the Doctor Creek confluence.	Use caged fish and potassium permanganate
Koessler	BMW	Antimycin	Livestock	Treated water will flow from lake to the Doctor Creek confluence.	Use caged fish and potassium permanganate
George	BMW	Antimycin	Helicopter	3.92 miles of stream between the lake and waterfall near its mouth.	Use caged fish and potassium permanganate

Pyramid	BMW	Antimycin	Livestock	Small pond downstream from the lake; 3.3 miles of stream between the lake & Youngs/Devine Creek confluence.	Use caged fish and potassium permanganate

JBHA = Jewel Basin Hiking Area; FNF = Flathead National Forest; BMW=Bob Marshall Wilderness

Based on past experience, piscicide treatments offer the best probability of complete fish removal. However, there have been instances where unforeseen circumstances have required implementing a second treatment to reach project goals. As a measure of treatment success, MFWP would conduct a post treatment survey, which may include netting and observation. Complete success would be defined as no detectible fish. If fish are detected, a second treatment may be implemented to reach project goals. The resultant action stemming from each post treatment evaluation would be considered on a case-by-case basis.

2.4.1 Piscicide Use

2.4.1.1 Background

MFWP has the statutory authority to manage (MCA 87-1-201) and/or restore (MCA 87-1-207) the fishery resources of Montana, specifically to prevent any species from being listed as **endangered** under the federal ESA. Furthermore, it is within the state's purview to stock fish into waters designated as sustainable fisheries, or into those waters where it is necessary to achieve the management goals identified under the above statutes to prevent a species from being listed as endangered.

From 1948 through 2001, MFWP has administered 74 rotenone applications on 63 lakes in the Flathead Basin. Seven of these lakes (11 percent) have required multiple treatments. Reasons for multiple treatments include: survival of unwanted fish in untreated areas (springs, tributaries, etc.); inability to completely remove the source of unwanted fish; or the illegal introduction of a fish species following a treatment. In some of these examples, complete removal has not been an objective of rotenone treatments. Rather the objective has been to reduce unwanted fish to improve angling. Hubbart Reservoir, west of Kalispell, is one such water body that has been treated four times since 1958 to restore quality trout and salmon angling at 12 to 15 year intervals.

The target species from these aforementioned seven lakes have been among the least sensitive to rotenone and include: pumpkinseed sunfish, northern pikeminnow, black bullhead, red-side shiner, yellow perch, largemouth bass, coarse scale sucker, longnose sucker, finescale sucker, and peamouth. Brook trout and rainbow trout are the other species removed from some of these lakes. The average length of time between repeat treatments has been 19 years; and ranges from 8 to 36 years. The number of lakes treated with rotenone in the Flathead Basin represents only 12 percent of the 505 lakes that MFWP considers as managed fisheries in this area.

Piscicides have been used successfully to remove non-native trout from lakes that occur in the project area. In 1986, the East, West, North, and South Jewel lakes were treated with rotenone to remove populations of rainbow trout. In 1994, Devine Lake (located in the Bob Marshall Wilderness) was treated with rotenone to remove the only known population of brook trout from the South Fork drainage. In 2000, Tom Tom Lake was treated with rotenone to remove hybrid trout. All six lakes were restocked with genetically pure westslope cutthroat trout.

2.4.1.2 Rotenone

Rotenone is a compound registered with the U.S. Environmental Protection Agency (EPA) that is used to remove undesirable fish from bodies of water. This compound is extracted from the roots of tropical plants. These roots have been used for centuries by South American natives for a variety of purposes, including capturing fish for food (Gleason, et al. 1969; Teixeira, et al. 1984). The compound was first isolated in 1895, and its chemical structure was established in 1933 (Haley 1978).

Fish managers in North America began using rotenone to manage fish populations in the 1930's. By 1949, 34 states and several Canadian provinces were using rotenone routinely for management of fish populations (Finlayson, et al. 2000). Rotenone is also used as a natural insecticide for gardening and agricultural purposes. Haley (1978) reported that it has been used in humans to control intestinal worms.

Rotenone acts by interfering with cellular respiration in gill-breathing animals. It is particularly effective with fish because it is quickly assimilated into the blood stream through the single cell layer of the gills. Formulations of rotenone products are manufactured (under the brand names Noxfish®, Nusyn-Noxfish®, Prenfish®, and others) and shipped in two different forms: powdered and liquid. For this project, liquid rotenone would be the preferred formulation. Powdered rotenone would have to be mixed at the site with a cement mixer, requiring an auxiliary power source, respirators, protective suits, and additional time to perform the mixing.

Typical dosages of rotenone-based formulations administered to kill fish, range from 0.5 to 6 parts per million (ppm) depending on the species (Gilderhus 1972; Grisak, et al. 2002; Finlayson, et al. 2000). Trout typically require low dosages of 0.5-1 ppm whereas more resilient species like carp and bullhead require dosages of 4-6 ppm. Both fish and aquatic invertebrates (Rach, et al. 1988) are highly susceptible to rotenone. Insects and plankton that are affected by rotenone recover within short periods of time, generally within weeks to months. Bills, et al. (1988) reported that no rainbow trout eggs died from exposure to rotenone.

Rotenone naturally degrades within one to four weeks, depending on water pH, water temperature, alkalinity, ultraviolet light, and dilution by fresh water (Schnick 1974b). Detoxification may be hastened with the addition of a neutralizing agent such as potassium permanganate (Engstrom-Heg 1971, 1972, 1976). For more detailed information on rotenone and its characteristics and uses, see appendix D.

2.4.1.3 Antimycin

Antimycin is an EPA registered chemical under the brand name Fintrol®. It was first discovered in 1945 at the University of Wisconsin as an antifungus treatment for plants (Leben and Keitt 1948). It is a product derived from the fermentation of a species of *Streptomyces* bacteria (Romeo 2002). It has been used in Japan for the control of fungus on rice (Harada, et al. 1959) and is an extremely potent fungicide (Dunshee, et al. 1949).

Antimycin works by inhibiting cellular respiration only in selected organisms. In 1963, Derse and Strong found that it was extremely toxic to fish in much lower concentrations than typically used to control plant diseases. It has been used for over 35 years in commercial aquaculture to kill scaled fish in catfish ponds (Finlayson, et al. 2000). Walker, et al. (1964) reported that trout were extremely sensitive to antimycin, but several plankton and aquatic insects were affected by concentrations much higher than those used to kill fish. Callaham and Huish (1969) reported that zooplankton were severely depleted by antimycin, but began to reappear within 6-9 days, and bottom insects were not affected. Fish are particularly sensitive to antimycin because their gill membranes are only one cell layer thick, which allows for the rapid transfer of it into the blood stream where it ultimately disrupts the electron transfer at the cellular level in vital organs (Schoetteger and Svendsen 1970). This is accentuated in trout because their high oxygen demand requires the movement of a high volume of water across their gills. Different species of fish manifest a different resiliency to the compound.

Antimycin is shipped by the manufacturer in two parts; one is the active ingredient antimycin A with some residual fats, and the second is the surfactant which consists of acetone and detergent. The two parts combined form one “unit,” 480 ml weighing 3.75 pounds.

The physical properties of antimycin make it beneficial for site-specific application. When applied to a stream, it loses much of its toxicity with every 200 feet of downstream elevation drop (Tiffan and Bergersen 1996; Romeo 2002). It detoxifies rapidly in a stream because of oxidation created by stream turbulence, interaction with organic substances on the stream bottom, and exposure to sunlight (photolosis). Numerous applicators have described the need to install drip stations at specified intervals to recharge a stream with antimycin in order to successfully carry out the treatment to the designated downstream boundary. This property also makes it an attractive tool in areas where a lake population is targeted and downstream populations are not. Non-target fish populations that occur downstream of a lake treated with antimycin may be safeguarded in this manner if this 200-foot elevation differential is met. In areas where non-target populations are within the 200-foot elevation zone, potassium permanganate has been used to detoxify antimycin (Stefferud, et al. 1992; Gilderhus, et al. 1969). In a stream treatment, more than 1 ppm potassium permanganate would be needed, due to the organic demand of the stream bottom, which reduces much of the compound before it can act with the antimycin.

2.4.1.4 Potassium Permanganate

Potassium permanganate is a strong oxidizer that breaks down into potassium, manganese, and water (Finlayson, et al. 2000). This compound is used in fish aquaculture to remove fungus and parasites, and to increase soluble oxygen in water, thus averting fish kills (Lay 1971). It can be used to detoxify both antimycin (Marking and Bills 1975) and rotenone (Engstrom-Heg 1972, 1976; Lay 1971). Although it is used in fish aquaculture to benefit fish and to neutralize fish toxin, it also can be toxic to fish. Marking and Bills (1975) reported that it is most toxic in low water temperatures, in hard water, and in high pH. Recent bioassays conducted by MFWP indicate that when applied at 1.5 ppm and greater, and with no other substances to oxidize with, it can achieve 100 percent mortality in westslope cutthroat trout after 16 to 24 hours of exposure (Grisak, et al. 2002). Fish exposed to concentrations less than 1.5 ppm survived. Grisak (2003b) found that tailed frog tadpoles and tailed frog adults exposed to 3 and 4 ppm caused 13 percent death at 16 and 24 hours exposure, respectively. No greater mortalities were observed after the 16-hour observation at 3 ppm. A hypothetical application of potassium permanganate might be 4.5 ppm, which includes 1.5 ppm to neutralize the fish toxin, and 3 ppm to account for the organic demand of the stream bottom.

Readily oxidizable substances rapidly decrease the activity of potassium permanganate (Marking and Bills 1975). These substances might include algae on a stream bottom, gravel, mud, leaves from trees, and soil. Applicators must be aware of the amount of time necessary for potassium permanganate and the oxidizing compound (rotenone or antimycin) to contact each other to facilitate detoxification. This time can range from 30 to 60 minutes depending on how fast the stream is flowing. Stream flow can be measured with a flow meter so applicators can calculate the distance a stream would flow over time. Potassium permanganate can detoxify these two compounds more quickly if higher concentrations are used. Typically, potassium permanganate is applied in streams at concentrations ranging from 2 to 6 ppm.

Potassium permanganate would be used to detoxify rotenone and antimycin applied to streams at designated boundaries below each lake. Detoxification drip stations would be monitored throughout the project until a time when caged fish survive below the treatment boundary for a period of 24 hours.

2.4.1.5 Sentinel Fish

Sentinel fish cages would be used in concert with potassium permanganate detoxification stations to evaluate the effectiveness of a treatment and to monitor the effectiveness of detoxification measures. Wild cutthroat trout captured from the target streams would be placed in cages at designated locations throughout the lake and stream drainages that are being treated. A surplus of sentinel fish would be kept at these sites in buckets on the shore in the event that first exposed fish die and more fish are needed for the evaluation. If local fish are not available, genetically pure hatchery westslope cutthroat trout would be used for sentinel evaluations.

2.4.2 Project Assessment and Preparation

Preparations for site-specific implementation would be conducted prior to any treatment. (A minimum of 21 lakes and associated stream segments located on the Flathead National Forest have been proposed for treatment. See appendix C for a detailed description of individual lakes.) Ideally, two to three lakes and the determined amount of each outflow stream would be treated each year over a 10 to 12 year period.

Prior to implementation, the genetic status of lakes would be confirmed through genetic analyses. (Volumetric testing has already been conducted and the amount of piscicide needed has been calculated for the proposed lakes. See figures in appendix C.) On-site assays and current flow measurements would be used to calculate the amount of piscicide and detoxification measures needed for each stream segment. Affected publics would be made aware of treatment times and places.

2.4.2.1 Genetic Testing

Genetic testing has been conducted on most of the lakes in the sub-basin. Confirmation of hybridization, through genetic analyses, has been the impetus for proposing these lakes for treatment. Genetic testing is conducted at the Wild Trout and Salmon Genetics lab at the University of Montana in Missoula.

Over the years, genetic testing methods have evolved with the growing demands and expanding uses for genetic analyses. The early stages of genetic testing in the South Fork Flathead involved the method of allozyme analyses, which was used by fish managers to identify pure populations for use in developing the state’s current westslope cutthroat trout hatchery brood stock. This method was later used to measure the progression of hybridization in select populations in the South Fork Flathead, including many of the lakes and streams listed in this proposal. In recent years, however, the methods of genetic testing have changed as have the management objectives for the South Fork Flathead. These changes have allowed different tests, like the PINE-PCR (Paired Interspersed Nuclear DNA Element--Polymerase Chain Reaction) analysis to be used to detect the presence of non-native genes in a population, rather than the percentage of non-native genes in a population. For the purposes of this project, all of the historic genetic tests and the newer PINE-PCR analyses have been used to determine the presence of non-native genes. Due to changing management objectives--primarily from one designed to increase the percentage of westslope cutthroat genes in a population by stocking pure cutthroat on a "frequent or annual basis," to one designed to completely eliminate non-native genes--the PINE-PCR analysis has been an adequate tool for measuring the presence of non-native genes in a population.

In 1986, tests at Upper Three Eagles Lake revealed that it contained Yellowstone cutthroat + westslope cutthroat hybrids (Sage 1993). These tests would be updated to determine whether changes have occurred. Because Upper Three Eagles drains into Lower Three Eagles, it is reasonable to conclude that the fish in the upper lake influence the genome of the fish in the lower lake. However, the lower lake will be sampled one final time to determine its status. Fish angled from Woodward Lake were recently tested and no non-native genes were detected. The lake will be resampled using gillnets in 2004 to confirm this result.

2.4.2.2 Lake and Stream Surveys

A crew would conduct a pre-treatment survey of each lake to map the number and location of surface water inflows and outflows, measure the flow rates, measure water chemistry and temperature, collect plankton samples, and make an estimate or determination of fish habitat features. Some of these surveys have already occurred. Amphibian surveys have been conducted on each lake and are ongoing. Lake **bathymetry** (depth measurement) and locational data have been collected using a handheld sonar device and a global positioning system (GPS) unit. A number of random depth measurements were recorded at GPS locations. These data were entered into a computer program that uses GPS and depth data to create a Triangulated Integrated Network (TIN) representing the lake volume. The program constructs a three-dimensional lake basin as a map and calculates lake volume (see appendix C).

Using this volumetric information, MFWP personnel calculated the proper amount of piscicide needed to remove fish from the lake. The piscicide must be applied at the proper concentration to treat the lake successfully. All calculations and procedures would be double-checked for accuracy by the designated application team prior to formatting the treatment plan for each lake and stream project. The team would then determine the appropriate time for treatment. Most of these projects would be implemented from late September to early November, depending on other, potentially conflicting activities in the area (e.g., spawning seasons, field surveys, and recreation), and weather conditions. Some of the lakes proposed in this project experience low outflow or no outflow during the fall of most years. Conducting treatments at this time would make containment much easier and safer, and would take advantage of lower volume pools. Treatment and detoxification of designated portions of outflow streams would still be required in areas where surface water exists.

Many of the designated streams have been surveyed to gather flow data, water inputs, geologic features, and fish community status. Those that have not yet been thoroughly surveyed would be surveyed in the future, and each stream would be surveyed again prior to any treatment.

Appendix C describes each lake, its associated streams, and the relative presence and distribution of bull trout downstream.

2.4.2.3 Pre-Treatment Plan

Before implementing, a treatment plan will be formulated for each specific lake and stream. The project would be separated into six plan categories each identifying personnel responsible for oversight of the plan and activities contained in each plan. The following are examples of activities that would be outlined in each plan.

(1) Lake treatment application materials management boat/pump maintenance drip stations at lake dead fish collection amphibian collection	(2) Stream treatment sentinel fish collection sentinel fish monitoring drip station spacing drip station monitoring dead fish collection stream flow measure amphibian collection	(3) Detoxification sentinel fish collection sentinel fish monitoring detox station spacing detox station monitoring colorimeter monitoring dead fish collection stream flow measure amphibian collection
(4) Materials management loading/unloading aircraft aircraft fuel	(5) Transport and safety livestock feed & water safety equipment first aid-humans/horses human food & water camp(s) maintenance trail closure/signing spill contingency plan emergency responders	(6) Monitoring water quality samples fish kill evaluation containment of treatment aquatic insects/plankton gill netting pre-treatment flow evaluation

The workers assigned to each area of responsibility would be supervised by an area leader who in turn would report to the project commander. The project commander oversees the entire project. Communication would be maintained by radio, telephone, satellite phone, and messenger.

Before treatment, MFWP fisheries biologists would assign personnel to these respective areas, and provide education and training. The pre-treatment plan would contain vital information on the proposed treatment including breaking the treatment area into zones and assigning personnel to their respective zone and area of responsibility.

In determining the dosage of piscicide needed, the project leaders would consider a variety of physical and biological factors; the most important being lake volume, fresh-water sources to the lake, pH level, elevation difference to downstream non-target fish populations, and proximity of non-target fish species.

Rotenone Dosage

Rotenone dosage is calculated based on a five percent rotenone solution, and is expressed as parts of this liquid formulation per million parts of lake water on a volume basis. One ppm is equivalent to one milligram per liter (1 mg/L). The most common dosages of rotenone formulation used in the lakes treated in Montana range between 1 and 4 ppm, depending on the species and water chemistry. The actual amount of rotenone needed is based on the calculated water volume of the lake (see appendix C). The amount of rotenone needed may be somewhat greater to account for treating freshwater inputs. In theory, rotenone added to freshwater inputs will be discharged into the lake and ultimately add the amount necessary to meet the target concentrations. The rotenone product label recommends using “0.5 to 1 ppm for normal pond use.” Based on assays conducted by MFWP, the target concentration for these lakes and stream segments is 1 ppm (Grisak, et al. 2002).

Antimycin Dosage

The recommended concentrations for lake application of antimycin range from 1 part per billion (ppb) (Derse 1963) to 10 ppb (Gilderhus, et al. 1969), depending on the species of fish. It has been used successfully to remove trout from high altitude lakes in the Mount Massive Wilderness/Rocky Mountain National Park at concentrations of 5 to 8 ppb (Rosenlund and Stevens 1992). The Fish Toxicant Kit Use Direction leaflet that accompanies the product label recommends using 5 to 10 ppb to remove trout. The target concentration for lakes in this proposal is 7.5-8 ppb, and would vary, depending on water chemistry. The amount of antimycin necessary to treat inflow and outflow streams would be determined based on a combination of the label prescriptions and on-site assays.

Potassium Permanganate Dosage

Potassium permanganate dosage is calculated by measuring the amount of organic demand of a stream using a colorimeter instrument, florescent dye, and flow meters to calculate stream discharge. After the amount of stream demand is determined, the appropriate amount necessary to neutralize the piscicide is added.

2.4.2.4 Permitting

Before treating a lake, MFWP must apply for and secure a 308 Permit from MDEQ. This permit would allow for a short-term exemption from surface water quality standards. MDEQ issues provisions to the permits that ensure the standards of the Water Quality Act would be observed.

- The activity must be conducted in accordance with the application.
- Application of antimycin and rotenone must be in compliance with the product label and in accordance with the provisions of the Montana Pesticide Act (Title 80, Chapter 8, MCA) [ARM 17.30.637(8)].
- Excess pesticides and pesticide containers must not be disposed of in a manner or location where they are likely to pollute state waters [ARM 17.30.637(8)].
- The pesticide must be applied by an applicator licensed by the Montana Department of Agriculture to apply restricted-use pesticides (ARM 4.10.313).

- Representatives of the Department of Environmental Quality (DEQ) must have reasonable access to the application site in order to inspect the site for compliance with the terms of this authorization (75-5-603, MCA).
- Signs must be posted at the trailheads, and the Forest Service's authorized outfitters in the area must be notified about the project. Signs must be in place until the project leader determines the pesticide has completely degraded [75-5-308(2), MCA].
- Within 90 days after the pesticide application, the MFWP must report the following information to the DEQ: 1) the amount and type of pesticide used, 2) the location where the pesticide was used, 3) the flow and/or volume of water treated in each lake, stream, stream segment, or tributary, 4) the volume of detoxification chemical used in each stream, stream segment, or tributary, and 5) the results of any chemical or biological monitoring performed [75-5-308(2), MCA].
- Since treatments are planned for lakes and the immediate downstream areas, detoxification will be required at locations designated by MFWP as lower project boundaries. However, to monitor the persistence of un-neutralized antimycin and rotenone, sentinel fish must be posted at designated locations based on stream flow times. If sentinel fish at the lowest site show signs of antimycin or rotenone toxicity, a neutralization station must be located as close as possible to the lowest location and be activated if needed. Sentinel fish at the lowest site will be used to monitor the effectiveness of antimycin and rotenone detoxification [75-5-308(2), MCA].
- Water velocity studies, using accurate instruments, must be performed before the project to determine chemical travel time and chemical application rates [75-5-308(2), MCA].
- The MFWP must notify MDEQ of its intent to apply pesticides at least seven days prior to the activity and within seven days after completion of the pesticide application.

2.4.2.5 Notifying the Public of Treatment Schedules

MFWP would notify the public of treatment schedules via newspaper ads and radio public service announcements. BPA would send a letter annually to its mailing list, including the Confederated Salish and Kootenai Tribes, the Blackfeet Nation, and the Kootenai of Idaho.

Outfitters and guides may be impacted economically when wilderness lakes are unavailable for a period of time due to removal of hybrid fish. Thus, MFWP would notify outfitters groups of the treatment schedule at least two seasons in advance. FS would work with these groups in advance to find alternative lakes that may be used until the lakes they normally use are fishable again. In addition, outfitters and guides planning to use an area during a scheduled treatment time would be notified and given the choice of using a different location or drainage.

2.4.3 Transportation of Staff, Materials, and Equipment to and from the Proposed Treatment Sites

Activities associated with this project are planned to comply with rules in designated wilderness areas and areas in the national forest that are set aside for hiking only. A minimum of six crew members would be used for each lake treatment. Crew size would increase with the size and complexity of each proposed lake. An additional number of personnel would be necessary for stream treatment, detoxification, and monitoring, and would vary depending on the size and complexity of each stream. A party size of 15 would not be exceeded within the wilderness. Pack strings would be broken into strings of 10 to 12 animals.

Treating a lake and stream in a remote location requires the conveyance of licensed applicators, the piscicide, potassium permanganate (the neutralizer applied after the piscicide), the equipment to mix and apply the piscicide, and camp materials. The material would be transported to the lake in one of three ways: livestock, helicopter, or fixed-wing aircraft; and equipment and personnel would be transported by hiking, livestock, or helicopter. Access to downstream areas for application and monitoring purposes would be by livestock or hiking. In wilderness areas, personnel and materials could be transported by livestock to all except two lakes--George and Lick Lakes, which have no maintained access trails, but do facilitate angling by cross-country users. In non-wilderness areas, personnel and materials could be transported by helicopter and, in the case of Handkerchief Lake, by truck. Downstream areas would be accessed at road crossings or by hiking. Single Engine Air Tanker (SEAT) aircraft could be used on non-wilderness lakes to transport and administer a large portion of piscicide to save transportation and application time, and to reduce the number of needed trips. Stock and pack animals are not allowed in the Jewel Basin Hiking Area nor are the trails maintained for such use. Thus, SEAT aircraft are proposed for use in the Jewel Basin.

The method or methods to be used at each lake depends on: (1) the amount and type of needed material, (2) the amount of equipment and required personnel, and (3) applicable land use restrictions.

2.4.3.1 Hiking/Livestock – Wilderness Areas

The use of livestock is a viable alternative in areas that have an improved trail. In 1994, livestock were successfully used to pack 10 gallons of rotenone, equipment, and personnel into the Bob Marshall Wilderness to remove brook trout from Devine Lake. Based on this action, pack stock could transport materials, personnel, and equipment to all lakes that are proposed for treatment that occur in wilderness areas with the exception of George and Lick Lakes, which do not have maintained trails. Lakes that occur on national forest lands outside of the wilderness (e.g., Jewel Basin Hiking Area and other areas) do not have improved trails that would support livestock use. Livestock are not allowed in Jewel Basin. Trails within Jewel Basin Hiking Area are not maintained to support livestock traffic, and livestock are not permitted.

As an example, the following description illustrates how pack animals would be used to navigate equipment, materials, and personnel in and out of the Pyramid Lake area. Similar logistics would be used for other lakes where only personnel would be able to access a candidate lake using pack stock on a maintained trail.

In this example, Pyramid Lake would be treated with antimycin. Access would be made over Pyramid Pass near the Town of Seeley Lake. The antimycin would be transported by livestock in sealed containers secured in reinforced wooden boxes. Manti tarps would be used to cover the boxes for greater protection during travel. The number of pack animals needed for any given treatment would be determined largely by the quantity of piscicide required to treat the lake, the number of personnel needed, and the time required to be at the site. A single pack animal could carry the 38 units (143 pounds) of antimycin. Pyramid Lake would require a total of 17 pack animals:

- One for the antimycin
- Up to six for the conveyance of people, depending on the mix of personnel riding or hiking in.
- Five for personal equipment, camp supplies, and livestock feed
- Five additional for boat motor, raft, drip stations, and miscellaneous equipment

These 17 animals would be separated into multiple pack strings. Travel from Pyramid trailhead to Pyramid Lake would take about 2.5 hours. This represents the least amount of stock needed for transporting materials.

2.4.3.2 Helicopter – Wilderness and Non-wilderness Areas

From 1986 to 2000, helicopters (Bell 47, a Bell 206, and a Hughes 500) were used to transport rotenone, personnel, and equipment to treat eight lakes in remote areas in the Flathead Basin. The helicopters that would be used most in this project would include two Bell OH58s and a Hughes 500. Loads of up to 800 pounds can be sling-loaded under these ships. Depending on air temperature and the amount of fuel onboard, the payload may be increased. An electronic cargo hook on each ship allows loads to be set at the worksite without landing. Each ship can transport three passengers per trip. One of the MFWP OH58 helicopters has floatation struts, making water landings possible. Given this capability, loads can be transported to lakes that do not have landing zones. The helicopter can also land on the water to drop off personnel and to pick up loads near the shoreline.

Photo courtesy of MWFP.

Figure 2-1. Bell OH58 helicopter at Birch Lake.

Helicopters have been used to dispense rotenone in small high mountain lakes (AFS 2002). A helicopter spray unit was used to apply rotenone to marshy areas of Rogers Lake, Montana in 1993. Although the project was successful, it has not been considered as a viable application technique since that time because rotor wash at this particular site caused excessive aerosolization of the rotenone and made application unsafe for personnel.

For Wilderness lakes with no trail access, administrative helicopter flights would be used to transport materials, equipment, and some personnel. Other personnel would hike or ride if feasible. Project managers would likely stage flights from the Condon airstrip, or other suitable sites near the Owl Creek trailhead. The helicopter flight protocol for treating wilderness lakes would be the same as that described above, but limited to the transport of materials, equipment, and limited personnel.

Because of the lack of trail access or regulations prohibiting the use of livestock, helicopters would be used to transport materials, personnel, and equipment to all lakes outside the Wilderness with the exception of Handkerchief Lake, which is accessible by vehicle. Flights into the lakes in the Jewel Basin area would be staged from the Ferndale Airport near the town of Bigfork. All materials would be brought to the airstrip by truck.

There are no major safety restrictions for wilderness or non-wilderness flights. However, the FWP OH58 is equipped with floatation struts for water landings and would minimize any potential for ground disturbance. Where possible, efforts would be made to avoid flying over camps and trails (see chapter 3, sections 3.8 Recreational Resources and 3.9 Socioeconomic Impacts).

The amount of weight a helicopter can carry per trip determines, in large part, how many trips would be required. Liquid rotenone is packaged in 30-gallon drums that weigh approximately 284 pounds each. The MFWP would likely use their Bell OH58 helicopters, which can carry two 30-gallon drums. The Montana Department of Natural Resources and Conservation (DNRC) have helicopters (Bell UH1) that may carry as many as seven, 30-gallon drums, at 1,988 pounds per trip. The DNRC ships are designated for first-attack fire-suppression, and would be available only if no fires were active. Commercial helicopters would be available, but at a much greater operating expense than that of state-owned ships. Appendix B gives estimates of the amount of piscicide that would be required for each lake.

A typical application using a helicopter for transport would require six people: one boat operator; two drip station installers; one detox station person; one spot sprayer; and one person to load barrels of rotenone, triple-rinse empty barrels, and load/unload cargo nets for the helicopter pilot. Additional personnel would be necessary to treat larger and more complex lakes and streams.

Table 2-2 below is an example of the round-trip flight sequence into Blackfoot Lake located in the Jewel Basin Hiking Area. Assuming rotenone is applied at one part per million (ppm), Blackfoot Lake would need an estimated 68 gallons and would require an estimated nine flights to execute the treatment procedure (see Table 2-2). All downstream applications and monitoring would be accessed by road and trails in the Graves Creek drainage.

Table 2-2: Sample helicopter flight plan: sequence, number, and purpose of flights for typical treatment.

Number of Flights (round-trip)	Purpose
DAY 1	
1	Bring in two crew members.
1	Bring in raft/boat and some equipment.
1	Bring in two, 30-gallon drums of rotenone.
1	Bring in second crew and 8 gallons of rotenone.
1	Remove most equipment and materials.
DAY 2	
2	Remove the remaining equipment.
2	Remove the remaining crew members.

2.4.3.3 Single Engine Aircraft Tanker Airplanes – Non-wilderness Areas

SEAT airplanes could also be used to transport and apply a portion of the piscicide in non-wilderness areas. M18A and M18B Dromader fixed-wing air tankers with a load capacity of 500 gallons are available for use. They have a wing span of 58 feet and are 33 feet long. These aircraft are sufficiently agile that they can apply rotenone from the air on lakes larger than ten surface acres. To test the safety of using SEAT on these applications, four candidate lakes have been pre-flown. Such use would be evaluated on a lake-by-lake basis to determine whether any additional limitations or obstructions would preclude their use, or to determine if this transport and application method could be used on more lakes than just the four that are proposed.

SEAT aircraft can vary the salvo (release) rate of their payload, and can range from full release in as quickly as two seconds to partial release over multiple passes. Distribution rates are calculated in standard distribution guidelines developed for fixed-wing fire suppression and fixed-wing crop dusting. In 2002, MFWP tested SEAT aircraft in Fort Benton, Montana to determine their applicability in this project. Based on the results of those tests, MFWP conducted a final test in May 2003 that involved dropping 500 gallons of dyed water on ice covered Clayton Lake (Grisak 2003d). At full salvo, 500 gallons of dyed water covered an area 403 feet long. Although the ideal application would involve spreading this coverage out, these tests prove that SEAT aircraft are highly precise aerial application tools. Factors that influence application can include air speed, altitude, target site, and terrain limitations. Typical drops are conducted at 40-60 feet altitude and 80 knots (90 mph) airspeed. These variables can be manipulated to achieve the desired outcome for an aerial application.

If SEAT aircraft were used, their role would be to administer a large portion of the rotenone to the surface of the lake, while a boat would be used to mix the compound and administer the remaining portion of rotenone at deeper depths. Due to the potential for aerial applications to generate aerosol, ground applicators would be required to wear protective clothing and respirators to guard against exposure.

In order for a commercial pilot to apply rotenone from the air, the operator must be certified to operate agricultural aircraft, and certified to apply economic poisons (pesticides, fertilizer, herbicides).

The May 2003 test proved that SEAT aircraft can transport and apply large liquid loads to remote high altitude lakes.

Since a paved airstrip is required for SEAT aircraft, they would be staged from the Glacier International Airport. The aircraft would be filled with the desired amount of piscicide and flown to the target lake where the piscicide would be administered over a designated number of passes as determined by the size of the lake. The piscicide administered by boat would be transported to the site by helicopter.

In 2002, four lakes that are candidates for SEAT application--Clayton, Black, Pilgrim, and Margaret--were pre-flown by the SEAT pilot and a project fisheries biologist in a Beechcraft Baron to determine any methodological limitations. No limitations were identified. In order to facilitate a safe and precise application, factors such as target size; approach; exit route, landscape; and probable wind currents, strength, and direction were evaluated at each lake. No factors were identified that could limit the success of the proposed application. Immediately prior to the application of piscicide while the plane is loaded, the lakes would be flown twice to test weather conditions and to establish clear communication with ground personnel. An application where SEAT aircraft are employed would only be conducted if the aircraft is able to administer its load. If weather conditions preclude the application from being conducted that day, it would be postponed until weather conditions improved.

According to the SEAT Program Coordinator for the Bureau of Land Management (BLM), the primary cause of retardant aircraft misplacing loads is misdirection by ground personnel. Ground personnel occasionally misdirect pilots, which results in retardant drops being made in unintended areas. A target that is easy to identify, such as a lake, would ensure no misplacement of piscicide during aerial transport and application. Furthermore, pre-application flyovers would further ensure that SEAT pilots are at the correct location before a load is dropped. Coupled with the flyovers in 2002 and 2003, the SEAT pilot would have flown over each lake at least three times prior to treatment. GPS navigation and communication with ground personnel further ensures proper site delineation.

Based on the information provided by the U.S. Department of Interior (USDOI), Office of Aircraft Services, BLM SEAT Program Coordinators, and independent SEAT aviation contractors regarding the safety record and accuracy of SEAT aircraft, as well as the time-savings for transport and application, SEAT aircraft would be used in combination with a helicopter to transport piscicide to Black, Pilgrim, Margaret, and Clayton Lakes. SEAT aircraft would apply a portion of the piscicide on these lakes in concert with a motorboat.

Because of the larger payload, SEAT aircraft would be used to transport and apply rotenone for the purpose of reducing overall aircraft transport flights, and to expedite applying a large amount of material to some lakes. According to the rotenone label, the directions provide guidance on how to make applications of rotenone to streams and rivers, and ponds, lakes and reservoirs. The label states that the unique nature of every application site could require minor adjustments in the method and rate of application. Should these unique conditions require major deviation from the use directions, a Special Local Need 24(c) registration would be obtained from the Montana Department of Agriculture. Applying pure or lightly diluted formulation with a SEAT aircraft to reduce aircraft transport and application time may constitute a deviation from the use directions. Prior to applying undiluted or slightly diluted rotenone formulation, this label re-write would be obtained; otherwise, label guidelines would be followed under standard application guidelines.

2.4.3.4 Summary of Application Methods

Most applications of piscicide would utilize a combination of transportation methods. This combination would result in the most efficient and least time consuming transportation of personnel and equipment with the least impact on the environment and surrounding designated land areas. Table 2-3 below presents the advantages and disadvantages associated with each mode of project transport.

Table 2-3. Comparison of methods of transportation.

Method	Advantages	Disadvantages
Hiking/Livestock	-Traditional method consistent with wilderness values. -May be more socially acceptable over other methods.	-May contribute to higher environmental impact to trail and surrounding area, depending on trail conditions and maintenance standards. -More time required to transport.

Method	Advantages	Disadvantages
		-Requires securely stored materials on site for longer periods of time. -Longer duration at site. -Potential conflict with other users. -Requires more materials (stock feed, camping gear, etc.).
Helicopter	-Greater time savings. -No disturbance to trails and ground. -Does not require securely stored materials for extended periods of time. -Can access all sites.	-Non-traditional, inconsistent with wilderness values. -May not be as socially acceptable as other methods; e.g., noisy and contrasts with wilderness values. -Short-term impacts from noise. -Less payload than SEAT (requires more flights). -Intrusion within the wilderness and Jewel Basin
SEAT	-Improved time savings. -Minimizes time required for transport and treatment over any other method. -Can transport high volume of material in one trip. -Reduces number of helicopter trips. -High probability of application success. -Does not require storing materials for extended periods of time. -Able to apply large volume of material in short period of time.	-non-traditional, inconsistent with wilderness values -not as socially acceptable as other methods -Public perception that plane may miss target. -Short-term impact from noise. -Intrusion in wilderness area and within Jewel Basin. -Not as agile as helicopter; cannot access every site.

2.4.4 Treatment

Once at the lake, the crew would need to prepare for the next day's application. A sample description of lake treatment is provided below.

Prior to conducting a treatment, the public would be advised of the action well in advance. Notices would target the general public, indicating the lifting of harvest limits from each lake and section of stream, and outfitters would be notified in advance so they could plan client activities accordingly. Immediately before the treatment, trailheads would be signed notifying local users of access restrictions and environmental considerations while recreating in the vicinity of lake and stream treatment areas. Sentinel fish would be collected from the streams. Amphibians also would be collected, if present, for release after the treatment.

2.4.4.1 Day One

After reaching the site, the respective crews would set up a camp, tend to livestock[2], and set up for treatment the next morning. Two crewmembers would travel downstream from the lake, with necessary materials to install sentinel fish cages and install a detox station in preparation to dispense potassium permanganate. As a precautionary measure, this crew would monitor the stream during and after treatment to ensure that the water leaving the lake was sufficiently detoxified. These precautions would be taken to ensure that the piscicide did not affect unintended or non-target fish downstream of the lakes. Trailheads would also be posted to notify recreationists that the lake would be temporarily closed for recreational use during the treatment period. A crew would set up drip stations on inflow streams and prepare for treatment the next day.

2.4.4.2 Day Two

The lake, inflows, and designated downstream sections would be treated with the appropriate piscicide and sentinel cages, drip stations, and detox stations monitored by attendants at each site. The application of piscicide on each lake is intended to be accomplished in a single day, but unforeseen circumstances may necessitate extending this time period briefly. Potassium permanganate would be on hand to administer at intended locations, and to be on hand in other areas in the event of an accidental spill, or in response to unanticipated results.

Application of Rotenone

Rotenone may be applied only by licensed applicators and in adherence to safety precautions identified on the product label. The project supervisor would be knowledgeable and experienced in state regulatory requirements regarding safe and legal use of the rotenone product and applicator safety. All personnel involved with the rotenone application would have received, before treatment, safety training specific to the formulated rotenone product that would be used. All personnel are required to wear protective equipment to avoid unintended exposure to rotenone.

Figure 2-2. Rotenone application by boat.

After the first crew prepared the boat and other necessary equipment, the rotenone would be distributed by motorized boat, using a specialized funnel-and-hose system. The boat would be used to distribute the rotenone around the lake in concentric rings, starting near the shore and then working toward the center. Either a garden hose or pressurized barrel and hose system would be used to distribute

[2] This step would not apply to those lakes where livestock would not be used for transport.

rotenone to deeper depths. Motorized pumps may also be used to pump rotenone to deeper depths.

Meanwhile, the second crew would prepare drip stations to distribute rotenone and potassium permanganate. At fresh-water inlets to the lake, drip stations would administer a known concentration of rotenone. This action would keep the fish from seeking out fresh water sources and thus avoiding exposure to rotenone. Crew members treating the downstream segments would set up drip stations, sentinel fish monitoring stations, and detoxification stations. All stations would be monitored throughout the treatment and detoxification process.

Information gathered from bioassays on westslope cutthroat trout exposed to 1 ppm rotenone indicates that, once rotenone is fully mixed with lake water, 100 percent mortality can be achieved within two hours of exposure (Grisak, et al. 2002).

On-site assays would determine the location and spacing of all monitoring stations.

As the application takes place, the pilot would continue to bring in rotenone and ferry out empty barrels. At the lake, the “loadmaster” would empty cargo nets, load barrels into the boat, load empty barrels into cargo nets, and hook nets to the helicopter. A second loadmaster (at the airstrip) would load cargo nets with full barrels, unload empty barrels, place them on a trailer, and help fuel the helicopter.

Most of the equipment and materials would be flown out, depending on time, weather, and other conditions; and a small crew would remain at the lake overnight to monitor the treatment.

Application of Antimycin

Prior to the lake treatment, applicators would install drip stations at freshwater inflows; and install drip stations, detoxification stations, and sentinel fish cages in the stream below the lake. The lake application and stream treatment would begin simultaneously.

Application of antimycin begins by administering the compound by boat using an electric bilge pump and a venturi suction mechanism fitted to the outboard motor. In lakes that are greater than 30 feet deep, a pump would be used to administer the compound in deep water using a weighted hose of appropriate length.

Larger lakes would require multiple motorized rafts to ensure the application is completed within one day. Up to date flow data and on-site assays would be used to determine the location and amount of antimycin and potassium permanganate and caged sentinel fish monitoring stations needed. Caged fish would be monitored for 48 hours after the application. Further detoxification monitoring would continue until the caged fish survived a 24 hour time period following the application, after which time, the caged fish would be removed.

2.4.4.3 Day Three and Beyond

If a prolonged detox station is required, then a small camp would remain behind. Two attendants would monitor the station until caged fish were unaffected by the treatment.

Dead fish would be removed from the lakeshore, taken to deeper water, and sunk. This serves to prevent dead fish from becoming an attractant to predators, improve aesthetics at the site, and to stimulate primary production in the lake. To the extent possible, with regard to access, dead fish would be removed from the streams over a several day period following the treatment (Parker 1970; Bradbury 1986).

Detoxification of Rotenone

The rotenone product label (Prenfish 1998) indicates that it will detoxify naturally within 1 to 4 weeks depending on water temperature, alkalinity, etc. Lakes that have no outflow are allowed to detoxify naturally over a period of a few days to several weeks at most (Gilderhaus, et al. 1986; Dawson, et al. 1991; Skaar 2001). A variety of factors influence the natural breakdown of rotenone, including water chemistry, water temperature, and sunlight intensity (photolosis). Sufficient amounts of fresh-water inflow reduce the concentration of rotenone to non-lethal levels to fish. Outflow stream water may also be diluted by freshwater inflows from downstream inputs. Additionally, many lakes in the South Fork Flathead drainage commonly experience low or no outflow in the fall. For this project, if a lake has no outflow it may be prioritized in the treatment schedule because containment of the treatment would be easier. In such cases, the outflow stream would still require treatment in order to remove hybrid trout, but the application would begin at the site where surface water appears in the stream bed and continue to the predetermined downstream boundary.

Additionally, rotenone breaks down rapidly in soil and water as it is exposed to light, heat, oxygen, and alkalinity. It does not easily leach from soil because of its ability to readily bind to sediments, nor is it a groundwater pollutant (see Appendix D). Any rotenone that may drain through fissures in the lakes would bind readily to soils and breakdown rapidly, thus avoiding the potential to contaminate downstream water and soil.

Potassium permanganate would be used to detoxify the rotenone at predetermined locations in the stream. Experiments conducted by Engstrom-Heg (1971, 1972, 1976) provide application rates and concentration levels that take into account the effect that water chemistry, water temperature, and biologic uptake have on the compound, as well as the neutralizing effect of stream and lake substrates. Water chemistry is the major factor that influences this process; it would be evaluated at each site to make the necessary adjustments to achieve the proper concentrations. The appropriate amount of potassium permanganate would be calculated using colorimeter instruments, water tracing dye, and stream flow calculations. MFWP tests indicate that stations can be prevented from freezing by installing them in insulated boxes with small pocket fuel heaters. All detox stations would be maintained until caged fish survive downstream of the detoxification site, which may require several days. The average designated length of the eight streams that would be treated with rotenone is 3.9 miles, with a range from 2.23 to 6.09 miles.

To detoxify a rotenone application, project managers would rely on the following:

- No outflow (detoxification will occur in the lake naturally)
- Dilution by downstream freshwater inputs
- Downstream detoxification with potassium permanganate
- Combinations of all of the above methods

Detoxification of Antimycin

The antimycin product label is accompanied by a Fish Toxicant Kit Use Direction leaflet that indicates that antimycin degrades rapidly and naturally, allowing for fish restocking within about one week (Romeo 2002). Antimycin loses much of its toxicity usually within every 200 feet of downstream vertical elevation drop (Tiffan and Bergersen 1996; Romeo 2002). It detoxifies rapidly in stream environments because of the oxidation action created by stream turbulence, interaction with organic substances on the stream bottom, and exposure to sunlight (photolosis). Numerous applicators have described the need to install drip stations within 200-foot elevation intervals to recharge a stream with antimycin. This characteristic makes antimycin a valuable tool when a lake population is targeted and certain downstream populations are not. Non-target fish populations that occur downstream of a lake treated with antimycin may be safeguarded in this manner if the factors most influencing natural detoxification are present.

The Fish Toxicant Kit Use Direction leaflet indicates, potassium permanganate can be applied at 1ppm to detoxify (more potassium permanganate may be needed if the stream has a high permanganate demand). Antimycin can be detoxified rapidly with potassium permanganate administered in small concentrations (Stefferud, et al. 1992; Gilderhus, et al. 1969). Marking and Bills (1975) reported that antimycin exposed to 1 ppm potassium permanganate had a half life of between 7 and 11 minutes and is rapidly detoxified by 1 ppm potassium permanganate in waters of pH 6.5 to 9.5. Berger (1966) reported that 1 ppm potassium permanganate was used to neutralize 10 ppb antimycin. Using a colorimeter to measure potassium permanganate demand of a stream, field tests would be conducted before the application to determine the appropriate level of potassium permanganate to ensure proper detoxification (Engstrom-Heg 1971, 1976). The likely potassium permanganate concentration would be 3 to 6 ppm, which accounts for the organic demand of the stream and the interaction with antimycin itself. Activated charcoal, tree leaves, and iron rich water will also readily bind with antimycin.

Potassium permanganate drip stations would be used to control the downstream boundary of each antimycin treatment. Below each lake proposed for antimycin treatment, a designated amount of stream would be treated to meet the project objectives. The average designated length of the 10 streams that would be treated with antimycin is 2.8 miles, ranges from 0.1 to 4.25 miles.

2.4.5 Follow-Up

Post treatment plan

Immediately after the lake is treated, evaluations would be made to determine the success of a treatment. As early as possible, during the following spring and summer, a survey would be conducted at each lake. The survey would include setting gill nets; monitoring caged fish to determine water quality and restocking conditions; and, if possible, the evaluation of the status of non-target organisms like plankton, amphibians, and aquatic insects. If live fish remain in the lake, a determination would be made whether to implement a second treatment.

2.4.5.1 Reports

A certified applicator is required to record each treatment and submit a Montana Department of Agriculture—Record of Application report every five years. The report describes, among other things: the type and amount of piscicide applied; the area treated; application rate; equipment used; possibility of a complete kill; water conditions at the time of treatment; and detoxification measures, if any are used. This reporting standard would be maintained throughout the project.

2.4.5.2 Amphibian Monitoring

Substantial evidence collected from past rotenone treatments in the Flathead Basin indicates rotenone would have no long-term adverse impacts on amphibians in the project area. Laboratory tests conducted by MFWP indicate that antimycin would not have a negative effect on amphibians at the levels prescribed to kill fish. Substantial literature supports these evaluations and tests. However, if the application of either compound shows any anomalous effects on local amphibian populations, MFWP would mitigate these impacts by replacing amphibians that may be impacted. This could be accomplished by transplanting egg masses and young and/or adult amphibians from adjacent populations. A follow-up survey for two years after the treatment would be used to confirm whether amphibians were present within treated areas, and whether they would need to be replaced in any given location. Additionally, tailed frogs could be collected from some streams prior to treatment at the location of drip stations and monitoring stations, and replaced following the treatment.

2.4.6 Restocking

Restocking the lakes is not an action funded by BPA, but rather is the sole responsibility of MFWP. Restocking is discussed in this document because it is connected, in part, to the actions proposed for funding by BPA.

In compliance with the piscicide product labels and supplemental label information, caged fish must survive for 48 hours in antimycin treated water before restocking occurs. The antimycin Fish Toxicant Kit Use Direction leaflet states that antimycin naturally degrades to the point where fish can be restocked within about one week. The rotenone label states that caged fish must survive 24 hours in rotenone treated water before restocking, and recommends waiting two to four weeks after the treatment before testing for restocking. Although the antimycin label supplement recommends using fingerling rainbow trout or fingerling bluegills as sentinel fish, these species are non-native to the project area and using them would present a risk of unintentional introduction if an accidental escapement occurred. For this reason, cutthroat trout from the area or genetically pure westslope cutthroat trout would be used as sentinel fish to determine when stocking can take place.

Historic fish stocking in South Fork Flathead lakes developed new fish populations in many cases, or supplemented existing populations for recreational use. Stocking has continued for various management and conservation measures from the 1920s to the present. Although both of the selected piscicides are highly effective at removing undesirable fish species, there have been instances where isolated fish have survived piscicide treatment by inhabiting undetected ground water inflows. To ensure the complete removal of hybrid fish from the system, continued fish stocking with genetically pure westslope cutthroat trout will dominate the lake and stream environments, thus keeping any potential surviving hybrids from re-establishing a population. Post-treatment stocking would begin immediately in the July following treatment, and would occur annually until a population is firmly established. Post treatment stocking is an integral component in all alternatives involving eradication and suppression. A variety of age classes would be stocked in many of the lakes to expedite restoring the fishery.

Once the population is established, it would be monitored to determine if continued stocking is necessary. Factors that influence continued stocking include the level of natural reproduction and angler harvest. Some lakes have adequate habitat for natural reproduction and may not require maintenance stocking, thus dramatically reducing the frequency of stocking from current levels. In this case, certain lakes could be managed as self-sustaining fisheries. Other lakes would require maintenance stocking to sustain angling quality and population viability.

Restocking pure westslope cutthroat trout in the lakes would establish pure cutthroat populations and ensure their domination over any remaining hybrid fish populations. It would also provide genetically pure fish to seed downstream creeks, and would greatly reduce the temptation for illegal introductions of non-native fish. Rather than relying solely on downstream drift from lakes, restocking streams would expedite the restoration of a viable fish population. MFWP would continue to manage the lake fisheries so as to safeguard the westslope cutthroat trout populations in the South Fork and maintain quality angling opportunities.

It is important to recognize that there is no proposal to impact these segments of the environment or socioeconomics through a “no restocking” option. The only change in fish stocking from the present level would be through the reduction in the number of fish stocked and frequency of stocking at some lakes. This action could be perceived as a benefit by reducing the number of flights and pack trips necessary to maintain the westslope cutthroat trout, area wilderness values, established socioeconomic practices, and angling opportunities and qualities.

2.4.6.1 Compliance

MFWP would comply with the ESA and the Wilderness Act for all restocking activities, including monitoring for the presence of any listed species in the area.

Additionally, MFWP would comply with the guidelines established in the Fish, Wildlife, and Habitat Management Framework for the Bob Marshall Wilderness Complex (BMWC); Memorandum of Understanding and Fish and Wildlife Management Addendum (FS and MFWP 1995). Per this management agreement, MFWP would work jointly with the FS in determining time of stocking, and would notify the FS of fish stocking schedules and numbers and species of fish to be stocked, and would adhere to other guidelines established in this document (FS and MFWP 1995).

2.4.6.2 Restocking Decisions

Once the lakes and designated portions of the streams are depopulated of fish there will be an opportunity to either restock the lakes or leave them fishless. The decision whether or not to restock them lies solely with MFWP. Historically, MFWP has stocked these lakes. One of MFWP’s responsibilities is to maintain cutthroat recreational fishing in these areas. If MFWP does not restock all treated lakes, it is likely that unauthorized, illegal stocking would occur as it has in the past. This could result in the introduction of another non-native species. Decisions would be made pursuant to the BMWC Management Framework Document.

2.4.7 Summary of Proposed Action

Table 2-4. Summary of Alternative B.

FS Land Use[1] Designation	**Lake Size[2]**	**Access**	**Delivery and Application Method**	**Type of Fish Toxin**
Wilderness	S, M, L	System trail	Livestock delivery & motor boat application	Antimycin
Wilderness (Lick & George Lakes)	S, L	No system trail	Helicopter delivery & motor boat application	Antimycin
Non-wilderness	S, M, L	System trail	Helicopter and/or SEAT delivery & motor boat application	Rotenone[3]
Non-wilderness	S, M, L	No system trail	Helicopter and/or SEAT delivery & motor boat application	Rotenone
Non-wilderness (Handkerchief Lake)	L	Road	Truck delivery & motor boat application	Antimycin

[1]*Non-wilderness includes lakes on other Forest Service lands, including the Jewel Basin Hiking Area.*

[2]*(S)mall = Lakes 1-19 acres in extent; (M)edium = Lakes 20-49 acres in extent; (L)arge = Lakes larger than 50 acres.*

[3]*Wild Cat Lake would be treated with antimycin to protect a downstream bull trout population.*

2.5 Alternative C: Fish Toxins – Motorized/mechanized Delivery and Application Methods

Alternative C is similar to Alternative B in many respects (see Table 2-4), but differs in the method used to transport materials, equipment and supplies to the project sites and in the application of fish toxins to the lakes. The main difference is in the use of aircraft as the sole means of transport.

Implementing this alternative would remove hybrid fish from selected lakes and designated stream sections in the South Fork Flathead that threaten to genetically contaminate the pure westslope cutthroat populations in the drainage. Rotenone and antimycin would be the fish toxins used to remove hybrid species from the lakes and designated downstream sections. The piscicides, equipment, and licensed applicators would be flown in by helicopter or by fixed-wing aircraft. After the application, materials and staff would be packed up and removed from the area as quickly as possible. The day after the treatment, personnel would evaluate the lake and collect and measure fish.

MFWP would install sentinel cages containing westslope cutthroat trout and monitor them for 24 hours prior to re-stocking. The lakes would be restocked with pure strain westslope cutthroat the following spring in order to establish genetically pure cutthroat populations in sufficient quantities to dominate any hybrid fish that might remain, and to re-establish the fishery. Monitoring of the restocked fish would continue for several years to determine population viability and overall program success. Lessons learned from these evaluations would be applied to succeeding applications on other lakes. Appendix D provides background detail on rotenone and antimycin, along with their characteristics and historic uses.

Table 2-5. Summary of Alternative C.

FS Land Use[1]	Lake Size[2]	Maintained Trail Access	Delivery and Application Method	Type of Fish Toxin
Wilderness	S, M, L	9 with system trails 2 with no system trails	Helicopter delivery & motor boat application	Antimycin
Non-wilderness	S, M, L	No maintained trails for pack stock	Helicopter and/or SEAT delivery & motor boat application	Rotenone[3]
Non-wilderness (Handkerchief Lake)	L	Road	Truck delivery & motor boat application	Antimycin

[1]*Non-wilderness includes lakes on other Forest Service lands, including the Jewel Basin Hiking Area.*

[2]*(S)mall = Lakes 1-19 acres in extent; (M)edium = 20-49 acres in extent; (L)arge = Larger than 50 acres.*

[3]*Wild Cat Lake would be treated with antimycin to protect a downstream bull trout population.*

2.6 Alternative D: Suppression Techniques and Genetic Swamping

This alternative proposes the combined use of two or more mechanical removal strategies to reduce hybrid trout numbers in an effort to protect downstream genetic purity of the westslope cutthroat. This alternative would rely on the use of mechanical fish collection methods (i.e., gill netting, trapping) as a means to suppress the hybrid trout populations by removing as many fish as possible. When population levels are adequately reduced, intensive fish stocking would commence on a “frequent or annual” basis (swamping) in an attempt to dominate the remaining hybrid trout in the lakes.

Suppression techniques are unreliable at completely removing fish populations; they are generally used to depress fish populations. Thus, a period of intensive gill netting or combination of suppression techniques that relied on mechanical fish removal methods would be used to deplete the hybrid fish population. This would be followed by stocking genetically pure westslope cutthroat trout in an attempt to breed the remaining non-native genes out of the population. It is believed that removing a high percentage of the non-native trout from the lake would give swamping an improved probability of success. Lakes that may be deemed too expensive or complex to treat with fish toxins may be candidates for this type of action.

The length of time necessary to implement a lake suppression operation depends largely on fish reduction objectives, the size of each lake, and the number of nets and traps used. The number of nets deployed at any given time would depend primarily on the number of boats and personnel available to perform the operation. Larger lakes would likely require the use of both traps and gill nets in order to maximize the effort of the suppression program. Other factors that dictate whether traps would be used include lake depth, the type of shoreline, the size of the lake, and the number of boats and personnel that would be used at each lake.

Gill nets can be used in all types of lakes. It is estimated that a large percentage of the fish population would likely be removed from any one lake in the first four years of effort. During that time, young fish would be produced each year at most lakes. Because of this, and because small fish are not vulnerable to gill netting and only marginally vulnerable to trapping, it is estimated that approximately three additional years would be required to capture fish that were naturally produced at the lake during the suppression program with the understanding that all fish would not be caught. Recognizing the differences among these lakes, it is estimated that any suppression program using mechanical methods would run for a time period of 5 to10 years. In addition, the number of fish captured per net could be used as a benchmark before implementing genetic swamping with pure westslope cutthroat. For example, when the average number of fish captured per net is reduced by 90 percent and is sustained for two years of netting, genetic swamping could then be implemented. Other factors such as age class strength, and fish size could be determining factors in deciding when to discontinue suppression and when to implement stocking genetically pure westslope cutthroat trout.

Angling limits may be lifted a few years prior to any action in order to allow the public to remove as many fish as possible.

A description of each method is provided below.

2.6.1 Gill netting

Gill netting is a passive capture technique used to collect fish by entangling or ensnaring (Hubert 1992). Both gill nets and trammel nets are arrangements of mesh that capture fish when they swim into it. Most often fish bodies become wedged or their teeth entangled in the net. Nets are typically made of cotton, nylon, or monofilament fiber. Mesh sizes can range from ½ inch for small fish to over 5 inches for larger fish species.

The method has been used successfully to remove unwanted fish from very small lakes and reservoirs. Bighorn Lake, a 5.2 acre lake located in Banff National Park in Alberta, Canada, was gill netted from 1997 to 2000 to remove an unwanted population of brook trout (Parker, et al. 2001). Over 10,000 net nights (one net night is defined as one net set overnight for at least 12 hours) were conducted over a four year period in Bighorn Lake to remove the population, which totaled 261 fish. Researchers concluded that the removal of nonnative trout using gill nets might be impractical for lakes larger than five acres. In clear lakes, trout have the ability to become acclimated to the presence of gill nets and avoid them. These researchers reported observing brook trout avoiding gill nets within about two hours of the nets being set.

Knapp and Matthews (1998) reported that Maul Lake, a 3.9 acre lake in the Inyo National Forest in California, was gill netted from 1992 to 1994 to remove a population of brook trout. The population, which totaled 97 fish, was successfully removed with an effort of 108 net days. The researchers reported that following the removal of brook trout from Maul Lake, it was mistakenly restocked with rainbow trout. Efforts to remove those using gill nets were implemented immediately. From 1994 through 1997, 4,562 net days were required to remove the 477 rainbow trout from the lake.

These researchers reported that gill nets could be used as a viable alternative to chemical treatment. They acknowledged that the small size and shallow depth of Maul Lake contributed greatly to the successful fish eradication by the use of gill nets. Their criteria for successful fish removal using gill nets includes: lakes should be less than 3.9 surface acres; less than 19 feet deep, with little or no inflow or outflow to perpetuate reinvasion; and no natural reproduction of targeted fish. Although not tested, the maximum size of a lake that they felt could be depopulated using gill nets was 7.4 surface acres and 32 feet deep.

Selective gill netting has been used in Yellowstone Lake in Yellowstone National Park in an attempt to control the lake trout population since 1995. From 1995 through 1998, approximately 20,000 lake trout were removed from Yellowstone Lake by gillnets. From 1999 to 2001, over 15,031 net nights were necessary to collect approximately 24,500 lake trout (YCR 2001). Yellowstone Lake is approximately 87,000 surface acres and 360 feet deep. This is an ongoing suppression effort not designed to totally remove the lake trout population, and will need to be continued indefinitely. The lake trout population, although reduced by aggressive netting, remains viable and would rebound if netting were discontinued.

Many reports describe the role of gill nets in reducing overpopulated rough fish (Meronek, et al. 1996). Riel (1965) reported that five successive years of intensive gill netting were required to reduce the overpopulation of yellow perch in Bow Lake, New Hampshire. Gill netting for commercial enterprise has been responsible for the collapse of many fisheries throughout the United States and Canada and includes species like lake trout, walleye, cisco, and lake whitefish. Mitchell and Prepas (1990b) reported that many years of intensive commercial gillnetting of Touchwood Lake, Alberta eliminated lake trout from the lake; attempts to re-establish the population between 1967 and 1990 were unsuccessful. Several other species still persist in the lake and the commercial fishery reportedly continues to harvest an average of 44,000 pounds of fish per year. Mitchell and Prepas (1990a) reported that intensive gillnetting of Lesser Slave Lake, Alberta prior to 1940 eliminated the lake trout population. Subsequent high intensity commercial netting for walleye, cisco, and whitefish caused those fisheries to collapse in the 1960's and 1970's. They have since recovered.

When evaluating the effectiveness of this management practice, the Montana Bull Trout Scientific Group concluded that gill netting would not result in a complete removal of fish that compete with bull trout (MFWP 1996). Rather, they recommended that it be used as a suppression technique. They concluded that in very specific circumstances, this method could lead to total removal.

Targeting concentrations of spawning fish can increase the probability of success using gill nets (Riel 1965). However, high altitude lakes in the South Fork drainage have sheets of ice present during normal spawning periods. Large rafts of ice are present as late as mid July. This would make setting and checking gill nets during spawning times difficult, if not impossible. Westslope cutthroat trout typically spawn in June. Spawning is often delayed in high altitude lakes because of cold water temperatures and ice conditions. Because westslope cutthroat do not sexually mature until about three years of age, at any given time there are at least two year classes of fish that would likely not be present at spawning areas. This would require the return of personnel to the spawning sites for at least two more consecutive years to capture the sexually maturing fish that are attempting to spawn.

Implementing an intensive gill netting program on a remote lake would require having an attended camp at each lake during the summer through fall months. A motorized raft would be required to set and pull gill nets on a daily basis in all weather conditions. To set a gill net, it is necessary to use a boat to ensure the net is deployed quickly and properly. A two person crew is required for gill netting--one to operate the boat and the other to set and retrieve the nets. Gill nets are set by first attaching a weight to the bottom line at one end and a float to the top line at the same end. The weights serve to keep the net from being moved by wind, wave action, and fish that are trying to escape the net. The floats serve to mark the location of the net and to make it easier to retrieve in rough water or in low light conditions. The net is deployed by placing one weighted end in the water and then reversing the boat while the netter feeds the gill net into the water, making sure it is deploying properly. At the other end of the net, a second weight is attached to the bottom line and float is attached to the top line. The net is left in place for the appropriate amount of time. To retrieve the net, the netter approaches the float, retrieves it, and draws it and the net with captured fish into a tub. Once the entire net has been removed from the lake, weights and floats are removed from the ends of the nets; thereafter, the fish are removed. The nets are placed back into the tubes and readied for deployment again. Afterwards, the fish are generally weighed and measured and processed accordingly. Although other researches have reported success using gillnets under the ice of very small lakes during winter months, avalanche debris is very common at nearly every lake listed in this proposal, thus, most likely, precluding any prolonged winter gill netting.

Attendees would be mandatory at these lakes during ice-off conditions to prevent vandalism or theft of gill nets. As recent as 2001, a gill net set in Wildcat Lake in the Jewel Basin Hiking Area was stolen by an unknown party. Because gill netting does not remove hybrid trout from the outlet or inlet streams, another suppression method would be required to remove fish from streams in concert with gill netting efforts on targeted lakes.

All of the necessary materials for gill netting could be transported to wilderness lakes by livestock, or by helicopter to lakes located within the national forest non-wilderness areas and the Jewel Basin Hiking Area. Gill nets, floats, weights, rafts, motors, fish working supplies, and camp materials could be transported to all wilderness lakes that have a trail to them. George and Lick lakes do not have system trail access, which would require access by helicopter.

2.6.2 Trap Nets

Trap nets are a passive method of fish capture (Hubert 1992). Trap nets most commonly used are hoop nets and fyke nets. Hoop nets typically consist of five hoops and frames with netting stretched around them and a mesh funnel on one end that directs fish into the net. A typical size would have a series of three, 4-foot diameter hoops that would stretch to about 20 feet in length. Fish that enter the trap are funneled into the cod end, which is a communal holding area. A hoop trap would hold fish alive for an extended period of time until a fishery worker empties it. A motorized boat is mandatory for setting the trap. The trap may be emptied by pulling it to shore, or by lifting it into a boat. Hoop nets are often baited to attract fish. Hoop nets are highly selective for migratory species and species that that are attracted to bait and cover. For these reasons, they can be selective in what species they will catch.

Fyke nets are similar to the hoop net but have a long net called a “lead” or “fence” attached to direct fish into the funnel. This lead can range in length from 50 to 200 feet. The trap lead is staked on the shoreline of a lake and the entire lead and net is stretched perpendicular to the shore. Fish swimming along the shoreline encounter the trap lead and swim into deeper water to get around the obstacle. In doing so, they swim into the funnel and are ultimately captured at the cod end. Fyke nets are selective for what species of fish they will capture, and work best with species that are mobile and orient to cover (e.g., bass, perch, and most trout species).

The vast majority of literature reviewed concerning trap netting for fish removal had objectives to only reduce the number of stunted or overpopulated rough fish, bluegills, perch, bass, and crappie (Meronek, et al. 1996); or were used in combination with other methods (Rose and Moen, 1952). The literature evaluated demonstrated that an incredible amount of effort was required to only reduce the number of fish in these lakes. Grice (1957) reported the results of fyke netting on several Massachusetts waters. Indian Lake (172 acres) was fyke netted from 1954 to 1956 and 19,300 pounds of panfish and rough fish were removed. Jordan Pond (20 acres) was fyke netted from 1953 through 1955 and 5,700 pounds of fish were removed. Netting did not completely remove all the fish from the water bodies.

Targeting spawning areas to capture fish when they are concentrated is one technique that could increase probability of success using traps (MFWP 1996). However, limitations to this method are similar to other netting methods in that sheets of ice are often present in many high altitude lakes during normal spawning periods. This would make setting and checking trap nets difficult, if not impossible.

As above, there is by-catch of non-target species with these traps. In the Flathead River sloughs, they were lethal to otters, and potentially a problem for other mammals. Negative impacts and risks associated with these techniques need to be understood by decision makers. There are also aesthetic concerns; floats and nets would be visible, detracting from the pristine appearance of these lakes.

When evaluating the effectiveness of trap netting, the Montana Bull Trout Scientific Group concluded that trapping would not result in a complete removal of fish that compete with bull trout (MFWP 1996). Rather, they recommended that it be used as a suppression technique. A motorized boat would be required to set and check trap nets, and a camp would be required at each lake to house personnel for an extended time period for this type of operation. To use a trap net, a motorized boat is required to set and check the net. The use of oared rafts is possible, but is very unsafe for those setting and checking the nets. It is also inefficient.

Setting begins by tethering one end of the lead net to the shoreline with a fencepost. The net is placed on the bow of the boat, which is traveling in reverse while the netter feeds the lead out, making sure it is deploying properly. Feeding the frame system from the bow is continued until reaching the cod end of the net. While the boat operator keeps tension on the net, a float and line is attached at his point with a carabineer as well as an anchor line. The float line is cast away, the netter holds onto the anchor line, and the boat continues to reverse until reaching the end of the anchor. A second float and line is attached to the anchor. The boat continues in reverse until reaching the end of this float line. One final tensioning pull is conducted from this point to stretch the whole apparatus and then it is released. Once the anchor reaches the bottom, it bites into the substrate.

When checking a trap net, the boat approaches the float line at the cod end of the net and retrieves the trap up to the boat. At this point, the anchor line is tied to one side of the boat, and the trap is attached to the other side of the boat. The fish are removed from the trap, float and anchor lines are reattached, and the boat backs away from the trap, which sinks back to the bottom and redeploys. Gradual sloping shorelines and banks are required for the most efficient operation of trap nets (Hubert 1992). However, occasional sets have been successful in steep rocky lake bottoms on Tongue River Reservoir, Montana for collection of walleye. Setting in these conditions often yields few fish and nets have a tendency to roll during deployment, which fouls their capture efficiency. To avoid this, three boats can be used to deploy a trap in areas with steep sloping lake bottoms to prevent rolling.

Many, but not all, lakes listed in this proposal have steep rocky shorelines. Because trap nets cannot be used to effectively remove fish from small high gradient streams, another method of fish removal would be required to meet that objective. Although it is not absolutely necessary to check trap nets on a daily basis, their performance is maximized through frequent checks. A daily presence at each lake would be necessary to deter vandalism of these traps.

2.6.3 Merwin Traps

These traps are very similar to fyke nets, but they are much larger. There is some variation in design and size, but a typical trap includes a lead net that directs fish into a holding chamber. Rather than the holding chamber resting on the bottom of the lake like a fyke trap, a Merwin is suspended by floats that allow fishery workers to check the nets from the surface. Deploying a Merwin trap requires at least one motorized boat to set the leads and to set anchors to keep the holding chamber from floating away. Merwin traps usually have leads that are 12 feet deep by 100 feet long. The holding chamber and float assemblies are approximately 20 feet long by 15 feet wide. Due to the size and weight of these traps, many have trailers built onto the trap so that fishery workers can back them directly into the water from a boat ramp for quick assembly and removal. Given the large size and great weight associated with this trap assembly, transporting them to remote lakes could only be accomplished using a helicopter. A boat is necessary to check a Merwin trap. It would be necessary to have an attended camp at each lake where a Merwin trap was used in order to deter vandalism and check the trap on a regular basis. Like the other mechanical fish removal methods, Merwin traps would not effectively remove fish from streams. For this reason, stream environments would require another fish removal method in order to meet objectives. There are also aesthetic concerns; floats and traps would be visible, detracting from the pristine appearance of these lakes.

2.6.4 Genetic Swamping

This concept is considered a passive method that changes the genetic material in a hybrid population by stocking genetically pure fish on a “frequent or annual” basis into lakes that harbor non-native trout to promote competition and hybridization between species, gradually diluting the non-native genetic material to a non-detectable level (Huston 1990, 1991). Between 1985 and 2000, in an effort to dilute non-native genetic material, 14 lakes in the South Fork Flathead drainage were subject to this type of stocking. It is believed that this method could be expedited if coupled with an intensive program of population suppression by removing hybrid trout using nets and traps.

Coupled with an intensive campaign of gill netting and trapping to suppress hybrid populations, it is believed that following up with genetic swamping could help to reduce the percentage of non-native trout genes in a population even further, though it may not be able to completely remove the genetic introgression. No literature has been found outside of Montana that describes the use of this type of management concept; therefore, it is considered an experimental measure of reducing the risk of hybrid trout expansion.

In remote locations, a helicopter has been used to conduct most of these stockings, including those in wilderness areas. If this type of management were continued, annual flights would be necessary to continue this effort. Discontinuing it would likely allow lakes to resume to a three to five year rotational stocking schedule, thus reducing the amount of stocking flights necessary to implement this management strategy. This method entails stocking at very high densities that can lead to poor trout conditions and growth, compromising the value of the recreational fishery and increasing the costs of hatchery production.

2.7 Alternatives Considered for Suppression and Others Eliminated from Detailed Study

There were ten methods of fish removal that were initially considered for inclusion as a potential alternative to achieve this project’s stated purposes. Seven of the alternatives have been eliminated from further consideration. The remaining three methods (gill netting, trap netting, genetic swamping) may be used in part, in whole, or in combination with each other in order to offer the best suppression strategy for individual lakes. Angling is one alternative that was eliminated as a sole means of removing hybrid trout. However, angling limits may be lifted a few years prior to any action in order to allow the public to remove as many fish as possible. Alternatives eliminated from further consideration are:

- Angling
- Seining
- Constructing downstream barriers

- Using explosives
- Electrofishing
- De-watering
- Introducing predatory fish (i.e., tiger muskellunge)

Each method was analyzed to determine its suitability to achieve fish removal goals in the lakes and stream networks of the sub-basin.

Public scoping comments received between April 30 and June 23, 2003 also provided additional information used in the formulation of alternatives. The following alternatives were developed and eventually discarded for economic or feasibility reasons, or because they did not meet the goals for the project.

2.7.1 Angling

MFWP has the authority under commission rule to modify angling regulations for the purpose of removing unwanted fish from a lake or stream. Unfortunately, this method is not likely to completely remove all fish. There are a number of reasons why this method may not work, especially in backcountry lakes.

First, liberalizing bag limits does not guarantee every angler would keep all of the fish they caught, primarily because of differences in value systems among anglers. Recreational angling has been shown, in many instances, to reduce the average size of fish and reduce population abundance. As the size of fish decreases, angler satisfaction tends to decrease also. For these reasons, it may be difficult to attract anglers to a site for voluntary angling if angling quality is poor.

Next, very small fish are not vulnerable to angling and require approximately two years to recruit into the fishery. During this time, adult fish have the opportunity to continue reproducing.

Finally, anglers in remote rugged country do not typically target small high gradient, inaccessible streams when larger fish prevail in larger streams and lakes. Lifting bag limits on streams would not likely succeed in removing significant numbers of fish due to access difficulties. The amount of time required for anglers to depress a population in a lake or stream would likely require many years to accomplish, and would work contrary to the management goals established for the South Fork Flathead drainage, which is to provide quality angling opportunities in lakes, rivers, and streams.

For these reasons, this method was considered unreliable at achieving the objective of complete fish removal from the lakes and streams; therefore, it was not developed further. MFWP would pursue lifting bag limits two full seasons prior to any removal effort to reduce the number of fish in most lakes, and to allow anglers to harvest fish for consumption. In addition, increasing angling limits at the wilderness lakes could lead to additional impacts of the adjacent lake shore and camp sites, requiring restoration measures and/or the limiting of wilderness users at these sites.

2.7.2 Seining

Seining is a method of fish sampling considered to be an active capture method that involves the use of a long fence-like net to encircle and draw in fish to the shoreline for collection (Hayes 1992). The top edge of the seine has floats attached to keep the net upright in the water, and the bottom edge of the net is weighted to keep it on or near the bottom.

There are several types of seines for varying applications related to water depth, rocky or mud bottoms, large fish or small fish. These include bag, purse, minnow, beach, and lampara seines. To deploy a seine, one end is attached to or held by a person on the shore of a lake, pond, or river and the other end is stretched out into deeper water while forming a "U" shape with the net. In a lake, a boat is used to stretch the seine into deeper water. The seine is gradually pulled into the shore to reduce the area of the "U" or "bag" and the fish are gradually concentrated where they can be removed by dip netting or by pulling the remainder of the seine onshore.

Factors that interfere with the capture efficiency of a seine include obstructions such as submerged trees, rocks, aquatic plants, flowing water, uneven lake bottoms, and steep banks. Seines have been used successfully to capture fish for commercial harvest. Warnick (1977) reported that commercial seining has been instrumental in providing about 80-85 percent of the 20-30 million pounds of carp commercially marketed annually in the United States. Under-ice winter seining in South Dakota was reported to be far more effective for this type of operation, though seining under the ice is seldom employed for fisheries management purposes.

Ricker and Gottschalk (1940) reported that seining was used to greatly reduce rough fish numbers, which improved game fishing in Bass Lake, Indiana. From 1935 to 1936, 142,000 pounds of carp, buffalo, and quillback were removed from the lake by seine, and subsequent surveys on game fish revealed an improvement on game fish size and abundance. The authors reported that although the Bass Lake experiment was successful, similar attempts made on many other lakes ended in failure, partly because of the scarcity of suitable beaches for seining.

Rose and Moen (1952) reported that 12 years of aggressive seining on Lake Okoboji, Iowa yielded nearly 2.5 million pounds of rough fish. Seining on this lake could not remove all of the rough fish, even when accompanied by gill netting and trapping over an extended period of time.

The use of seines to remove non-native trout from the proposed lakes was examined and found to be impractical for several reasons. The three major papers cited for this sampling methodology employed large seines measuring up to 2,500 feet in length. Although complete removal was not listed as an objective, the intensive effort only reduced the number of target fish, never removing them completely. The amount of time necessary to effect a complete removal would require many years, which is similar to other methods of mechanical removal. A crew of approximately three or four people with a boat would be required to be at each lake for an extended period of time.

Given the remote nature of the lakes in the South Fork Flathead, long-term operations would have a negative impact on the aesthetics of the lakes. The general lack of gradual beaches and snag free shorelines makes depending on seining an impractical method. Although seining is used successfully to capture fish in larger rivers and low gradient streams, it would not be a practical method of fish removal from small high gradient streams because of steep stream bottoms, coarse substrates, and frequently changing habitat features (pools, riffles, waterfalls). In addition, there are ample ways for trout to avoid seining in this type of stream, such as hiding under large rocks. For these reasons, seining was found to be an ineffective method of complete fish removal, being inferior to gill and trap netting; thus, it was not developed further as a viable alternative.

2.7.3 Downstream Barriers

The use of a barrier device to contain non-native trout within the proposed lakes was considered. Barrier devices are commonly used to exclude fish from an area rather than contain them within an area. Barriers are typically used in streams rather than lakes, and are used mostly to prevent upstream fish migration. Rotary drum screens are commonly used on irrigation diversions to prevent fish from entering arterial channels.

Barriers have been used with some success to exclude fish from upstream migration in Muskrat Creek, Montana (Shepard, et al. 2001). Thompson and Rahel (1998) reported that a gabion barrier in Wyoming was unsuccessful at stopping upstream migrants because it passed 18 of 86 marked brook trout.

The Michigan Department of Natural Resources (MDNR 1990) reported that barriers are not completely effective in most cases. It is nearly impossible to keep fish from moving downstream with the flow of water. To be effective, downstream movement barriers must account for the exclusion of all sizes of fish. Smaller screen mesh is often used to exclude the smallest of fish, but it is prone to clogging from algae, leaves, pine needles, and insect exoskeletons. In order to keep screens clean and functional, maintenance requirements must be increased. Several mechanical apparatus have been used successfully to harness the energy of the water to clean rotary screens. One such device is used on Hell Canyon Creek in the Jefferson River drainage of Montana (Spoon 2002). However, the structure is surrounded by a concrete box to keep leaves and sticks from fouling it.

Containing fish in a lake using a screen or barrier would require construction of a fortified structure at each lake outlet. These structures would have to contain fish at high flow and be able to function in low flow to prevent damming. Fish screens are designed for application on waterways where the flow can be controlled, most commonly on irrigation channels. If flow is too low, the screen would not pick up debris and deposit it downstream of the structure. If flow is too high, the screen may pick up small fish and deposit them downstream of the structure. A rotary screen would not pick up coarse debris, which necessitates it being cleaned by an attendant periodically. The cost of installation can range from $2,000/cfs to $7,000/cfs (Lere 2002). This cost would most likely be increased greatly because of the remote location sites. In addition, to be effective, the mechanical structure would require frequent maintenance. While screening mechanisms would be installed only for a given time period before being removed, they would constitute a structure within Jewel Basin and a wilderness area.

Fish screening mechanisms are prone to vandalism, especially in remote areas. Finally, rotary fish screens do not work in the wintertime because snow and ice cause them to freeze up. Additionally, the greatest limitation for the use of fish screens in this project is that they would not remove non-native trout that are already in the lakes and streams. For these reasons, a fish barrier and screen alternative was not developed for further consideration.

2.7.4 Explosives

Pneumatic and percussion explosions were considered as a method to remove fish from a lake. The shock wave created by underwater explosions would kill fish by rupturing air bladders and inner-ear structures, and would most likely cause massive hemorrhaging in the gills and brain. Campbell and O’Neil (1999) found that pneumatic concussion during petroleum exploration under the ice caused severe internal damage to the swim bladders, gonads, and kidneys of northern pike and walleye in Sturgeon Lake, Alberta, Canada.

However, caged fish located 5 meters away from the sounding device suffered no injuries, and no delayed mortality was observed on any of the test fish after 72 hours.

A traditional explosive such as dynamite could be used to cause severe injury and death to fish. Lennon (1970) reported that explosives have been used to control fish populations, with only limited success against sharks and gars. Licensed professional blaster Daniel Lewis of Libby, Montana, was consulted to determine the feasibility of using explosives to remove fish from the project lakes. He recommended that 75 percent or 80 percent semi-gel dynamite should be used for such a project because it is water resistant, it would not **detpress**, and it throws a fast shock wave. In his opinion, “an 85 to 95 percent kill can be expected on all living creatures in the water.”

Non-electric blasting caps would be needed to initiate the powder; primacord trunk line would initiate the non-electric caps; and a cap and fuse would be needed to initiate the primacord. Additionally, charges might have to be delayed to reduce damage to a lake bottom or surrounding structure. Millisecond connectors would be required along the primacord trunk line to create the necessary delays. A geologist would be needed to conduct a comprehensive geological survey of the area to determine whether rock fissures in the lakebed would be opened up (possibly dewatering the lake), or an avalanche would be triggered as a result of the shock wave.

At least two professional blasters would be needed at each lake and would require approximately two-four days to survey and develop a blasting plan, and two to three days to set a grid of charges to cover the surface and depth. A final day would be required for the blasters to retrieve lines, make sure every charge was detonated, and to clean up the refuse from the explosives. A motorized raft would be required to safely and efficiently set up the explosives. The amount of dynamite necessary to accomplish this objective would be between two and five pounds per acre-foot.

All of the necessary blasting materials could be safely packed by livestock, or airlifted by a helicopter. Packing explosives into Woodward Lake, for example, would require 4,500 pounds of dynamite, and an estimated 1,000 pounds of detonating materials e.g., caps, fuses, primacord, connectors, rope, floats, and weights. Assuming each mule could carry 175 pounds, approximately 31 mule loads would be required to transport materials to Woodward Lake only. Additional stock would be required for rafts, motors, camp, SCUBA gear, and personnel.

Based on the estimates of only 85 percent to 95 percent success of a complete fish kill, the apparent difficulty of using explosives in many miles of stream environment, and the lack of information available that indicates this method has been successful at removing all live fish from deep lakes in remote rugged mountainous terrain, this method was determined to be ineffective at achieving the goal of complete fish removal from the lakes and streams, and was not developed for further consideration.

2.7.5 Electrofishing

Electrofishing is considered an active capture technique that involves introducing an electric current into the water (Reynolds 1992). The electricity causes an involuntary muscle contraction in fish, and attracts them to the source of the electricity (electrode) where an attendant nets them. Afterwards, the fish revive within about 30 seconds. Electrical variables like voltage, amperage, pulse frequency, and waveform are manipulated to achieve the desired response by fish. Environmental conditions like water temperature, water clarity, water conductivity, and substrate influence its effectiveness. Species of fish, fish behavior, time of year, and time of day are all variables that play a vital role in the effectiveness of electrofishing. Electrofishing works best in shallow water (Reynolds 1983). It is most commonly used to sample fish in rivers and streams, but is occasionally used to sample the shallow water zones of lakes.

The area of coverage of a typical electrofishing boat has been measured and described by Grisak (1997) to be about two meters. The use of electrofishing for population surveys in the Flathead Basin is conducted almost exclusively on small streams. The primary reason for this is that glacial water is low in conductivity, which does not allow for efficient distribution of electrical current to facilitate fish capture. Small streams have a reduced area for fish to hide and therefore fish can be captured despite low conductivity conditions. In deeper water of rivers and lakes, however, electrofishing is not an efficient means of fish capture, especially in low conductivity clear water. In high altitude lakes in the Flathead, electrofishing would need to be conducted at night to offer the greatest probability of capture. For this method of fish capture to be effective, every fish in the lake would have to swim into the shallow zone of the lake and be exposed to the relatively small electric field during the time the electrofishing operation is being conducted. Because electrofishing in a lake is limited to the shoreline, one disadvantage is that there is ample space for fish to escape the electric field. Reynolds (1992) reported that electrofishing is selective for larger sized fish.

Electrofishing a high altitude lake in the Flathead would require a large motorized boat approximately 14 to 17 feet long, two operators, a 5,000 watt generator, a large water tank, a rectifying unit, nets, and miscellaneous equipment. Inflatable rafts have been retrofitted with electrofishing systems and used to sample rough rivers, but this type would not be feasible in a lake. In low conductivity water, larger electrodes are valuable at creating a larger electrical field, but still do not penetrate much beyond two meters in depth. In many electrofishing operations in Montana, the hull of the boat is constructed of metal and serves as the negative electrode. Boats made of fiberglass or plastic employ an external negative electrode, but these are rarely used in lakes, but more often in areas where water conductivity is much higher than in the Flathead Basin. Because the water is very clear in the Flathead Basin, the operation would need to be conducted at night. The boat would need to be transported to the site with a large helicopter. Because of the extended period of time (summer months for 3-5 years) required for mechanical removal of fish, a boat and operators would need to stay camped at the lake for an extended period of time. An outboard motor and 5,000 watt generator would need to be operated for 5-8 hours each night. The operation would involve conducting multiple electrofishing passes along the shoreline for most of the dark hours each night.

Numerous attempts have been made to remove unwanted fish using electrofishing, but this has occurred mostly in streams. MFWP conducted an electrofishing removal of brook trout from 6 km of stream above a barrier on Muskrat Creek (Shepard, et al. 2001). Over a four year period, researchers electrofished 5,386 brook trout from this section and moved them below a barrier. After four years of the electrofishing effort, they concluded that the operation was not 100 percent effective and recommended that some type of fish toxin be used to permanently eliminate the brook trout from the study section.

While targeting spawning areas and capturing fish when they are concentrated is one strategy that could increase the probability of this method's success, it is still selective for large sized fish. Large debris and log jams occupy outlets of many lakes where spawning occurs. Shelf ice is still present in outlet streams of many high altitude lakes during normal spawning periods. Some lakes have been observed to have large rafts of ice present as late as mid July. Westslope cutthroat trout typically spawn in June. Often times spawning is delayed in high altitude lakes because of cold water temperatures and ice conditions. Because westslope cutthroat do not sexually mature until about three years of age, at any given time, there are at least two year classes of fish that would not be present at spawning areas. This would require returning to the spawning sites for at least two more years to attempt to capture fish as they are becoming sexually mature and attempting to spawn. These factors further complicate the use of electrofishing as a method to remove fish from high altitude lakes. Cold-water temperatures and ice free conditions in many of these lakes reduce the window of effective opportunity using electrofishing to about three months per year.

Little literature was found that described the use of electrofishing to eliminate fish from a lake. Spencer (1967) reported that alternating current (AC) electrofishing in experimental ponds killed excessive numbers of intermediate sized bluegills, but had little effect on largemouth bass. A great number of reports were available on the use of electrofishing to remove or reduce numbers of fish from streams (Shetter and Alexander 1970).

This alternative was deemed infeasible because of: the extended amount of time required for an attempt at fish removal; poor aesthetics associated with operating a boat with a generator and a camp at a lake in a primitive area for an extended period of time; low capture efficiency of electrofishing in clear and deep water; low capture efficiency of electrofishing in low conductivity water; and the lack of past success using this method to fulfill the objectives of this type of project.

Lennon (1970) reported that the greatest use of electricity to control fish has been in the sea lamprey program on the Great Lakes. Because this method involved using an electric field to repel lampreys at weir sites, it is not believed to have a viable application in removing fish from the lakes proposed in this project. For these reasons, electrofishing was found to be ineffective at complete removal of fish from the lakes and streams; therefore, this alternative was not developed for further consideration.

2.7.6 Dewatering

Dewatering involves the complete removal of all water from a lake. Dewatering would require the rerouting of water at lake inlets, and the use of one to several high-volume motorized water pumps for an extended period of time. This alternative would completely kill all species of fish in a given lake and is 100 percent effective.

Pumping would require field generators for operation, extensive amounts of fuel that would need to be replenished periodically, long outflow lines to the lake outlet, and periodic machinery maintenance. Transporting the generators, pumps, fuel storage tanks, and other equipment would require several loads by helicopter or aircraft, including the periodic transporting of diesel to refuel the tanks.

Cleanup of the remaining fish in the lake would need to be performed by hand or by allowing the lake to remain dry for a few days. Lake inlets would be opened again, allowing, over time, lakes to refill to their typical depths.

This action alternative was discarded from further consideration because the process for a number of reasons; dewatering would take extensive setup time and equipment; generate sustained noise for several weeks; greatly increase outflow from lakes, which could cause erosion and associated environmental problems immediately downstream; severely impact lake utility for other wildlife and amphibians; and negatively impact recreational resources. Dewatering operations are also prone to fuel spills.

2.7.7 Introduction of Tiger Muskellunge

The tiger muskellunge is a highly voracious predatory fish that is created by hybridizing the muskellunge with the northern pike. Hybridization in the wild was first observed in 1937 in Wisconsin (Black and Williamson 1947), and Eddy first reported artificial hybridization in 1941 in Minnesota (Crossman and Buss 1965). The hybrid is considered to be sexually sterile (Stein, et al. 1981), but some have reported empirical information suggesting fertility in females is possible, though backcross experiments with northern pike have yielded very few viable offspring (Black and Williamson 1947).

This fish has been used for management purposes to reduce the number of rough fish in lakes in order to provide space for more desirable game species (Storck and Newman 1986). Since 1987, MFWP has stocked 53,500 tiger muskellunge in ten water bodies for species control and diversity of angling opportunity. Most of these fish have been spawned at the Miles City State Fish Hatchery with muskellunge semen imported from Minnesota.

Tiger muskellunge prefer soft rayed fish for prey (Tomcko, et al. 1984). They are territorial fish that tend to stake out areas of a lake. Recapturing them by trap and electrofishing in Iowa has been difficult (Gengerke 1985). Similar territorial behavior has been reported for Little Warm Reservoir in Blaine County, Montana and in H.C. Kuhr Reservoir in Phillips County, Montana (Gilge 2002). This difficulty in recapturing has made evaluating some populations difficult. Although growth is slower in cool water ($<62^{o}$F), survival in cool water at stocking time is better (Lemm and Rotters 1986). Confounding information has been presented in the literature about their value to anglers as a sport fish (Storck and Newman 1986; Wahl and Stein 1993).

If tiger muskellunge were introduced into a lake in the South Fork Flathead, they would be allowed to live in the lake until they died of natural causes. Longevity of tiger muskellunge is not reported, but the parental species can live from 24 years (northern pike) to 30 years (muskellunge) (Scott and Crossman 1973). Hybrid vigor is reported to be manifested well in this species causing accelerated growth. This suggests longevity of the hybrid may be reduced.

The lack of information regarding the efficiency of tiger muskellunge to capture trout as prey may make their use in carrying out project objectives unreliable. If trout are not sufficiently used by tiger muskellunge as a prey source due to low abundance or behavioral differences, shifts to other prey items by this top-level predator could have devastating and long-term effects on lake amphibians, reptiles, and water birds. The parent species of this hybrid are notorious for feeding on frogs, salamanders, and ducks (Scott and Crossman 1973).

The time necessary for tiger muskellunge to remove trout from a lake would be protracted because the trout in many of the lakes would be reproducing and providing a continual source of fish to the lake. The size of prey selection increases with tiger muskellunge length (Wahl and Stein 1993; Gillen, et al. 1981). Given this, proportionately smaller prey would be available to tiger muskellunge in the project lakes as the predators grow larger. This may confound the efficiency of the predator to remove the non-native trout from the lakes.

Schmitz and Hetfeld (1965) reported studies that showed the failure of “the pikes” to secure prey of appropriate sizes resulted in marked reductions in growth. Weithman and Anderson (1977) reported that the introduction of tiger muskellunge for fish management purposes is conducted to crop underused prey fish, convert it to valuable game fish, and to reduce the density of adult prey species. They reported that the species should be used in reservoirs with a surplus of prey.

If the desired outcome of the tiger muskellunge introduction in the South Fork Flathead was to eliminate all non-native trout from a lake, the diminishing food supply would undoubtedly lessen the condition of the predator and ultimately affect its ability to remove all of the fish. Total elimination of non-native trout by tiger muskellunge has not been reported. Introduction of tiger muskellunge into the project lakes would not address the problem of hybrid fish in the outlet streams of some lakes. Finally, using tiger muskellunge to accomplish the goals of this project would require the introduction of a new species in a federally designated wilderness area, and in waters in the lower drainage that support federally endangered bull trout. For these reasons, the use of tiger muskellunge was determined to be an impractical alternative for complete removal of fish from the lakes and streams; therefore, it was not developed for further consideration.

Other hybrid species considered during this evaluation included *saugeye* (walleye x sauger) and *splake* (lake trout x brook trout) but were considered impractical, primarily because these hybrids are sexually fertile (Scott and Crossman 1973) and could become self-sustaining in the South Fork Watershed.

2.8 Comparison of Alternatives and Summary of Impacts

To determine which alternatives were the most reasonable and viable, specific decision factors were used to determine advantages and disadvantages for each proposed alternative. This section compares the above alternatives in context of their ability to satisfy project requirements (purposes) and their potential to affect the human environment (impact).

2.8.1 Comparison of Alternatives and their Ability to Meet Project Purposes

Table 2-6. Predicted performance summary.

Project Purposes	Alt. A: No Action	Alt. B: Proposed Action Fish Toxins – Combined Delivery and Application Methods	Alt. C: Fish Toxins – Motorized/ mechanized Delivery and Application	Alt. D: Suppression Techniques and Genetic Swamping
1. Follows the Northwest Power Planning Council's recommendations for the Hungry Horse Mitigation Program	No	Yes	Yes	Yes
2. Administratively efficient and cost-effective	Yes	Yes	Yes	No
3. Avoids or minimizes adverse environmental impacts:				
a) Toxins	Yes	No	No	Yes
b) Ground Disturbance—Site	Yes	No	No	No
c) Ground Disturbance—Transport	Yes	No	Yes	No
4. High probability of achieving the following biological objectives:				
a) Preserves the genetically pure westslope cutthroat trout populations in the South Fork drainage.	No	Yes	Yes	Yes
b) Eliminates from headwater lakes, to the extent possible and in a timely manner, the non-native trout that threaten genetically pure stocks of westslope cutthroat.	No	Yes	Yes	No

2.8.2 Summary of Impacts from Alternatives

Table 2-7. Comparison of effects on the human environment for each alternative.

Affected Resource	Alt. A: No Action (includes current management practices)	Alt. B: Proposed Action Fish Toxins – Combined Delivery and Application Methods	Alt. C: Fish Toxins – Motorized/mechanized Delivery and Application Methods	Alt. D: Suppression Techniques and Genetic Swamping
Fisheries	• No loss of angling opportunities. • May result in loss of genetically pure populations because of length of time required for development of pure lake populations. Hybrids will continue to outmigrate threatening downstream pure westslope cutthroat populations. • Allows time for hybrid trout to influence remaining pure populations. • Requires continued stocking of pure cutthroat. • May reduce size and quality of fish.	• Antimycin works quickly (within days). • Rapidly detoxifies in streams. • Rotenone detoxifies in 1-4 weeks. • Detox can be hastened with KMnO4. • Alternatives B and C have highest probability of restoring westslope cutthroat populations to lakes and outlets in shortest time period, which eliminates outmigration of hybrids and actively conserves downstream pure westslope cutthroat populations.	• Antimycin Works quickly (within days). • Rapidly detoxifies in streams. Rotenone detoxifies in 1-4 weeks. • Detox can be hastened with KMnO4. • Alternatives B and C have highest probability of restoring westslope cutthroat populations to lakes and outlets in shortest time period, which eliminates outmigration of hybrids and actively conserves downstream pure westslope cutthroat populations.	• Genetic swamping will only work if spawning habitat is present in each lake and stream. Allows time for hybrid trout to influence remaining pure populations. • Severely impairs angling opportunities for 5-10 years during implementation. • Not a proven technique. • Selective for larger sized fish. • High densities of fish may reduce size, weight, and fitness of populations, and may affect ability to reproduce.
Wildlife	• None.	• May affect some plankton & insects (gill breathers) for 0-3 years. • None to minor impacts to amphibians. • No impacts to birds.	• May affect some plankton & insects (gill breathers) for 0-3 years. • None to minor impacts to amphibians. • No impacts to birds.	• No risk to plankton, insects, amphibians. • Birds, mammals and other non-target organisms may get caught in nets or traps. • Fish eating birds may get caught in nets. • Selective for larger sized fish.
Water Quality	• None.	• Water quality standards lowered for 0-3 years.	• Water quality standards lowered for 0-3 years.	• Does not work in streams.
Soil and Vegetation	• None.	• At lake sites and during transport, more trampling of vegetation and ground disturbance than Alternative C.	• The least of the two proposed--trampling of vegetation and ground disturbance at lake sites only.	• Requires an attended camp at each site for 5-10 years, thus the greatest trampling of vegetation and ground disturbance of all the alternatives.
Land Use and Wilderness	• Potential loss of wilderness value in the form of pure westslope cutthroat trout. • Does not meet the goals of Conservation Agreement.	• Requires limited motorized equipment to apply in wilderness and in the Jewel Basin. • Delivery methods are an intrusion within Jewel Basin, but preferred over livestock delivery.	• Requires limited motorized equipment to apply in wilderness and in Jewel Basin. Delivery methods are an intrusion within the wilderness and in Jewel Basin.	• Requires extended motorized equipment use (5-10 years). Could have additional site impacts with longer term staffing onsite.
Recreation	• No loss of angling opportunities. • No user conflicts. • May involve future restrictions to safeguard pure westslope cutthroat. • Poor quality of fish due to high stocking rates.	• Loss of angling quality and quantity for 1-3 years. • Temporary noise and visual impacts at treatment sites. Other recreational values would still be intact.	• Loss of angling quality and quantity for 1-3 years. • Temporary noise and visual impacts at treatment sites. Other recreational values would still be intact.	• Long-term angling loss. Fishery is impaired for 5-10 years.
Socioeconomic	• No disturbance to outfitting.	• Loss of angling quality and quantity would impact outfitters for 1-3 years.	• Loss of angling quality and quantity would impact outfitters for 1-3 years.	• Fishery is impaired for several years. • Long-term (5-10 years) impact to outfitters.

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2.9 Preferred Alternative

Based on the findings of analyses summarized in Chapter 3, it has been determined that Alternative B: Fish Toxins – Combined Delivery and Application Methods, offers the highest probability of success by rapidly removing the non-native trout from both lakes and streams while reducing social conflicts regarding wilderness values over mechanical or biological suppression and transportation means. For this reason, it has been designated the preferred method to achieve the purpose and need of the project.

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