Kuehn, Ginny - DM-7

SFFW-037
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From: dale luhman [dtck@digisys.net]

Sent: Monday, August 23, 2004 1:11 AM

To: BPA Public Involvement

Subject: south fork flathead watershed westslope cutthroat trout conservation program comments

attached are my comments on this project. also my 6/23/03 letter with attachments a and b that did not seem to be well incorporated into the draft eis.i figured no one was going to read these comments on saturday and sunday so if i got them to you by monday 8/23 morning to read that would work. i assume you are striving to receive public input at any time in this process so that better decisions can be made by the various decision makers. i would appreciate acknowledgment that you received and will consider these comments. thanks,

dale luhman

8/23/2004

SFFW-037

AUG 23 2004

August 20, 2004

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Attention: Environment, Fish and Wildlife
Email - comment@bpa.gov

This is in response to the South Fork Flathead Watershed Westslope Cutthroat Trout Conservation Program proposal Draft EIS, DOE/EIS-0353.

37.1 While I think the objective to protect Westslope cutthroat trout from becoming listed as an endangered species is a very good one, I do not believe it should be at the expense of the wilderness resource. Wilderness is set aside as a place humans to not dominate or manipulate, where natural processes are allowed to operate freely. Wilderness is a very small percentage of the United States that are best suited to represent flora, fauna, and the natural processes before human changes are done to manipulate most of the landscape to try to better suit his needs. Most higher elevations lakes in the western United States were originally fishless. Over the last 100-150 years, most lakes of any size with any reasonable access had fish planted in them. Many lakes ended up with self-sustaining populations, some were repeatedly stocked, and some were not stocked again because they froze out, were too remote, etc. Most lakes were stocked with fish that were not native to the local drainages. Some eventually were stocked with fish that had the same basic genetics for a drainage. In any event, any fish that were stocked were exotic, not part of the natural system, and disrupted natural processes and non-fish species that existed for thousands of years before these fish were artificially introduced.

37.2 The draft EIS says that 50 of 355 lakes in the South Fork have fish in them, all except Doctor and Big Salmon Lakes were very likely originally fishless. The draft EIS proposes to only remove fish from 20 of these 50 lakes that do not have genetically pure WCT in them. Fish are now located mainly in the larger, deeper lakes in the South Fork. Apparently, research has not been done on these South Fork Lakes except in the last couple of years on the proposed lakes to be treated to determine what assemblages of non-fish species inhabited these lakes, marshes, and downstream areas before the introduction of exotic fish predators.

37.3 Glacier National Park, North Cascades National Park have done research and are doing an EIS to determine what species existed there in lakes before fish. Studies in the Sierras show a dramatic decline in yellow-legged frog due to the introduction of fish. There is so much that we do not know about these natural systems. We tend to focus on species that have immediate, direct benefit to humans- elk, deer, fish, and maybe grizzly bears and wolves because they are large and people can relate to them better. However, it seems that many of human management actions can have dramatic impacts on the associated flora and fauna as humans attempt to manage species so they can more directly benefit human needs. Humans pave, build, and farm on

1

37.3 99% of the United States. It seems only reasonable that at least wilderness should be left as unaltered as possible. In wilderness lately we even try or propose to manipulate habitat and systems to try to undo past human influences - consider lighting fires to make up for the lightning strikes that have been put out over the years. Consider planting whitebark pine to replace trees that have been killed by an exotic blister rust. Consider building new trails or reopening long unused trails to facilitate more human use and access into the wilderness. If the Bob Marshall Wilderness Complex at 1.5 million acres, the second largest wilderness in the lower 48 states can't have natural processes left basically unaltered in the large size with limited potential effects on areas outside of the wilderness, where can we have places that are not manipulated, turned into gardens to try to undo past human impacts or shape the wilderness landscape into something that is more desirable from a human perspective? Not a natural process perspective, but from current human needs?

37.4 This draft EIS displays several methods of accessing the area for fish removal, by stock or aircraft. This seems to have a reasonable discussion.

37.5 For the actual fish removal, the poisons to be considered, rotenone and antimycin, are well discussed, but the gill netting gets minimal consideration. The EIS quotes gill netting might be effective on lakes 7.4 acres in size and 32 feet deep. This would include Necklace Lakes #2, 3, 4, 6,7,9,10,11. With much thought and consideration of minimum tool and the potential effects on non-fish species with the use of poison, it seems like Pyramid Lake at 9.6 acres and 37 feet deep could also be reasonably be considered for gill netting. The EIS then discounts this method because the Montana Bull Trout Scientific Group concluded that gill netting would not result in a complete removal of fish. (p.2-32) in the discussion in Alternative B, the Proposed Actions, one of the excuses for immediate restocking of lakes the next summer after the fall poisoning of each lake, was to ensure genetically pure cutthroat populations in sufficient quantities to ensure domination over any hybrid fish that might remain, and to re-establish the fishery. (P.2-5) this seems to display that rotenone and antimycin are not 100% sure to kill all fish by treatments. If this is the case, then gill netting, trap nets, using explosives might certainly be reasonable to consider.

37.6 The DEIS does not say that for each lake and downstream area following fall poisoning, that the following summer, in what manner the lake would be monitored to see if any fish remain for the next year or two. This would serve two purposes, the first to ensure that all fish had been removed and if not, a second treatment would be in order to actually remove those non-wct genes and not just swamp them, and second, it would open the possibility to leave the lake fishless.

37.7 To leave some lakes fishless, to be more in their original condition, especially for non-fish species, would certainly be appropriate for the natural processes to occur in wilderness instead of the initial stocking and continued stocking in the case of some lakes. Of the over 220 wilderness lakes in the South Fork Flathead, the 20 lakes with fish average over 90 acres in size, while the 200 lakes without fish average less than 1 acre. Certainly leaving representative larger lakes in larger basins with other fishless lakes to represent the original natural systems and to allow possible seriously depleted non-fish species to reestablish themselves would be prudent. Pillod's paper, "Evaluating Effects of Fish Stocking on Amphibian Populations in Wilderness Lakes, " describes such a

2

strategy method. In Jason Dunham's paper "Assessing the Consequences of Nonnative Trout in Headwater Ecosystems n Western North America"; they list 7 key issues for assessing the consequences of nonnative tour in headwaters ecosystems. The North Cascades National Park in the beginning of their EIS to determine strategy on long-term fish management strategy will look at this alternative to restore natural processes in some historically fishless lakes.

37.8

With the seemingly good intentions Montana Fish Wildlife and Parks has now decided that genetically pure Westslope cutthroat trout would be good for the long term for the restocking of these originally fishless lakes and the downstream areas with the fish they want to remove. One thinks of the good intentions of miscis shrimp in Flathead Lake and the disruption on native fisheries. Lead poisoning of hatchery raised fish this summer and how that might affect fish that are stocked in the wilderness. The Hungry Horse dam has cut off the rest of the South Fork Flathead River to protect the upstream section from the various problems of introduced fish down stream. This originally genetically pure Westslope cutthroat trout population has evolved with the stocking of fish (except in these lakes). They have adapted to their places on the 1,898 miles of habitat. A WCT trout likely has different characteristics if it is found in Abbot Bay then if it is found in Youngs Creek. The basic genetic material may be the same, but the behavior and local adaptations cannot be duplicated. if these hatchery fish that were taken from various streams on the South Fork Flathead and an entirely different Clark Fork drainage and are all mixed together, then are continually stocked into lakes and dribble down into the main originally "pure" WCT area, aren't we potentially polluting these original native genes with our new combo mix genes and saying it is close enough as far as we know now?

37.9

Again, 50 years ago as outfitter, angler, and fish and game folks all dumped fish into these barren, useless lakes to try to make productive fisheries out of them, no one gave a second thought to the non-fish species and natural processes that were being disrupted. They just did it. Now it seems, with a broader awareness of ecosystems and how intricately connected everything is, to continue to just dump more exotic fish, even if the basic genetics match, and how humans can so easily mess up things they really do not understand, it is appalling to think that is what is proposed. Most of these lakes have had fish since before the 1964 Wilderness Act, it is a state's right to manage the fishery, so the state will just continue to keep stocking fish as it always has.

37.10

The Forest Service manages the habitat, and for broader landscape systems. Since the state does not really show much more than required cursory concern about non-fish species, it is incumbent on the forest service to look out for non-fish species and natural processes. There is a link and precedent for the forest service to have a say in short and long term impacts of stocking of fish and impacts on habitat. See Peter Landres paper, "The Wilderness Act and Fish Stocking: An Overview of Legislation, Judicial Interpretation, and Agency Implementation."

37.11

My proposal for the wilderness lakes would be to consider all lakes with fish, since all but Big Salmon and Doctor were originally fishless. This must be done to correlate the cumulative effects on the wilderness of fish introduction into these fishless lakes. Since almost all lakes with fish have exceeded Limits of Acceptable Change standards, most in one to four of the measured standards, most for all years since the standards were adopted

3

in 1987, over 17 years it should be a major consideration on whether to continue to stock or not stock fish. Opportunity Class should be the main player in trying to balance which of the larger, deep fishless lakes should remain fishless after fish removal. Opportunity Classes I and II are to be managed as an unmodified and and essentially unmodified natural environment. Ecological and natural process are not measurably affected by the actions of users. Management strongly emphasized sustaining and enhancing the natural ecosystem. These are the most primitive, natural areas within the wilderness. To meet this Forest Plan management requirement, I would remove all fish from Opportunity Class I and II areas and not replant them. Woodward, Lena, Lick, Koessler, George, Devine, Upper and Lower Marshall, and Diamond. I would remove all fish in Opportunity Class 3 and 4 areas and replant them with WCT as a compromise with more recent recreation values, and realizing that continued stocking will likely continue to have LAC standards exceeded well into the future. These two areas are the more impacted end of the wilderness use spectrum. Necklace Lakes, Pyramid, and Sunburst. I would leave Big Salmon and Doctor Lakes alone, since apparently they originally naturally had fish, they have exceeded LAC standards, even though they are in Opportunity Classes 4 and 2 respectively.

37.11 Westslope cutthroat trout are important, and we want to protect this species. However, WCT is part of the river system, not a part of these alpine wilderness lakes. To artificially continue this fish stocking gives a unique recreation experience for visitors, but at the expense of natural processes. We do not achieve naturalness or wildness. as Landres describes in "Naturalness and Wildness: The Dilemma and Irony of Managing Wilderness."

The lakes of the Cascade Mountains in Washington and Oregon, the Sierras of California, the Rocky Mountain Lakes of Idaho and Montana all have had exotic species put into originally fishless lakes. This proposal to remove fish from originally fishless lakes, and then to leave lakes fishless as outlined in the previous paragraph would meet the purpose of action of the project - to preserve genetically pure Westslope cutthroat populations in the South Fork drainage, and to eliminate from headwater lakes and their outflow streams, the non-native trout that threaten genetically pure stocks of Westslope cutthroat trout.

My proposal above would even better meet these two goals, and provide additional wilderness resource benefits. by treating these lakes, once, possibly twice to make sure all non-WCT trout were removed, you would know for sure those non-WCT genes were out of the system, never to trickle down to pollute those original pure WCT genes. The opportunity class 1 and 2 lakes remaining fishless would not have any fish to trickle down to pollute river genes. The OC 1 and 2 areas are more remote and would cause less impact on recreational users. Having no fish would reduce for at least some people the draw of going to a lake to fish. This should contribute to LAC standards improving. Also, the non-fish species would have a chance to have a comeback. If remote, nearby ponds, and marshes that did not ever get planted with fish, might allow amphibians, and insects to recolonize and possibly restore at least some of these originally fishless lakes to a more natural system. The state would not continue stocking and further disrupting these lakes. They could eventually be more representative of natural processes in the

4

37.11 wilderness. The lakes that would be restocked in OC 3 and 4 areas, would also be tested and monitored after the initial poisoning to ensure all non-WCT genes were gone. Once this was assured, then as a compromise between natural processes and recreation use, WCT would be planted into these lakes. If these WCT trickled down to the river, at least every lake would not dribble down these hatchery genes. LAC standards would likely still be exceeded, but this is no worse off then the last 17 years. The original non-fish species of these stocked lakes would be severely suppressed or become extinct, but at least it is in only part of the deep fishless lakes. The state would hopefully just stock these lakes until they became a sustainable fishery and then cease stocking. This would at least leave the human manipulation finished at each lake, and the lake could evolve with these fish. Visitors would not have planes flying over with fish being dumped into them every few years, and a new normal could evolve.

Additional background that shows the impact of fish on non-fish species-

1. 37.12 Ptarmigan Lake Project, Glacier National Park, Jack Stanford- Ptarmigan Lake and two nearby control lakes were studied 2001-2002 and the biotic assemblages that exist in the three study lakes differ noticeably form one another during the 2001-2002 sampling seasons.
2. 37.13 Amphibians of Glacier National Park, Leo Marnell- the introduction of sport fish into a large number of formerly fishless lakes may have contributed to the loss or decline of several amphibians in portions of Glacier National Park. The presence of fish has been implicated in the decline of some amphibian species. Long-toed salamanders were particularly vulnerable to predation by introduced fished in portions of the Cascade Mountains in western Washington and Oregon. Long-toed salamander larvae were not observed in any Glacier National Park water harboring fish, and this species existed close to fish at only 2 of 25 sites. The extent of damage to native amphibians in Glacier National Park as a consequence of fish introductions may never be fully understood.
3. 37.14 The Fish-stocking Controversy, North Cascades National Park Service Complex, 1968-2003, David Louter- the consent decree required that the agency review the fish stocking program through an EIS. The research program, carried out by Oregon State University, lasted for 12 years instead of 3, and only recently concluded in July 2002. The research concluded that zooplankton, insects and amphibian in lakes with high densities of reproducing fish have undergone statistically significant changes in abundance and species composition.
4. 37.15 An evaluation of Restoration Efforts in Fishless Lakes Stocked with Exotic Trout, Deanne Drake- Diatom assemblages in two restored lakes have not returned, with several potential explanations- First, recovery may take longer than the 20-30 years since fishes were removed from the lakes. Second, ecological conditions in stocked lakes may have been driven past a threshold of change- exceeding the bounds or resiliency- from which they will not return spontaneously. Third, other disturbances, such as loss of lakeshore vegetation, may also have affected diatom communities in lakes over the last 30 years. Because few ecosystems are well understood in terms of history, function, or structure, the results of our study imply that ecological restoration of other systems also may be more difficult than managers expect.

5

Repeat 3x If the project is to proceed on any lakes, I feel the following items should be included:

1. 37.16 Trails that do not have a well maintained system trail should not have stock used to transport people, gear and chemicals into them - this includes Woodward, Lena, Lick, George, and Koessler.
2. 37.17 Any stock carrying in people, gear, supplies should be round tripped out back to the trailhead if this mileage is 20-22 miles. It sounds like each lake will take 3-7 or more days to complete. At these sensitive alpine lakes, have many head of riding and pack stock staying for 3-7 nights would largely contribute to the continued exceeded LAC standards. Round tripping stock out to the trailhead should include - Sunburst, Necklace, Pyramid, and possibly Woodward.
3. 37.18 If boats with motors have to be used to effectively mix in poisons, it seems like electric motors or at least 4 stroke cleaner motors should be used. They are quieter, would not spill fuel, and would not give off fumes. It would only seem like the state would have to buy an electric motor.

Specific draft EIS comments include:

37.19 S-3- the EIS implies that more lakes and streams than the 21 listed might be treated if hybridization was determined. I assume a new EIS would be prepared if this came to pass.

37.20 S-4- in Alternative B, the EIS says that all lakes that have fish removed would have WCT stocked in the lake without sampling to see if all of the fish in each lake were killed. Why wouldn't another poisoning occur to make sure all non-WCT genes were removed from each lake instead of just swamping over the top? For each lake and stream below each lake to be treated, what is the expected success rate for the proposed action, 80%, 90%, 99%, 100%?

37.21 S-4- in Alternative D, the EIS says that when fish numbers are reduced, intensive fish stocking would be used to swamp the remaining fish. How does this compare to Alternative B in the number of fish that would be swamped, percentage of success, etc.? It sounds like they are they same alternative except that in some cases some lakes in alternative B would have fewer fish remaining to be swamped.

37.22 S-5- gathering and sinking dead fish in the treated lake would stimulate plankton growth as a food source for restocked WCT. The poisoned fish as well as the restocked fish are exotic species to the wilderness. The poisoned fish should be removed. The wilderness should not be considered a garden when the original natural processes are manipulated for human perceived better conditions.

37.23 S-6- Alternative D- gill netting would require long term camping and storage of equipment to accomplish and this lead to trampling and site degradation. This is what currently exists at almost all lakes with fish. Limits of Acceptable Change standards are exceeded, largely because of the human impacts of people being attracted to lakes with artificially placed fish. Many stock users, outfitters, and hikers come to fish at lakes and cause LAC standards to be exceeded because of these fish. By saying that gill netting might cause standards to be exceeded might be a short term price to pay if the fish were removed and not replanted, so fewer people would come to each lake without the unnatural fish attractant.

37.24 1-8- the 1999 MOU and Conservation Agreement for WCT, says WCT is to be managed

6

37.25 within its historic range in Montana. These fishless lakes are not within its historic range. Protect all genetically pure WCT. The South Fork Flathead River is the only genetically pure WCT. Get rid of all fish in its headwater lakes and the river WCT will take care of itself. The more we try to garden fish management, the more disruptive this is to fish and non-fish species, especially in wilderness where natural processes are to dominate.

37.26 1-9- purpose- eliminate from headwater lakes the non-native trout. Removing all WCT and non-WCT from these lakes and not restocking them meets this purpose very well. This is not displayed as an alternative to be considered.

37.27 1-13- MFWP is proposing to continue historical practices of stocking fish for recreation and to increase biological integrity. Again, not having any fish, WCT or non-WCT in lakes or streams from these lakes, does the best job of protecting the genetics of the native WCT in the South Fork Flathead River.

37.28 2-4- management goals for the fisheries in the South Fork focus on- managing fisheries consistent with wilderness management guidelines - the fact that it is proposed to do at least some of this project with primitive tools, stock versus aircraft, is a plus. However, in the bigger picture, removing fish and then putting more fish back into originally fishless lakes has the bigger impact to the overall natural processes that are supposed to be occurring in wilderness. Your proposal does certainly not meet wilderness values.

37.29 2-5- alt b. again, it is not displayed what the expected outcome is by lake for poison treatment. is Lick Lake expected to have 100 of the original 1,000 fish remain alive after poisoning, then it is restocked with 10,000 WCT so the genetic swamping dominates more quickly than waiting for 40 years? If the objective really is to remove all non-WCT genes from the South Fork Flathead River drainage, would it not be prudent to sample each lake after poisoning to confirm if all fish are dead and then re-treat the lake if fish still live? And if indeed fish are finally all gone, does that not meet the objective of not having any polluting non-native WCT genes dribbling down to the main South Fork Flathead River?

37.30 2-8- speaks to a post treatment survey, but does not commit to anything besides just restocking with more fish.

37.31 2-12 amphibian surveys have been conducted at each lake. Surveys have not been done at all large, deep lakes in the South Fork to see what non-fish species do or did exist at these lakes. Fish certainly had an impact on non-fish species, and by only looking and comparing what exists at lakes with fish, you are not looking at what species have been lost and how stocking and restocking effects them in the short and long term.

37.32 2-25- post treatment gill nets. If live fish remain, a determination would be made to impellent another treatment. Are you supposed to remove all non-WCT genes or not? What is the threshold that will be used to remove the last fish or just dump 10,000 more fish on top of them? What are the professionals anticipating the success is? See S-4 above.

37.33 2-25- rotenone would have on long-term adverse impacts on amphibians in the project area. it is not displayed what the range of amphibians currently are at the proposed treatment lakes, much less what amphibians were there before fish.

37.34 2-26- isolated fish have survived piscicide treatment. So you are saying that no treatment at these lakes is 100% effective. All treatments at removing fish are really to reduce as many fish as possible and continue long term swamping. If this is the case, poison, gill netting, and explosives all seem reasonable methods to use and may have less impact on

7

non-fish species.

37.35 2-27 - there is not a "no restocking" option. This is a reasonable alternative to be displayed to show what the effects on possible non-WCT genes dribbling out of lakes might be, what types of non-fish species could recolonize deep, fishless lakes, etc.

37.36 2-27- restocking decisions - the flat out statement that all lakes would be subject to illegal restocking is not accurate. with some credible education of the public about natural processes in the wilderness, the only places that they have any chance to possibly work with little human manipulation, and FWP puts fish into basically every lake outside of wilderness. putting fish back into opportunity class 3 and 4 areas, and not restocking in opportunity class 1 and 2 areas, would keep the more pristine, remote areas that way and more likely to return to Limits of Acceptable Change standards.

37.37 Just restocking all lakes shows little appreciation or understanding of the wilderness resource, or natural processes. Wilderness is just another recreation place to hunt and fish, it does not have any roads, but fish and wildlife can be manipulated like they can in any non-wilderness area.

37.38 2-35- genetic swamping may not be able to completely remove the genetic introgression. Genetic swamping seems to be part of all alternatives, it just varies by how many fish are being swamped. In this event, none of the alternatives completely remove all non-WCT genes. If that is the case, then the project is to just take out as many potential non-WCT genes as we can.

37.39 2-39- explosives estimate 85-95% fish kill. This is from one persons estimate. It seems like maybe 5 people should be asked their opinion, or maybe do a test lake. If poisons and gill nets do an estimated 95-98%, is that that much better?

37.40 2-45- not discuss wilderness in terms of naturalness and wildness in terms of short and long term impacts as per Landres paper.

37.41 3-2- bob marshall wilderness complex is 1.5 million acres, about 110 miles north to south from hwy 2 to lincoln.

37.42 3-7- protect and restore WCT in their historic range. Outside wilderness, maybe the FWP is empowered to do more manipulation, but it still should consider natural processes. Inside wilderness, natural processes should be dominant, and putting exotic fish into originally fishless lakes does not promote natural processes today or into the future. Growing WCT in the wilderness lakes where they were not historically located does no service to natural processes in the one area where natural processes are to prevail.

37.43 3-10- there is internal and external debate as to when a fish should be considered indigenous. If 1964 is the date, then hybrids should count as indigenous. Continuing to stock fish in fishless lakes regardless of semantics does not serve the natural processes of wilderness.

37.44 3-12 - protect bull trout by removing as many hybrid WCT as possible. Again, it sounds like some, it's not quantified, WCT will remain after poisoning to protect bull trout, and because poisons might not be effective in every nook and cranny of every lake and stream. If this is so, say so and what the anticipated success is for each lake and stream segment. This display might help determine which treatment is best for each area.

37.45 3-13 if piscides combined with swamping any remaining non-WCT should reduce but not eliminate non-WCT genes. Again, what are the chances of success by lake and stream segment? If some are very assured of success, this would rate that segment much higher in remaining fishless.

8

37.46 3-13- using the same M012 stock for all lakes again seems economical, but likely will lead to future genetic contamination of the really, original genetically pure WCT in the main South Fork Flathead. If the proposal persists in wanting to stock WCT into lakes, the least that should be done is to get WCT fish that live in the main stem and use these fish to stock lakes that drain into them. For example, for Lick, Koessler and George Lakes, use WCT that naturally live where Gordon Creek empties into the South Fork for brood stock. Plant these fish into Lick, Koessler and George Lakes. If over the years, fish happen to dribble down from the lakes to the main river, at least these fish will carry the genetics of the original fish from the drainage.

37.47 3-18 - amphibian baseline data has been collected from the project area that indicates that these species are widely distributed throughout the project area. Apparently, the amphibian survey did not consider other large, possibly deep fishless lakes to compare what the lakes currently stocked with fish might have had for non-fish life forms before fish. Lakes without fish, such as Palisades, Olor lakes, Crimson, Pendant, Christopher, Hart, Recluse, Rubble, Marshall Mt., Cooney, Lion Creek, Terrace, are some examples of the many larger and possibly deep lakes that could be surveyed to see what amphibian, reptile, plankton, aquatic insect, etc. may have existed in these lake prior to fish introduction. Until the surveys are done on all large lakes with and without fish, it seems that saying none of the alternatives would have any effects is premature.

37.48 3-20- basing a Glacier National Park FONSI that said noise would not effect wildlife, without displaying what the FONSI said, the project background, etc. seems pretty presumptuous in saying the same effects apply for this project.

37.49 3-22- what food storage method would be used at lakes? Camp occupancy or bear resistant containers? Will piscide be stored in bear resistant containers? Although they are not a food consumed by humans, it could be odorous and intriguing to a grizzly bear to just check it out and tear it open or bite it to see what it is, like has been know to happen with oil and gasoline containers.

37.50 3-23- impacts on amphibians would be minimal. If piscide use kills all fish, it seems likely that it will kill all amphibians in the water. It might be true that some amphibians would still be around after treatment, it does not go into the various life cycles that different amphibians have, where over several years they go from pond, to marsh to lake, and depending on time of year, treatments can be deadly to different species.

37.51 3-28 - spills from pumps and outboard motors. It seems like electric motors instead of those run from gasoline would prevent this possible problem.

37.52 3-26- "Maintain wilderness in such a manner that ecosystems are unaffected by human manipulation and influences so that plants and animals develop and respond to natural forces." This project is supposed to help correct imbalances cause by past actions. People put fish in lakes in the past. We do not like those fish, so we want to kill off the old fish and everything else that lives in these lakes and streams, then put in new fish into these originally fishless lakes, and continue to stock them with fish so people can fish for them. What about this description sounds like wilderness responding to natural forces?

37.53 3-37- "where a choice must be made between wilderness values and visitor and other activity, preserving the wilderness resource is the overriding value." Maybe taking the fish out of lakes might help preserve the wilderness resource, but putting them back into every lake to continue an unnatural process certainly does little to preserve the wilderness resource.

9

37.54 3-37 maintaining naturalness and wildness should dominate what is done in this proposal. Natural and Wildness: The Dilemma and Irony of Managing Wilderness, Peter Landres- paper says that wildness is free from human control or manipulation. Naturalness is native, indigenous. Both are essential elements of wilderness. The present and future of these originally fishless lakes meets neither. In the past fish were planted in fishless lakes- human control of stocking, manipulating the setting, and making less native. Every time the lakes are stocked it is more human manipulation of a non-native organism put into a lake at the expense of those species that were there before fish. This proposal would have deadly human manipulation to remove most life from lakes and affected streams, and then put non-native fish in the short and long term back into these lakes. Neither naturalness nor wildness is met by any measure.

37.55 3-38 a final minimum tool analysis it not normally completed prior to having an approved decision. At a minimum the analysis and decision go side by side. If a decision is made without knowing what the minimal tool choices are, it is not a very informed decision. The EIS should display what minimum tool is for each lake and stream segment. To say that it will be discussed in the details after a broader decision is made does not reasonably display to the public and decision maker what the various consequences are to each decision.

37.56 3-39 - cumulative effects on wilderness resources. There are 50 lakes in the South Fork stocked with fish; all but two were originally fishless. Almost all are in designated or proposed wilderness. The cumulative effects of having 50 of 355 large, deep lakes stocked with exotic fish, on the non-fish species needs to be displayed as an effect on wilderness resources.

37.57 3-40- it is not clear how gill netting and other suppression techniques would disrupt natural wilderness processes and adding poisons and swamping would not.

37.58 3-42-it seems to misrepresent the fishing impacts of listing 21 lakes for this project, and adding them up to represent the 157th out of 1,529 fisheries in the state. Each is a widely separated lake and the highest any lake rates is 320. To then say all of these together represent the 157th biggest fishery does not seem to make sense. One lake ranks at 1,175 out of 1,529.

37.59 3-43- Limits of Acceptable Change- most lakes with fish have exceeded standards. Most have one and up to four measured standards, most have been exceeded for all 17 years since these standards were established. Lakes stocked with fish play a major role in attracting people to lakes. The fact that the forest plan states that wilderness is to be managed within standards should prevail. the fact that some lakes might be getting closer to being within standard, but are still are outside standard after 17 years should be part of the display of information and have a bearing on which, if any lakes should be considered for restocking with fish.

37.60 3-48 - the EIS notes that the LAC standards are not expected to change in alternative B. The connected action of restocking lakes will continue to have lakes not being managed within LAC standards. An alternative that would not restock some or all lakes based on Opportunity Class would likely have at least the lakes that were not stocked come back within LAC standards.

37.61 In general, even though we will never know all we need to know before making a decision on these lakes, I still believe there is a basic level we need to know on the larger,

10

deep fishless lakes. Do we have representative basins that can reflect what non-fish
species were present before the introduction of fish? Can we keep the most pristine areas
37.62 fishless as they originally were in Opportunity Class 1 and 2 areas whether they have any
fish at all? If we must remove fish from all lakes and restock them into some lakes for
compromise or political or social reasons, can we stock the fish for one or two years, and
37.63 then let them become self-maintaining or not, and try to restore as much naturalness and
wildness as we can to wilderness without continued human manipulation? In the
proposed wilderness for Jewel Basin, can you keep the more remote lakes fishless to
37.64 represent natural processes in other areas as well, especially those areas likely to become
wilderness?

Attached is my 6/23/03 letter to you with Attachments A and B. Your EIS addressed
37.65 many of the issues I outlined in attachment A, and did not seem to embrace and include
much of the wilderness and amphibian research outlined in attachment B. This EIS is
still not a very balanced document. Poison non - WCT in some lakes, put WCT back in,
and keep providing a recreational fishery. This does not contribute to natural processes,
37.66 naturalness or wildness, as part of wilderness; it is totally subservient to fish. A
dangerous precedent to manage for a wildlife species at the expense of the overall
wilderness resource.

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11

SFFW-037
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Attachment A

ISSUES FOR WESTSLOPE CUTTHROAT TROUT IN MOUNTAIN LAKES IN THE SOUTH FORK FLATHEAD RIVER – REMOVAL AND RESTOCKING –6/23/03

Alternative methods to remove fish

37.67 Alternatives include ending all fish stocking, liberal angling rules, netting, electrofishing, targeting spawning areas, stocking with predatory sterile hybrids, etc. All alternatives should be fully considered and displayed, not just for convenience and economics.

37.68 Non-toxic alternatives such as trapping, and screening off of spawning beds. These alternatives could be combined with gill netting and other non-toxic methods in treating some lakes.

37.69 Antimycin, advantages should be listed. You need 1/5 the volume of rotenone so for wilderness situations it has merit. Its effect on nontarget organisms is less than rotenone. Antimycin is used in the Wilderness lakes but rotenone is proposed in the non-wilderness. Both sets of lakes have non-fish species that are sensitive to chemicals and areas of streams below lakes that have hybrids. Explain why there is the difference in the types of chemicals being used.

37.70 Gill netting has been shown to be effective in lakes up to 33 feet deep and 8 acres in size. (Knapp and Matthews June 1998) this method should be seriously evaluated and considered for the Necklace Lakes and Pyramid Lake.

37.71 Lakes with chemicals flown in – have people walk in, stay there, walk out. To minimize flights, serious consideration should be given to having people walk in instead of riding stock and then having stock not stay at the lake but taken out to the trailhead to minimize impacts to trails and to lakeshore areas.

Bull trout

37.72 Bull trout spawning and rearing tributaries. It will be critical that a failsafe method be adopted to preclude the accidental discharge of toxified water downstream from these removal efforts. How many miles of stream have both bull trout and hybrid fish? In those areas with both types of fish, is the hope that potential dribble down of planted wct from the lakes will swamp out any hybrids in these sections? If wct were not planted in the lakes, couldn't any hybrids be swamped out with pure native wct from the South Fork Flathead River?

What is uppermost bull trout distribution in each of these drainages? Also, assuming that most of the uppermost reaches end at some kind of barriers or falls. Again, why

Page 1 of 14

can't hybrid wct above the barriers be removed, and not replant wct in the lakes and in the streams above the barriers? If these toxins are supposed to be so effective, there should not be a problem with not having to plant wct in lakes to dribble down to do more swamping.

Directions and agreements

37.73 FSM 2320.22: Objectives – "Maintain wilderness in such a manner that ecosystems are unaffected by human manipulation and influences so that plants and animals develop and respond to natural forces". This is not being proposed based on past actions of planting by FWP, by fish removal, then proposed continued restocking of lakes forever.

37.74 FSM 2320.3: Directs FS Line Officers to select an action alternative which gives precedent to maintenance of wilderness values where there are alternatives among management decisions…except where limited by the Wilderness Act, subsequent legislation or regulations. Maintaining naturalness and wildness should dominate what the Forest Service does and what the Forest Service does in partnership with Fish, Wildlife and Parks. Both agencies need to consider wilderness values, not just specific wants and needs for one project like this fish removal and restocking proposal.

37.75 FSM 2320.6: "where a choice must be made between wilderness values and visitor or any other activity, preserving the wilderness resource is the overriding value.." Wilderness values should dominate all agencies decisions, not just Forest Service decisions based on one species of fish.

Inconsistency between FSM direction and MOU guidelines/criteria -

37.76 Define statutory authorities given court rulings. (Landres and Meyers 2000). This paper notes that "backed by the Supreme Court decisions, federal managers can be involved in wildlife management decisions to defend wilderness values." By having the Forest Service say that the state can stock and continue to stock fish in any and all wilderness lakes that it so chooses, is an abdication of federal responsibility of protecting long term wilderness values, natural processes, and minimizing continued human manipulation of the wilderness.

37.77 "Territorial imperative" is a barrier to wilderness management - *There is some comfort level with the current perception that State has jurisdiction over fish stocking in wilderness as long as there is recognition of* ***shared responsibility*** *for meeting intent of the Act, as well as, other laws that regulate Forest Service actions.* There does not appear to be any shared responsibility for meeting the intent of the Wilderness Act. This project is purposely divided into decisions that each agency is supposed to make independently, without cooperation or adherence to the much touted Bob Marshall Wilderness Complex framework of cooperation between the Forest Service and FWP. There should be shared responsibility for meeting needs of wct as well as wilderness values.

Page 2 of 14

Believe that the Forest Service does not have the authority to allow the State to perform this procedure. It does not seem to meet the Forest Service mission of maintaining wilderness values and natural processes by just letting the state perform exotic fish removal from lakes, and then just let them put in different exotic fish back into these lakes.

Fishless lakes

37.78 We have a very unique and rare opportunity to recreate many large fishless lakes.

37.79 Stocking fish in naturally fishless waters has had a devastating effect on native aquatic biological diversity and biological integrity. I don't believe non-fish species in these originally fishless lakes has been fully considered. What did all fishless lakes look like prior to fish? What is left in these and the remaining lakes as far as non-fish species diversity and makeup?

37.80 Use such lakes for the study of recolonization by amphibians and affected aquatic insect populations? For any of the lakes that don't end up being restocked, they should be studied to see what the recolonization by non-fish species looks like.

37.81 How many of these 355 lakes are capable of sustaining fish. A rough guess is that 95-100% of lakes that can sustain fish in the South Fork have fish in them. Bottom line is that there are few to no large deep fishless lakes due to stocking practices. Large, deep fishless lakes likely have different, if not unique, assemblages of non-fish species. Even though most lakes in the Wilderness lakes have not had fish planted in them, most of the lakes with fish planted, are the largest and deepest. Some of the largest and deepest lakes need to be left fishless.

37.82 There were some lakes, Marshall and Crimson that were stocked by FWP after Wilderness designation. Of all of the lakes in the wilderness, when was each lake likely stocked and by whom, and when was each lake first officially stocked? If any lakes were first stocked after 1964 they stock have all fish removed and not replanted.

37.83 Which lakes are most likely to have 100% fish kill? This should be a strong consideration for lakes to be left fishless.

Genetics

37.84 From a genetic standpoint, it is important that we provide for local adaptations and phenotypic variation. We thought that it would not make any difference to plant lake trout, Kokanee, and shrimp in Flathead Lake, and now a lot of the native fish populations are declining. How do know that using MO12 brood stock from 2 Clark Fork and 10 South Fork drainage streams will not seriously impact the pure native wct that is in the South Fork Flathead River? Is it possible that the unique adaptations that the wct have in the main river and the side streams may allow unique opportunities to survive and thrive?

Page 3 of 14

37.85 The South Fork is the best wct river system that we have left. We have kind of messed up the lakes and some streams from them with hybrid fish. What makes us think by the continued gardening of adding fish with genes not of the exact local streams may lead to genetic pollution and the eventual losing of this native species?

37.86 What is the best WCT source for rebuilding the lake fishery? Can a downstream pure WCT population or other nearby wild WCT populations serve as the donor? This might take more time and expense for the short term, but for the long term would this be a better consideration?

37.87 MOU for Wct in Montana, "Protect all genetically pure populations," "Thus, each tributary that supports WCT, regardless of its length, constitutes a population." If this is the case, MO12 should not be used to stock lakes or other streams.

37.88 We have been told that the genetic diversity among WCT populations may be the result of founder effects or genetic drift. How likely is this?

37.89 What is the Committee's best informed estimate on the issue of whether or not the diversity of these local populations reflects a significant amount of local adaptations rather that founder effects or genetic drift?

37.90 Suppose the appropriate genetics data formed into, say four or five clusters of local populations. And suppose a lake cluster brood stocks were formed by taking stock over the tributaries in each cluster. Would the use of such stocks (compared to M012's serve to: a) decrease the chances of losing alleles, b) decrees the extent of loss of local adaptations, and c) decrease that loss of genetic diversity among the local populations? Extensive discussion on the genetic implications of this project is needed.

37.91 We have been told that, since M012's have been in these lakes for some time now as part of the "swamp-out" program, the downstream WCT populations are probably already inter bred with the M012's. Is this simply a guess, or is there evidence for this claim? Is there any reason to think that there are pure local populations in sections of the tributaries that are not interbred with the M012's? Are there any genetic markers that can be used to distinguish (with a fairly high degree of confidence) pure WCT's that have M012 genes from those that have not?

37.92 It has been suggested that the leaking of M012's into the downstream local populations could provide a remedy (or prevent) inbreeding depression. Is there any evidence that these populations are suffering from (or on the verge of) inbreeding depression? If so, is interbreeding with M012's the best way to deal with the problem from the conservation genetics standpoint?

37.93 If there is currently insufficient genetics (or other) data to answer many of the above questions, does the Committee believe that – strictly from the standpoint of the conservation biology of the project – acquiring the relevant data before restocking these lakes with M012's would be the appropriate course of action?

37.94 We are deeply concerned about the ongoing hybridization in thee tributaries, and agree that the immediate remedy is to eliminate the non-native (and hatchery cutthroat) lake populations using techniques most compatible with wilderness.

37.95 We believe that in a project of this magnitude and potential impact on wild native WCT populations, it is extremely important that it not be launched until the scientific issues most relevant to its success as a conservation project are considered and resolved in accord with the best available science.

37.96 Our preliminary review of the genetics data available indicates that it is focused on the hybridization issue and is insufficient in scope to provide a basis for assessing the overall genetic makeup of the tributaries affected by the project.

37.97 Before restocking, we would like to see a thorough review of alternatives to restocking with a single generic brood stock. (Raise local brood stocks instream, or at a local hatchery, or plant lakes directly from their associated tributaries?

37.98 Restocking with M012 WCT appears to be in conflict with the Upper Missouri Westslope Cutthroat Trout Committee. We do not now recommend that WCT be introduced into waters containing or connected to waters that contain pure WCT populations unless the existing pure population is the source of the introduced fish. This recommendation will prevent the possibility of breaking down local adaptations due to interbreeding of extant fish with introduced fish.

37.99 At a minimum FWP should address the consequences from stocking M012 on phenotypic variation versus the consequences of a few remaining hybrids (if a complete fish kill is not achieved) on the downstream native fish population.

37.100 It is highly possible that once hybrid genes are removed from lakes that seeding and swamping of remaining hybrids in the stream is achieved by pure wild fish moving upstream. This possibility without restocking the lakes should be displayed.

37.101 Given that hybrids have been present for 70 years, it is important to remove hybrids, but not sure of the urgency. Whatever we do, let's do it right with the best information that we have, or with more information to collect if needed.

37.102 If we are stocking with M012 is viability an issue since there is always a hatchery source?

37.103 We know that there are WCT downstream. We don't have enough genetic info yet but in all likelihood there is a gradient of hybridization with the highest near the lake to little or no downstream at confluence. If hybrids are removed from lake and trickle down effect is removed or reduced doesn't seeding also happen from downstream pure wild fish upstream? In other words, wild pure fish swamp out hybrid stream fish since hybrid source is gone from lake.

Grizzly bears

37.104 Indicate how the thousands of poisoned fish will be disposed. If they are not removed from the wilderness, what will be the effects on wildlife, including threatened and endangered species like grizzly bears, that feed on the poisoned carcasses and to whom fish will be food attractants?

37.105 Fish are not a natural part of this ecosystem- all dead fish should be removed from site by packing or flying out to minimize unnatural food sources for grizzly bears and to minimize artificial nutrient additions to this area. To sink dead fish to add to the unnatural nutrient loading of the lake further disrupts natural processes.

Illegal fish stocking

37.106 In response to the concern that outfitters or other will illegally stock these waters with exotic fish, we would suggest that if the existing fish are removed, the State of Montana should permanently close these lakes to angling. This should be included as mitigation in alternatives.

Monitoring

37.107 The success of chemical rehabilitation should be assessed through pre and post treatment inventory using gill nets, electrofishing, and/or underwater visual inspection. If this isn't done, FWP will never know how successful their treatments were.

37.108 The full extent of the impact of introduced fish on amphibians (specifically Columbian spotted frogs) will probably only be able to be determined through experimental removal or introduction of fish with post, pre and post treatment estimates of relative abundance.

37.109 We have been told that one reason for immediately restocking the lakes is to swamp out any remaining Yellowstone cutthroat trout or rainbow that remain after rotenone or antimycin treatment. This project has as its goal the total removal of all exotics in the lakes involved. It is technically reasonable to suppose that (at least in some cases) the rotenone or antimycin treatment will be totally successful? Could a program of subsequent monitoring (say, by netting) give reasonable assurance of the completeness of the treatment program?

37.110 Some amphibian surveys have been done over the last year or two, but I don't believe they have been done on all 350 lakes to determine what biota is out there or what used to be out there. What is the likelihood that a species like the mountain yellow-legged frog exists near extinction or is extinct from past fish introduction? What type and amount of surveys should reasonably be done to be satisfied what species are or have been out there?

37.111 This project should not proceed without substantial information on the biota of the lakes being treated. It is critical to know what species of zooplankton, invertebrates and

Page 6 of 14

37.112 amphibians live in these lakes prior to treating them. This project has focused on the fish and barely addressed the other organisms in the lakes. The best way for this project to proceed it to use 2-3 lakes as a pilot to document the impacts, or lack of impacts, on these aquatic communities to justify proceeding with the full scale watershed restoration project. I highly recommend doing a BACI (Before, After, Control, Impact) type pilot study to document the potential effects of this project before proceeding. This could be completed in 2004 and 2005, and would not hold the project up because (1) 3 lakes could be treated in 2004 as part of the pilot study and (2) the pilot study could provide useful information by the end of 2005. By conducting biotic inventories prior to treatment, this project could be used as a model for future restoration work throughout the west and provide important and timely scientific information.

37.113 We specifically request discussion of impacts to non-target organisms such as amphibians and invertebrates from local and national research.

37.114 There is an assumption by FWP that we may not get a complete fish kill. The effectiveness of the treatment will vary by lake, the most compounding factors being depth and volume. We should be ranking lakes from low to high on what our expectations are for a complete kill and then monitor to determine if we get a complete fish kill. We could defer stocking for 1-2 years at a minimum in high probability lakes (of getting complete fish kill) to determine if we met our objective to remove hybrids. If we get a complete kill, this should eliminate the need to stock a lake to "swamp" the remaining hybrids. We can couple this information with angler days, remoteness, chances of bait bucket reintroduction, needs of non-fish species, etc. to identify lakes which provide the best opportunity to return to fishless characteristics. To date FWP has had a 100% success rate on the 7 treated lakes to remove trout. Observations from the lakes that have been treated in the Flathead over the last 7 years was that a complete kill was achieved in all cases. Professional fisheries biologists concur that complete kills for trout are common in lakes.

37.115 Several times over two seasons survey all 44 lakes with fish and their surroundings to determine existing biota to determine, which, if any lakes should remain fishless. This should capture most of the life cycles of non-fish species.

Motorized Project

37.116 Agencies should set a good example by conforming to the regulations that make Wilderness Areas special places.

37.117 I think the only way this project can justify the use of helicopters and motorboats in federally designated wilderness is if doing so will result in higher success of exotic fish eradication. And then, how much higher success?

37.118 Outboard motor use should be specified to consider 4 stroke motors or other low pollution models such as electric motors. We request further substantiation that rowing is infeasible.

Page 7 of 14

37.119

Helicopters are noisy and obtrusive. The noise assessment should include the numerous overhead trips affecting residents living in adjacent wilderness and users of wilderness expecting freedom from such motorized obtrusion.

I urge you to avoid setting an undesirable precedent by using motorized equipment for this purpose.

37.120

This is definitely not an emergency. If this is not a cost effective project, by using conventional methods such as horseback or on foot, then it should not be done.

37.121

I hope that at some point there is some strong consideration given to using an efficient helicopter. Cost can't be the only factor considered. There needs to be some discussion of the value of reducing the number of flights.

The number of flights and cost could be reduced by leaving the crew on site over night in non-wilderness lakes. People should walk in, or ride in if they must, but stock should not overnight at the lakes.

37.122

Would it be better to disturb 2 lakes in the same area in a year rather than 2 lakes in 2 very different areas?

37.123

Motorized use precedent from the past. For ALL lakes with fish, identify when fish were first officially or unofficially planted by foot or stock, and then each was first planted by aircraft.

37.124

When were Sunburst, Pyramid and Woodward Lakes planted?

37.125

It should be clearly displayed when and how fish were originally stocked in the lakes. If they were stocked before the Wilderness Act in 1964, there might be an argument for a preexisting condition, but any lakes originally officially stocked after 1964 for the first time really should have done so with analysis and public review in context with the Wilderness Act and I do not believe this has been done. This current proposed project should take into account the cumulative effect of the Wilderness and non-wilderness lakes of the South, Middle, and North Forks, and put it in context with the rest of the Bob Marshall Wilderness Complex and how many lakes remain in their original fishless state. Put this in context with the western United States as to how many lakes of any size and depth really remain fishless to fully represent the non-fish flora and faun of these unique ecosystems.

Non-motorized project

37.126

The wear and tear of the trails can be done by lighter loads and traveling when the trails are dry. Consider packing in any chemicals in bear resistant containers in August when the trails are more apt to be dry.

Page 8 of 14

37.127 No size and number limit Yellowstone Cutthroat, Rainbow, cutthroat, for a three-year period.

But this may ultimately be a social issue where some compromises become necessary to gain public acceptance. A more limited use of motorized equipment may be feasible for some of the lakes.

37.128 We realize that some of the lakes will be hard to access, but with a little work and some ingenuity we are sure a non-motorized solution can be found. One of the things that make wilderness areas stand out from the other 99% of the land in the United States is that motorized and mechanized equipment are not allowed.

The management of wilderness is not always cost efficient.

37.129 Where round trip travel is less than 20-22 miles consider taking stock out of the wilderness rather than camping with stock at the lakes.

37.130 So will non-motorized boats with oars be used to go around each lake for 2-3 days to make sure all fish are picked up and removed from wilderness?

Non-fish species

37.131 Once extirpated from a lake, the large-bodied species may not be able to recolonize, even if fish are removed, due to their limited ability to disperse.

37.132 Loss of amphibian species and populations are of global concerns. Declines for both endemic and widespread amphibians are believed to be the result of habitat degradation and alteration. Despite widespread declines of amphibians, we still to not have a definite answer with regards to our local species, spotted frog, long toed salamander, and boreal toad. Deferring stocking will enable us to search for answers.

37.133 Describe what other species exist in these lakes, and how they might be affected by rotenone or antimycin. What will happen to the native amphibians, zooplankton, macroinvertebrates, and the wealth of native biota that may still exist?

37.134 Trout reproduction was occurring in inlet/outlet streams (presence of juveniles) which indicate that rotenone or antimycin would have to be applied to the streams also, not just the lakes. Result of applying rotenone to feeder streams would be the probable loss of 4 years of tailed frog cohorts.

37.135 Leave the lakes fishless, so the native biota can regenerate. Regeneration of the native biota will be in the long-term interest, support, and preservation of the Concept of Wilderness and the wild character of this area.

37.136 While it is possible that fish stocking has extirpated species from local sites and portions of watersheds they clearly have not extirpated either of these species from the entire landscape.

37.137 We concluded that various life stages of 4 species could be negatively affected by the use of chemicals.

37.138 The effects from inbreeding depression and changes in local adaptations should be discussed. What are the effects of restocking on amphibians, WCT, invertebrates. What is the effect on impacts around the lakes, etc?

37.139 For all 44-50 lakes with fish in the South Fork, a strategy will be determined to insure that native amphibians and other biota are represented in natural processes to restore or maintain these populations.

Non-lake origin streams with non-native genes

37.140 Are there any thoughts of how to treat non-lake origin streams that contain non-native genes?

It would also be useful to complete more genetic surveys of the tributaries in question to get some measure of the genetic diversity of these populations.

Planning

37.141 Start developing "subbasin management plans" which should cover how we manage all aquatic (including fishless lakes, amphibians, etc.)

37.142 I propose that there are several lakes in the South Fork that can be considered isolated and thus should have fish removed and not replanted.

37.143 Identify the lakes which pose the greatest threat to WCT genetic integrity.

37.144 The main purpose for this proposed action seems to maintain the integrity of westslope cutthroat trout. I believe at least an equally compelling reason for this project is to restore and maintain naturally occurring processes in the Wilderness as required by the 1964 Wilderness Act.

37.145 How can we ensure the persistence of native amphibians at the level of a local watershed for the long term given that fish may not be the only management issue of concern while maintaining enough sport fishing opportunities to maintain public support?

37.146 From a cumulative effect and looking at the short and term effects of allowing natural processes to operate at least in the wilderness, should the different environments that the 350 lakes represent - size, depth, elevation, wetlands, amphibian habitat, etc. be sorted into some kind of representative groups for the 350 lakes, and then see how many of the total 46 lakes with fish should be kept fishless to represent natural processes in these groups? If only the 27 of 46 lakes with fish are looked at for removing fish, the 19 lakes with wct that aren't being considered to have fish removed might have better representative habitat for being fishless for the long term.

37.147 I think this project is somewhat misguided. Wilderness lakes should not be used as genetic refuges or a source of genetic swamping for westslope cutthroat trout at the expense of native biota. This approach may be appropriate management for non-wilderness lakes, but wilderness lakes should be managed to maximize both naturalness and wildness. Removing an exotic fish using invasive procedures (helicopters, boats, poison) only to restock with a different non-native fish (to those ecosystems) is inappropriate for wilderness. From the wilderness perspective, leaving the lakes as they are is far better than what this project proposes to do. However, given the status of westslope cutthroat trout and the perpetual (and real) problems with downstream movement of exotic fish out of these mountain lakes, I recommend leaving the lakes fishless after treating with rotenone or antimycin. The argument against this approach is that any fish that were not killed by the treatment would repopulate the lake. If this is true, then maybe an alternative or combination of fish eradication procedures should be implemented to insure success. Leaving the lakes fishless would serve several purposes: (1) protect downstream pure strain populations of westslope cutthroat trout, (2) allow amphibian populations to recover (there are many well documented studies that demonstrate that introduced salmonids suppress native amphibian populations), (3) allow other native flora and fauna to recover, restoring the natural ecosystem processes of the lakes, (4) gain support from wilderness advocates.

37.148 A recent federal court ruling now requires, under the Clean Water Act, a National Pollution Discharge Elimination System permit?

Public involvement

37.149 Our original intent with forming the Limits of Acceptable Change approach to planning and dealing with Wilderness issues was to involve as many diverse citizen interests as possible. In doing so, we hoped a better understanding of state and federal responsibilities could be achieved (i.e. "consensus building"). It appeared to be a better way of doing business.

Research

37.150 High mountain lakes have had little research conducted on them. There is so much that we do not understand. Are there unique assemblages of zooplankton or aquatic invertebrates in large, deep, fishless lakes that do not occur in shallower lakes because of potential winter kill?

37.151 One of the objectives would also be to conduct research in cooperation with the State and the Aldo Leopold Wilderness Research Institute.

Page 11 of 14

Rotenone and Antimycin

37.152 Discuss the effectiveness of the rotenone and antimycin treatment for killing all the existing fish in the lakes. Without that information there is no way to determine how MDFWP's preferred method stacks up against other potential methods of fish removal.

37.153 The effects of the rotenone or antimycin downstream as water flows from lakes.

37.154 There should be analysis of impacts to other species such as amphibians, plants, insects, invertebrates and other sensitive taxa from using rotenone or antimycin.

37.155 Poison making their way down creeks via the extensive faulting of sedimentary rock in this area? How long will the poison persist in the lake? The creek and other streams?

37.156 What about the thousands of dead and decaying fish after treatment and affect on water quality? The nutrients from the dead fish are not part of the natural system.

37.157 Does rotenone or antimycin pose any threat to other species – birds, mammals, aquatic micro-organisms?

37.158 Concerns with the use of potassium permanganate (KmnO4).

37.159 What would be the tradeoffs of powdered vs. liquid in terms of weight? If pack animals are to be used it might be worth pursuing an analysis?

37.160 To date FWP has had a 100% complete kill on mountain lakes. Options also exist to do a 2nd treatment rather than stocking to remove remaining fish if a complete kill is not achieved. What are the economics of a 2nd treatment vs. restocking to remove remaining hybrids if any?

37.161 Fish would be removed from the shoreline. How would they be disposed of?

37.162 $KMnO_4$ can be applied using detox stations far downstream of the lakes, but still above bull trout range. This implies that streams may be treated so the effects should be analyzed and sites disclosed.

37.163 If rotenone and antimycin are supposed to be so effective, why is there a need to restock? It doesn't seem reasonable to not consider gill netting or other methods than chemicals because they aren't 100% effective, and then propose chemical use as very effective. But if chemicals too are not 100% effective, and then say you must swamp just in case, then all methods of treatment should be reasonably considered.

Stocking

37.164 An alternative would be to request a one time stocking that will minimize long term mechanized impacts from aerial stocking.

37.165 Likelihood to be restocked by public – size, access, ease in getting to lake, amount of use, wilderness opportunity class, LAC standards, average angler use, outfitted use, year originally stocked- if so, by who? Should help determine which lakes remain fishless.

"Accessibility" by the public would seem to be criteria for stocking.

37.166 I do not believe this project can be fully accomplished as planned due to your statements that the Big Salmon Lake would not be treated because of its size would be impossible to do so. Therefore, there would always be the exotic fish in the wilderness.

37.167 If stocking after rotenone or antimycin is proposed because there may not be a complete kill, is it possible to pursue these other alternatives and achieve similar objectives and outcomes? It appears that they may have been dismissed too quickly.

Swamping

37.168 Has swamping out worked in many cases and has failed in other cases?

37.169 You also state that populations have not responded to swamp-out over a 16 year period. Has swamping out been working on other lakes and their outlet streams and can this be proven with genetic data?

37.170 If we attempt to remove exotic fish, and not all are successfully removed, do we need to deep adding more fish to these lakes indefinitely to try to swamp out the exotics? What is the probability of success with swamping lakes, and when do we know when we have succeeded?

37.171 "Swamping" could occur from wild pure fish downstream rather than from M012 from the lake.

37.172 Swamping has been attempted and cannot assure complete eradication of exotic species – why then is swamping all lakes still part of the proposed action?

Wilderness

37.173 Limits of Acceptable change standards from the 1988-1992 period and changes to the 1993-1997 period and on to the 1998-2002 period should be reviewed to determine which lakes might benefit by not restocking to reduce the human impacts on these Wilderness lakes.

37.174 Once designated as Wilderness, nature must be allowed to operate unrestrained or untrammeled. Thus, unless there is a management requirement (such as protecting an endangered species) or a specific exception in the law (such as fire control), the existing condition should evolve on nature's terms. This should be discussed related to wildness and naturalness.

37.175 While FWP may view economic considerations as the overriding factor for the alternative it chooses, the Forest Service is required to put Wilderness first. "Where there are alternatives among management decisions, wilderness values shall dominate over all other considerations…" FSM 2320.3 "Where a choice must be made between wilderness values and visitor or any other activity, preserving the wilderness resource is the overriding value. Economy, convenience, commercial value, and comfort are not standards of management or use of wilderness." FSM 2320.6 FWP cannot undertake this project without Forest Service approval, and is should strive to meet the standards of the federal agency and the Wilderness Act before requesting it.

37.176 A minimum requirement decision guide evaluation including a minimum tool analysis should be completed for each lake that is determined to be restocked with western cutthroat trout.

37.177 How accessible are the lakes to stocking/ consideration should be given to how many miles in by maintained stock trail? How many miles by user made trail? How many angler days occur at each lake now? Are one or more Limits of Acceptable Change standards at a lake exceeded? The lakes in the most pristine opportunity classes 1 and 2 should have as natural occurring processes and be as fishless as possible.

37.178 The sight and sound of helicopters and motor boats in these areas is offensive to those who enjoy and recreate in these areas.

37.179 Highlight wilderness solitude versus outside wilderness.

Page 14 of 14

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SFFW-037
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Regarding - The Proposal to remove non – westslope cutthroat trout and then plant westslope cutthroat trout back into Wilderness Lakes –

The Montana Department of Fish, Wildlife and Parks (FWP), with funding from the Bonneville Power Administration (BPA) is proposing to remove and then replant fish in lakes that were historically fishless in the South Fork Flathead River in the Bob Marshall Wilderness and other lands proposed as wilderness to protect westslope cutthroat trout (wct) values.

My understanding of this FWP proposal is that the State is trying to protect the westslope trout and attempt to prevent it from being listed as a threatened species. Over the years private parties and the state have stocked many lakes that were originally fishless for recreation fishing opportunities. Some westslope trout and other species not native to the drainage were planted. In those lakes that have species that are not native to the drainage, i.e., non-westslope trout, the state wants to remove these fish so they don't "dribble down" from the lakes into the creeks and then down to the South Fork Flathead River where they might interbreed with the native westslope cutthroat trout and taint the gene pool.
37.180 The State wants to remove fish from just those lakes containing non-wct, and then put wct back into those lakes to maintain recreation fishing opportunities. They want to do this as economically and efficiently as possible and do not want to consider any other variables or options.

37.181 Most of this proposed project is located in Wilderness, whose legal mandate is to retain its primeval character and influence, and is protected and managed so as to preserve its natural condition. Wilderness should promote both wildness- an area free from human control or manipulation, and naturalness- native and indigenous systems in Wilderness. Wilderness is intended to be managed with minimal human intrusion and to let natural systems operate freely.
37.182 37.183 Past and continued fish stocking provides recreational fishing opportunities, but does not promote or provide for natural processes within Wilderness. Fish stocking impacts many non-fish species, such as amphibians, zooplankton, and invertebrates and the unique food webs that each lake represents.
37.184 Almost all of the other lakes proposed for fish removal and restocking are located in areas that are proposed as wilderness in the Flathead National Forest Plan, and management direction states that no action can occur which will reduce these area's wilderness attributes.

Page 1 of 3

37.185 Initial issues that should be considered in developing the purpose and need and creating a proposed action – (see attachment A) I believe that all of these issues should be considered in the assessment of this project.

37.186 From the research I have read (See attachment B) related to this project, I believe a broader study should evaluate all 224 Wilderness lakes and also the 134 non-wilderness lakes in the South Fork Flathead River drainage. In Wilderness determining how many lakes have ever been stocked, how many still have fish (17?), how many may have fish (10?), and what the non-fish flora and fauna currently looks like at each lake. What deep lakes need to remain or which lakes need to become fishless so that at least representative natural systems can remain in place and endure for the long term? Right now in the wilderness, the average size of all lakes is 8 acres, while the size of the lakes with fish is 83 acres. For the non-wilderness lakes the average size of all lakes is 5 acres and the size of lakes with fish is 17 acres. The point is, that even though there are many lakes without fish, most of them are very small, and probably freeze out every winter and have very different characteristics than the larger, deep lakes with fish that probably don't freeze out and support different types of non-fish life.

37.187 All of this referenced research indicates that there is so much more to consider in these wilderness lakes than just the westslope cutthroat trout and hybrid trout that people have put into these lakes. I think All of these referenced research papers should be considered to develop a better proposal. Two articles seem to be especially relevant, "Local and Landscape Effects of Introduced Trout on Amphibians in Historically Fishless Watersheds" and "Evaluating Effects of Fish Stocking on Amphibian Populations in Wilderness Lakes", both by David S. Pilliod and Charles R. Peterson.

37.188 To restore natural processes it would be important to consider and evaluate removing all fish from all lakes that were originally fishless. (Except Big Salmon and Doctor Lakes that apparently originally had fish)

37.189 For Wilderness character and values, the effects on wildness and naturalness should be fully considered. The use of motorized equipment, chemicals, gill nets and other tools should be fully evaluated with the minimum tool analysis to determine, which lakes, if any, might warrant some kind of manipulation.

37.190 The action of restocking lakes with westslope cutthroat trout that have had fish removed should be evaluated separately and fully consider whether stocked lakes are necessary to provide a recreational fishing as a wilderness-dependent activity. A balance between recreation fishing opportunities and natural processes needs to be assessed, with the effects of exotic fish on non-fish native species, and the short and long term impacts of stocking considered, evaluated, with effects displayed.

37.191 While westslope trout conservation and protection is a very important objective, I don't believe it should be the primary or the only objective for this proposal. I think the purpose and need should protect westslope cutthroat trout, but also maintain and restore natural processes, to increase wildness and naturalness, to manage wilderness within limits of acceptable change standards, and to manage the wilderness for the use and enjoyment by visitors, but keep the lands unimpaired for future use and enjoyment as

Page 2 of 3

wilderness. Limiting the purpose and need to just fisheries values and not including wilderness with its natural processes and native non-fish species seems to be an abdication of Forest Service management responsibilities to use this opportunity of this fisheries driven proposal to help in restoration of wilderness natural systems. All lakes in the South Fork should be assessed for the cumulative impacts of past actions from the historical base of not having fish in any of the lakes but two. The proposed restocking of new exotic fish by the state into these lakes is a foreseeable connected action, and needs to be considered for the short and long term effects.

37.192 I would offer these types of alternatives to be considered to meet your proposed purpose and need, while also meeting other wilderness values. (See Attachment C) I believe that this is a reasonable range of alternatives to consider for this EIS that would still meet your proposed primary objective of protecting wct.

37.193 With what I know about the entire project, I would offer my Attachment D as my preferred alternative to be evaluated. This would provide some recreational fishing opportunities in the more accessible opportunity classes of the wilderness, while maintaining fishless status and more pristine conditions in the more remote areas. Note that I would consider ALL lakes for their potential for fish removal, whether wct or hybrid. This would meet your proposed primary objective of protecting wct, but would also protect the wilderness values of naturalness, wildness, and natural processes.

Thank you for the consideration of my comments. Please keep me on the mailing list.

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Page 3 of 3

SFFW-037

AUG 23 2004

Attachment B

Research

Repeat throughout

37.b1

These are quotes from the research paper summaries that follow. It is perfectly clear to me that there is so much more to the issue recreational fishing of westslope cutthroat trout in Wilderness Lakes. Wilderness values, effects on the original non-fish species, and disruption of natural processes have as much weight, if not more, then a potentially threatened fish species being considered to be stocked in originally barren, fishless lakes in the Wilderness. I believe that at least all of these referenced research papers should be considered in a balanced proposal to address fish removal and the possible replanting of fish into originally fishless lakes in the Wilderness.

See 37.b21

Because they have the potential to provide the best remaining standards of relatively unmodified landscapes, protected areas in North America (such as wilderness areas and national parks) have tremendous ecological and scientific value (Cole and Landres 1996). Although the montane ecosystems of western North America are particularly well represented in this complex of protected lands, aquatic habitats within these protected areas are often subject to management practices that are inconsistent with the goal of maintaining natural processes. The most prevalent of these practices is the introduction of salmonid fishes (such as trout) into historically fishless ecosystems to create recreational fisheries.

These stocking programs have dramatically transformed the formerly fishless aquatic ecosystems within protected areas of western North America. For example, of the estimated 16,000 naturally fishless mountain lakes in the western US, the majority of which are located within national parks and wilderness areas, 60% of all lakes and 95% of larger, deeper lakes now contain nonnative trout (*Oncorhynchus* spp., *Salmo* spp., *Salvelinus* spp.) (Bahls 1992).

The management of nonnative trout populations in protected areas is highly controversial due in large part to increased awareness of the ecological effects of introduced fishes on naturally fishless ecosystems (Duff 1995; Fraley 1996). Although the state agencies charged with managing aquatic ecosystems within protected areas have historically focused on providing recreational fishing while placing little emphasis on ensuring the maintenance of natural processes, fisheries managers are increasingly being asked to justify their stocking programs in light of a growing body of literature that documents the effects of fish introductions into naturally fishless lakes. These studies have repeatedly demonstrated that fish introductions dramatically alter native vertebrate and invertebrate communities, often resulting in the extirpation of native fishes, amphibians, zooplankton, and benthic macroinvertebrates (Anderson 1972; Stoddard 1987; Bradford and others 1998; Carlisle and Hawkins 1998; Tyler and others 1998; Knapp and Matthews 2000). However, these studies have typically focused narrowly on the direct impact of fish introductions on the native fauna and ignored the possible disruption of ecosystem processes (but see Leavitt and others 1994) as well as indirect landscape-scale impacts transmitted beyond the boundaries of those habitats subject to fish introductions.

37.b2

He concludes that in the face of increasing public support for protecting natural processes, the continued stocking of fish into wilderness ecosystems is no longer justified.

37.b3

They conclude that although US federal policy currently grants the authority for fish stocking to the states, case law allows the federal agencies to be directly involved in decisions regarding fish stocking in wilderness areas.

37.b4

This work shows that the introduction of salmonid fishes into headwater lakes can result in disproportionately larger effects on native fishes than introductions lower in drainages

However, introductions of nonnative fishes into headwater lakes provide point sources capable of invading all downstream habitats, as the fish surmount barriers that normally hinder upstream-directed invasions.

Page 1 of 5344

These results suggest that widespread fish stocking has caused substantial changes to nutrient cycles in hundreds of lakes throughout montaneprotected areas of western North America, with impacts being greatest in lakes stocked with high densities of trout.

37.b5
They report that at a local scale, after accounting for habitat differences between fishcontaining and fishless water bodies, the abundance of all life stages of long-toed salamanders and spotted frogs was lower in water bodies containing nonnative trout than in water bodies remaining in a fishless condition. At the landscape scale, the presence of fish in some water bodies had important influences on the abundance of amphibians in the remaining fishless water bodies.

37.b6
Of the two large zooplankton species believed to have been present in the lake prior to fish introductions, one reappeared while another failed to do so, apparently because the egg bank of this latter species had been depleted during the 30 years of fish presence.

37.b7
Collectively, these papers indicate that the effects of widespread trout introductions into wilderness landscapes are not limited simply to direct effects on prey taxa, but instead can be transmitted throughout lake food webs and even beyond the shorelines of fish-containing lakes to fishless lakes. In addition, following fish removal, full recovery of ecosystem structure and function may not occur

37.b8
If managers are to truly balance these often opposing goals, it is imperative that current fisheries management practices be evaluated in the context of their effects on ecosystem and landscape processes.

37.b9
. The highly utilitarian ethic that drove resource management until well into the 1960s was gradually replaced by one that acknowledges the value of all life forms and their ecological complexity, a view currently supported even by many anglers. The necessity for wilderness fish stocking is now the subject of widespread debate, especially in view of changing social values and priorities. Options for future generations cannot be preserved if introductions continue to erode the biodiversity of mountain lake ecosystems.

Future management of waters that already contain introduced trout must be directed toward overall ecosystem health and stability, with biodiversity and ecosystem integrity as a paramount objective.

Options for future generations cannot be preserved if introductions continue to erode the biodiversity of mountain lake ecosystems. This should be our greatest concern.

37.b10
. Further, although current federal regulations recognize state authority for fish stocking, judicial interpretation gives federal agencies the authority for direct involvement in decisions regarding fish stocking in wilderness.

Fish stocking does compromise certain wilderness values, and wilderness designation does impose restrictions on the types of wildlife management actions that are appropriate in wilderness areas. In some cases, these compromises and restrictions have led to an "either/or" dichotomous view that pits state fish stocking programs against federal responsibility for protecting wilderness values. Differences in agency missions, traditions, and cultures also tend to exacerbate "us vs them" attitudes.

Backed by Supreme Court decisions, federal managers can be involved in wildlife management decisions to defend wilderness values.

37.b11
, headwater lake stocking provides source populations that may be capable of invading most downstream habitats, including headwater refugia of native fishes.

Trout introductions to high-elevation headwater lakes thus pose disproportionately large risks to native fishes— even when the place of introduction may appear to be spatially dissociated from populations of the native species.

It is important to consider, however, that stocking of a mere handful of lakes could allow nonnative fishes access to nearly an entire stream network.

Page 2 of 5344

37.b12

Similarly, the stream area negatively affected by nonnatives could be minimized by stocking multiple lakes in one tributary basin instead of one lake each in multiple basins. Systems where nonnative fishes have emigrated from headwater lakes and occupy, but have not successfully colonized, the outlet streams should be considered good candidates for eradication projects.

. Introduced fish may alter lake nutrient cycles and primary production, but the magnitude and variation of these effects have not been fully explored.

The results of our modeling and paleolimnological analyses indicate that introduced trout fundamentally alter nutrient cycles and stimulate primary production by accessing benthic P sources that are not normally available to pelagic communities in oligotrophic mountain lakes. These effects pose a difficult challenge for managers charged with balancing the demand for recreational fisheries with the need to maintain natural ecosystem processes.

See 37.b25

Implications for Current Stocking Practices in Mountain Wilderness Areas

Although the largest perturbations to lake communities and ecosystem processes probably occur soon after fishless lakes are stocked for the first time, our analyses show that continued stocking only serves to exacerbate the original effects.

In addition, our analyses of fish nutrient regeneration rates suggest that the contributions of introduced trout to nutrient cycles are approximately double the level estimated for lakes that have not been stocked for several decades (Figure 7).

Therefore, to truly minimize effects of introduced fish on mountain lake ecosystems, all stocking should be halted. This would allow the lakes that lack sufficient spawning habitat to revert to a fishless condition, while reducing the density of fish in lakes with self-sustaining trout populations. Because many currently stocked lakes are likely to harbor self-sustaining trout populations (Bahls 1992; R. A. Knapp unpublished), a moratorium on trout stocking in all lakes would provide fisheries managers a simple means by which to reduce the effects of introduced fish on native invertebrate communities and ecosystem processes while still providing ample recreational fishing opportunities. It remains to be seen whether native faunal assemblages and ecosystem processes in mountain lakes can be restored simply by eliminating fish populations (Funk and Dunlap 1999; McNaught and others 1999).

At the scale of individual water bodies, after accounting for differences in habitat characteristics between fish-containing and fishless sites, the abundance of amphibians at all life stages was significantly lower in lakes with fish. At the basin scale, densities of overwintering life stages of amphibians were lower in fishless sites of basins where more habitat was occupied by trout. Our results suggest that many of the remaining fishless habitats are too shallow to provide suitable breeding or overwintering sites for these amphibians and that current trout distributions may eventually result in the extirpation of amphibian populations from entire landscapes, including sites that remain in a fishless condition.

Restoration

37.b13

Conserving natural biodiversity and maintaining functioning ecosystems is a goal of protected area management. The results of this study suggest that wildlife managers need to consider restoring a few deep lakes in each basin to create fishless breeding and overwintering habitat for amphibians (Knapp 1996; Knapp and Matthews 1998; Pilliod and Peterson 2000).

37.b14

Gill netting is a viable fish eradication technique for smaller (less than 10 ha, (25 acres)), shallow (less than 10 m (33 feet) deep)) lakes that lack habitable inflows and outflows or other sensitive species. Further work is required to define appropriate removal methods for larger lakes and watersheds.

Page 3 of 5344

37.b15

We believe that shallower lakes (less than 10 m deep) of up to 10 ha should be amenable to gill net eradication of nonnative fishes over reasonably short periods, without resorting to rotenone or other poisons.

If the restoration of substantially larger or deeper lakes is proposed, alternate methods of fish removal including, but not limited to, electrofishing, trap netting on spawning grounds, disturbing spawning habitat, creating under-ice anoxia by the addition of nutrients (see Brunskill and others 1980 for a possible method), lake drawdown, and/or the application of piscicides should be given consideration in addition to, or as a replacement for gill nets. These alternate methods will be controversial, but they may be more practical for removing fish from certain lakes. Canadian national parks managers have previously used chemical agents in their attempt to eradicate fish from dozens of lakes.

37.b16

Further, nontarget species such as Harlequin Ducks (*Histrionicus histrionicus*) and even bears might be adversely affected by restoration activities on some water bodies.

37.b17

Last, because organisms such as *Gammarus* may be extirpated but leave no trace of their prior existence, it will be difficult to ascertain that full food web restoration has been achieved for the many lakes that lack prestocking records of their original invertebrate communities.

37.b18

Further experimental restoration work is needed to better define the practical limits of gill netting as a management tool and to provide alternate solutions for larger or otherwise "difficult" stocked lakes. A better understanding of our few remaining pristine ecosystems is also needed if we wish to undo a century of past fisheries management practices and return a small suite of lakes to their natural state

Naturalness and Wildness: The Dilemma and Irony of Managing Wilderness

The origin and value of these concepts are discussed, as well as the dilemma and irony that arises when wilderness managers contemplate manipulating the environment to restore naturalness at the risk of reducing wildness

It is concluded that large scale wilderness restoration based on manipulating the environment will always cause a dilemma and entail the irony of balancing wildness against naturalness. One of the biggest hurdles facing wilderness policy-makers and managers today, as well as the concerned public, is how to reconcile these views and manage wilderness for both wildness and naturalness.

See 37.b28

Two independent but related concepts are intertwined in the idea of wilderness. In the 1964 Wilderness Act, wilderness is defined in Section 2.(c) as "...an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain." Later in this same section, wilderness is further defined as an area "retaining its primeval character and influence...which is protected and managed so as to preserve its natural conditions." The key words in these quotes are *untrammeled* and *natural*. When the Wilderness Act was passed, these key words undoubtedly were intended to be complementary because untrammeled areas were certainly natural. Today, however, we are witnessing regional ecological impacts to areas that are untrammeled in every other way, as well as new understanding of the long-term ecological consequences of natural resource management. As a result, we now have divergent philosophical views of what wilderness is and what it should be. These views are encapsulated by the words untrammeled and natural in a way that was likely unforeseen by wilderness proponents as they crafted legislative wording. This dialogue session explored the management dilemmas and social ironies resulting from these divergent views and presented a case study that brings these diverging views into sharp focus.

Synonyms for untrammeled include unimpeded, unhampered, uncontrolled, self-willed and free. We suggest that the word "wildness" strongly connotes this sense of an area free from human control or manipulation.

Synonyms for natural include native, aboriginal, indigenous and endemic, and we suggest that the term "naturalness" be used to capture this biological sense of wilderness.

While these concepts of wildness and naturalness differ from one another, both are essential elements of wilderness, wilderness is the idea and place where the concepts of wildness and naturalness reach their highest expression. These concepts strongly influence, either directly or indirectly, virtually all of the decisions and actions taken in wilderness management.

In each of these cases, the naturalness of the area has been compromised by broad-scale human actions, and some form of manipulation of the environment is proposed to restore this naturalness. The crucial issue this raises is whether large-scale manipulation, however undesirable, should be used to restore natural conditions, thereby sacrificing wildness for naturalness (Cole 1996). In these situations, where human-caused impacts have caused wholesale changes to the wilderness environment, should the wildness of present day wilderness be compromised to restore naturalness? In other words, should an undesirable means, such as manipulation of wilderness, be used to achieve a desirable end, such as restoration of natural conditions in wilderness?

Different people hold strong views on this issue, which goes to the heart of whether wilderness is, or should at least remain from this point on, wild or natural. Some people think the provision in the 1964 Wilderness Act that "...these [areas] shall be administered...so as to provide for the protection of these areas, the preservation of their wilderness character..." is a clear mandate for restoring natural conditions in wilderness to overcome a myriad of human caused insults. Indeed, restoration of these areas is often expressed in terms of an obligation and responsibility to correct human-caused problems (Windhager 1998). Others, citing the Wilderness Act definition of wilderness as "...an area where the earth and its community of life are untrammeled by man," claim that the fundamental character of wilderness is to be free of human manipulation (Worf 1997). Here, wilderness is the one and only place on our ever more crowded planet that is left free from our conscious manipulation, and these areas yield important and vital benefits to people and society because they are untrammeled.

The Central Dilemma of Wilderness Management: When to Take Action?

Deciding when to take action in wilderness was described by Landres and others (1998) as the central dilemma in wilderness management. Proposals to manipulate ecological conditions in wilderness to restore naturalness bring this dilemma to new heights, as well as raise significant and difficult questions: Does manipulation compromise the very values that are protected and preserved in wilderness? Is there sufficient technical knowledge to use large-scale manipulation to restore wilderness landscapes? What are the consequences and risks of taking action versus not taking action? Does the public sufficiently trust the agency to allow such large-scale actions? Does the desire to restore the ecological value of naturalness outweigh the social value of wildness? How much trammeling is necessary and tolerable in wilderness? Is it appropriate to even define a target for desired future ecological conditions in wilderness? Must we accept, albeit reluctantly, the human "gardenification" of wilderness, as suggested by Janzen (1998)?

See 37.b28

Separating the concepts of wildness from naturalness helps clarify and partially resolve this management dilemma of when to take action. A two-way matrix of wildness and naturalness (figure 2) illustrates when a proposed action is not appropriate, when it is appropriate and when it entails weighing wildness against naturalness. Briefly, some proposed management actions, such as manipulating habitat to increase a wildlife species' density above natural levels, decrease both wildness and naturalness and should not be pursued. Conversely, proposed actions that support wildness or at least do not reduce it while increasing naturalness should be pursued. Closing and restoring a campsite, for example, doesn't manipulate the environment in a way that impedes wildness on a large scale, and restoring native plants increases naturalness.

Management dilemma and irony can be seen when either wildness or naturalness must be compromised to enhance the other (figure 2).

		WILDNESS	
		Decrease	Support
NATURAL-NESS	Decrease	NO ACTION	DILEMMA AND IRONY
	Increase	DILEMMA AND IRONY	ACTION

Figure 2—A two-way matrix showing suggested outcomes when proposed management actions support or decrease wildness and increase or decrease naturalness. Proposed actions that both decrease wilderness and naturalness should not be considered, while actions that both support wildness and increase naturalness should be considered. Proposed actions that compromise either wildness or naturalness create management dilemmas and social irony forcing wildness to be weighed against naturalness.

If the degraded area and restoration actions are localized, if the actions taken today will allow managers to reduce their interference with the "will of the land" in the future, and if there are good reference sites to know what the undisturbed condition is, manipulative actions are probably justified. In contrast, if restoration actions are being considered over a large area and there is uncertainty about the effects of these actions or about the target conditions, much more caution and scrutiny is warranted.

Large-scale wilderness restoration based on manipulating the environment will always cause a dilemma and entail the irony of balancing wildness against naturalness. In one way, this dilemma is good because it forces us to carefully consider our actions and their consequences. "Doing the right thing" for wilderness used to be fairly straightforward. Today, with our increased knowledge of regional-scale human impacts, coupled with our desire to restore areas known to be degraded, "doing the right thing" is no longer a simple path because it is based on a philosophical choice between wildness and naturalness. Two people or groups may differ, sometimes strongly, about what they perceive is "right" for wilderness, and both views are valid. If there are significant doubts about a proposed action, one view would err on the side of protecting wildness, while the other view would err on the side of naturalness. One of the biggest hurdles facing wilderness policy-makers and managers today, as well as the concerned public, is how to reconcile these views and manage wilderness for both wildness and naturalness.

See 37.b28

To balance wilderness lake use between recreational fisheries and protected habitat for native species, managers need to understand how stocking non-native predaceous fish affects amphibian populations within a landscape. The goal of this paper is to help managers design and conduct studies that will provide such information. Desirable study characteristics include multiple- visit surveys of all wetlands within a watershed to provide information on amphibian distribution, abundance, breeding, recruitment and seasonal variation in habitat use. By identifying the distribution of critical amphibian habitat and source populations, this approach should enable managers to target specific lakes for protection or restoration as fishless amphibian habitat without overly compromising wilderness fishing opportunities.

Wild areas, large or small, are likely to have values as norms for land science. Recreation is not their only, or even principal utility.
—Aldo Leopold, Sand County Almanac

6. How Can This Information Be Used to Evaluate Potential Management Actions?

Like many ecological problems, the anthropogenic effects of trout stocking on amphibians can vary for different species and even different populations of the same species under a variety of conditions. This variability makes it difficult to make general management recommendations that will adequately protect all species and their habitats. However, research can greatly improve the evaluation and implementation of effective management actions that may balance the needs of the recreational public with conservation of native species. Ideally, any alterations in stocking practices should strive for the lowest cost-benefit ratio in terms of decreasing threats to amphibian persistence with the fewest changes to current recreational fishing opportunities.

Possible management actions include: (1) ceasing stocking in all lakes, (2) ceasing stocking and possibly removing fish from some lakes, (3) reducing stocking frequency and density, (4) reducing naturally reproducing populations of fish by restricting access to spawning areas and/or gill netting, (5) changing species stocked (cutthroat may be less predatory than rainbow or brook trout), (6) stocking sterile fish, or (7) making no changes in stocking practices if fisheries threats to amphibian persistence are negligible.

See 37.b29

Cessation of stocking in all wilderness lakes would most likely benefit amphibians and reduce threats to persistence (fig. 3). Undoubtedly, this action would be extremely unpopular for many anglers and could result in less support for wilderness. Economic impacts on outfitters and guides may also occur. Despite the potential socioeconomic costs of this management strategy, some wilderness proponents argue these costs will be minimal and will not overly jeopardize public support for wilderness (Murray and Boyd 1996). This view appears to be supported by resolutions from potentially opposing groups like the Society for Conservation Biology (SCB) and Trout Unlimited. The SCB recommends "phas[ing] out incongruent stocking practices and restor[ing], where appropriate and feasible, previously damaged ecosystems" (SCB 1995). Trout Unlimited states that it "oppose[s] salmonid stocking in historically documented non-salmonid waters where scientific evaluation indicates that such stocking would be likely to adversely affect native biodiversity" (Trout Unlimited 1998).

An example of the potential costs and benefits of restoring wilderness lakes through the cessation of fish stocking comes from the National Park Service, which recommended phasing out and eventually terminating all fish stocking (NPS 1975). In Sequoia, Kings Canyon and Yosemite National Parks, fish stocking was curtailed in the 1970's and completely halted in 1991. This management decision resulted in the loss of recreational fisheries from 29% to 44% of previously stocked lakes (Knapp 1996). Due to a reduction in the proportion of lakes containing fish, as well as historic differences in stocking intensity, the mountain yellow-legged frog currently has a greater distribution in Kings Canyon National Park, compared with the neighboring John Muir Wilderness, where lakes have continued to be stocked and frog persistence is at risk (Matthews and Knapp 1999).

A similar pattern was observed in the Bitterroot Mountains, Montana where six of 18 stocked lakes (33%) no longer supported trout populations in 1996, following cessation of stocking in 1984 (Funk and Dunlap, in press). Funk and Dunlap (in press) found that long-toed salamanders recolonized five of these currently fishless, but previously stocked lakes within two decades, even in lakes over 5 km from the nearest salamander populations. These studies indicate that widespread cessation of stocking does not result in the loss all trout populations and that amphibians will recolonize lakes after fish disappear.

Page 6 of 5344

Cessation of fish stocking, and even removal of fish, in some but not all lakes may be more amenable to recreational anglers. If conducted properly, this management strategy could provide the necessary amphibian habitat for species recovery. The success of this management action, however, is dependent on which lakes are selected for fish elimination. Choosing lakes to be restored to a fishless condition based solely on anthropogenic variables, such as difficulty of access and amount of angler use, may have little effect on reducing threats to amphibian persistence (fig. 3). However, restoring fishless lakes based on their potential for amphibian recolonization and their importance as amphibian habitat should improve the success of this action.

For fish elimination, we recommend targeting: (1) stocked lakes that already have some amphibian breeding occurring, (2) lakes that appear to provide deep-water overwintering habitat for amphibians in surrounding shallow, fishless lakes, (3) lakes that have the potential for fish elimination (low or no natural reproduction), and (4) lakes that are the least important for recreational anglers. Of these recommendations, the first three should take priority over the last. In our study, over 40% of the stocked lakes had at least some frog reproduction, yet few of these lakes had any frog recruitment. Eliminating fish from a lake where frogs are already breeding should result in faster frog recovery than eliminating fish in a lake that has no amphibian reproduction. Furthermore, restoring lakes that provide over-wintering habitat for amphibians can benefit amphibians both locally and potentially across a watershed. Finally, when selecting a lake for fish elimination, choosing a lake that will require the least amount of invasive management (fish removal) is important. Nonreproducing fish can be eliminated from a lake by simply removing that lake from the stocking schedule. However, if fish removal is required, techniques such as gill netting (Knapp and Matthews 1998), coupled with blocking spawning habitat, are preferable to piscicides, such as rotenone and antimycin A. Both of these chemicals may harm other aquatic vertebrates, including amphibians (Fontenot and others 1994; Schnick 1974), and their use in wilderness is controversial.

See 37.b29

Finally, managers should keep in mind that most systems are not isolated, and fish stocking practices in adjacent regions can significantly affect restoration efforts. For example, fish dispersal from upstream locations may colonize wetlands that are actively managed as fishless habitats. In addition, fish predation in streams may act as barriers to migration, dispersal and hence colonization of amphibians (Bradford and others 1993).

Despite the range of possible management actions, we believe the best management strategy is to use species and watershed-specific biological information to make management decisions. This information can be obtained only through carefully designed and conducted studies that provide adequate information about the distribution, abundance and life history characteristics of amphibian species across local landscapes. Hopefully, using appropriate information at the watershed scale will enable managers to restore critical amphibian habitat and the biological integrity of wilderness lakes. Creating a few fishless lakes to provide the necessary habitat requirements of amphibians in a watershed may disproportionately reduce the threats of fish stocking on amphibian persistence. For example, having two amphibian source populations in a watershed, instead of one, may increase the probability of amphibian persistence in that watershed by an order of magnitude. With proper management, we believe amphibian populations can be recovered and protected while maintaining recreational fishing opportunities in many wilderness lakes.

Abstract—Native and nonnative sport fish have been introduced into the majority of historically fishless lakes in wilderness, generating conflicts between managing wilderness as natural ecosystems and providing opportunities for recreation. Managers faced with controversial and difficult decisions about how to manage wilderness lakes may not always have ready access to research relevant to these decisions

See 37.b30

The conflicts between managing wilderness as "natural" ecosystems and providing opportunities for recreation are especially acute in fisheries management. Native and nonnative sport fish have been introduced into the majority of historically fishless lakes in wilderness (Bahls 1992), usually to the detriment of the native biota (Bradford and others 1993; Chess and others 1993; Tyler and others 1998). Alpine lakes are the primary target for recreation in wilderness (Hendee and Schoenfeld 1990), and fishing opportunities may further concentrate use in these areas, resulting in resource damage and compromising solitude in the wilderness experience.

Fish stocking, especially using aircraft, is also considered to conflict with wilderness values (Duff 1995).

However, fish stocking in mountain lakes long predates the Wilderness Act of 1964, and fishing is the objective of a sizable proportion of wilderness visitors (Fraley 1996; Hendee and Schoenfeld 1990). Language in the Wilderness Act, reserving the rights of the States with respect to management of fish and wildlife, is often cited as justification for continued active management of fisheries in wilderness (Duff 1995; Fraley 1996). Conversely, other language in the Wilderness Act promoting the preservation of natural systems, and increasing emphasis on wilderness as a reference point for the study and management of ecosystems (Hendee and others 1990; Kaufmann and others 1994) are difficult to reconcile with many of the current practices of fisheries management.

Consequently, managers are faced with controversial and difficult decisions about how to manage wilderness lakes, and they do not always have ready access to research relevant to these decisions. Considerable research has been conducted recently on the biological effects of fish stocking on resident biota. Many managers tend to minimize these effects, however, instead promoting untested alternative hypotheses

Page 7 of 5344

an overview of fish stocking in wilderness from federal, state, tribal and user perspectives, including summaries of key legislation, policy and description of current management practices. A session on community and ecosystem effects included effects of fish stocking on lake nutrient cycling, algal dynamics and invertebrates and interactions between predators, hydroperiod and amphibians. The third session focused on effects on vertebrate species and included discussions on effects of stocking on native fish and amphibians. The final session described restoration and management.

37.b19

Life history traits vary among amphibian species, however, and fish stocking may affect species differently. In addition, amphibian population structure may be affected at a broad scale when a portion of lakes and streams in a watershed are stocked. This habitat fragmentation may isolate amphibian populations and result in increased extinction rates.

Results: Historical records indicated that Idaho Fish and Game stocked over 60,000 cutthroat and rainbow trout into 12 to 30 previously fishless lakes in 1937 and 1938 in the Bighorn Crags area. Beginning in the 1960s, fish were restocked every three to six years. In total, 37 lakes were stocked with 300,000 fry or fingerlings.

Cutthroat, rainbow, and golden trout and their hybrids were found in all 11 basins searched. Overall, fish occupied 43% of sites. Large, deep lakes (greater than 1 ha in surface area and more than 4 m deep) were more likely occupied than small, shallow wetlands. As a result, fish occupied 90% of the available surface area of water in the basins. More importantly, only two basins had more than one deep, fishless lake.

See 37.b31

Densities of both long-toed salamanders and Columbia spotted frogs were lower in sites with fish than in those without fish. Indeed, when site characteristics of deep lakes were held constant, fewer amphibians of all stages were found in stocked lakes than in lakes without fish. Moreover, densities of salamander larvae at least two years old, and both adult and juvenile frogs in *fishless* sites decreased as the proportion of wetlands in the basin occupied by trout increased.

Management Implications:

Survival of salamander larvae and juvenile frogs may depend on deep lakes (>2 m), yet few of these habitats are not stocked with fish.

Negative effects of stocked lakes may extend across a landscape. Lakes with fish may have insufficient juvenile recruitment to compensate for adult mortality. Amphibians with extended larval periods may be forced to breed in shallower wetlands where the risk of extirpation due to desiccation, anoxia, and freezing are higher than in the deep, lentic environments. Likewise, amphibians that complete their life cycle in one summer may breed in shallow wetlands but may be forced to immigrate to deep lakes to overwinter. If those lakes are stocked with fish, the progeny may be completely eradicated.

Information necessary to evaluate the effects of fish stocking in high-elevation lakes should include knowledge of:

(1) **the amphibian and fish species in the area** – Because little information is available about distributions of many amphibian species, surveys should be based on what species are potentially in the wilderness area and the life histories of those species. Different types of surveys conducted at various times of the year may be needed to assess abundances and life stages.

Page 8 of 5344

(2) the extent of area impacted – Surveys of entire watersheds provide the most unbiased information to determine production, habitat use, and potential interaction between fish and amphibians and allow the most accurate assessment of management actions. Because watershed sampling requires considerable time and effort, the number of watersheds in a wilderness that can be sampled may be limited. Surveying a subset of wetlands in different watersheds using stratified sampling may broaden the scope if all wetland types can be adequately represented. Integrating fish and amphibian surveys may also expand sampling ability. photo by Steve Corn

See 37.b31

(3) the effect of management actions – Because the basin-wide effects of fish stocking have only recently been identified, information on the results of specific management actions is unavailable. Potential management actions include: cessation of stocking and/or removal of fish, which reduce the number of lakes supporting fish; reduction in stocking frequency/density/fertility (stocking sterile fish or limiting access to spawning habitat), which may result in fishless habitats for short periods; and alteration of the species stocked (e.g. cutthroat trout may be less predatory than brook or rainbow trout).

The consensus of the participants of that meeting was that amphibian populations declines were real but documentation was largely anecdotal, and much work was needed on the causes of population declines

Knowledge about the status of amphibians is important, because amphibians occupy important ecological niches and a high proportion of western amphibian species have undergone recent declines, often in protected habitats.

Introduced trout are often implicated in the decline of high mountain amphibian populations, but few studies have attempted to understand whether the effects of trout in lakes where they have been introduced may also influence the distribution and abundance of amphibians throughout entire mountain basins, including in remaining fishless lakes.

Our results suggest that many of the remaining fishless habitats are too shallow to provide suitable breeding or over-wintering habitat for these amphibians, and that current trout distributions may eventually result in the extirpation of amphibian populations from entire landscapes, including from sites that remain in a fishless condition.

37.b20

Amphibian Research and Monitoring Initiative

Initiate long-term monitoring to determine trends in amphibian populations

Conduct research into causes of amphibian declines and malformations

Habitat alteration and destruction have long been major causes of amphibian declines. More recently, significant declines have occurred in protected areas in the western United States that have not shown obvious changes in habitat. These unexplained declines may be caused by conta minants, non-native species, or disease.

Page 9 of 5344

Research related to the effects of stocking fish in fishless lakes within Wilderness,

37.b21 The paper **"The Introduction of Nonnative Fish into Wilderness Lakes: Good Intentions, Conflicting Mandates, and Unintended Consequences"** references 6 other papers which describe the effects of stocking fish in wilderness lakes. The abstracts and conclusions of these 6 papers follow. At the end of these papers are additional references that are relevant to the fish stocking issue.

- 37.b22 **"Wilderness Fish Stocking: History and Perspective",** Edwin P. Pister
- 37.b23 **"The Wilderness Act and Fish Stocking: An Overview of Legislation, Judicial Interpretation, and Agency Implementation,"** Peter Landres, Shannon Meyer, and Sue Matthews
- 37.b24 **"Geography of Invasion in Mountain Streams: Consequences of Headwater Lake Fish Introductions",** Susan B. Adams, Christopher A. Frissell, and Bruce E. Rieman
- 37.b25 **"Alteration of Nutrient Cycles and Algal Production Resulting from Fish Introductions into Mountain Lakes",** Daniel E. Schindler, Roland A. Knapp, and Peter R. Leavitt
- 37.b26 **"Local and Landscape Effects of Introduced Trout on Amphibians in Historically Fishless Watersheds",** David S. Pilliod and Charles R. Peterson
- 37.b27 **"The Effects of Stocking and Removal of a Nonnative Salmonid on the Plankton of an Alpine Lake",** B. R. Parker, D. W. Schindler, D. B. Donald, and R. S. Anderson

<u>Additional references</u> -

- 37.b28 **"Naturalness and Wildness: The Dilemma and Irony of Managing Wilderness",** Peter B. Landres, Mark W. Brunson, Linda Merigliano, Charisse Sydoriak, Steve Morton
- 37.b29 **"Evaluating Effects of Fish Stocking on Amphibian Populations in Wilderness Lakes",** David S. Pilliod, Charles R. Peterson
- 37.b30 **"Fish Stocking in Protected Areas: Summary of a Workshop",** Paul Stephen Corn, Roland A. Knapp
- 37.b31 **"IMPACTS OF TROUT STOCKING ON AMPHIBIAN POPULATIONS",** David S. Pilliod, Charles R. Peterson, Peter B. Landres
- 37.b32 **"Amphibian declines: review of some current hypotheses",** Corn, Paul Stephen
- 37.b33 **"Perspectives from the Aldo Leopold Wilderness Research Institute: amphibians and wilderness",** Corn, Paul Stephen
- **"Local and landscape effects of Introduced trout on amphibians in historically fishless watersheds",** Pilliod, D.S.; Peterson, C.R.
- 37.b34 **Leopold Institute, Current Wildlife Research Projects, Amphibian Research and Monitoring Initiative**
- **Leopold Institute's Wildlife Publications (1991-2002)**
  1. 37.b35 **WILDLIFE MANAGEMENT ACTIVITIES IN WILDERNESS**
  2. 37.b36 **RECREATION IMPACTS – GENERAL**
  3. 37.b37 **EFFECTS OF HUMAN INTRUSIONS ON BIRDS**
  4. 37.b38 **AMPHIBIAN CONSERVATION AND FISH STOCKING**

37.b39 FISH STOCKING IMPACTS TO MOUNTAIN LAKE ECOSYSTEMS

Page 10 of 5344

37.b21

The Introduction of Nonnative Fish into Wilderness Lakes: Good Intentions, Conflicting Mandates, and Unintended Consequences

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Because they have the potential to provide the best remaining standards of relatively unmodified landscapes, protected areas in North America (such as wilderness areas and national parks) have tremendous ecological and scientific value (Cole and Landres 1996). Although the montane ecosystems of western North America are particularly well represented in this complex of protected lands, aquatic habitats within these protected areas are often subject to management practices that are inconsistent with the goal of maintaining natural processes. The most prevalent of these practices is the introduction of salmonid fishes (such as trout) into historically fishless ecosystems to create recreational fisheries.

These stocking programs have dramatically transformed the formerly fishless aquatic ecosystems within protected areas of western North America. For example, of the estimated 16,000 naturally fishless mountain lakes in the western US, the majority of which are located within national parks and wilderness areas, 60% of all lakes and 95% of larger, deeper lakes now contain nonnative trout (*Oncorhynchus* spp., *Salmo* spp., *Salvelinus* spp.) (Bahls 1992).

The management of nonnative trout populations in protected areas is highly controversial due in large part to increased awareness of the ecological effects of introduced fishes on naturally fishless ecosystems (Duff 1995; Fraley 1996). Although the state agencies charged with managing aquatic ecosystems within protected areas have historically focused on providing recreational fishing while placing little emphasis on ensuring the maintenance of natural processes, fisheries managers are increasingly being asked to justify their stocking programs in light of a growing body of literature that documents the effects of fish introductions into naturally fishless lakes. These studies have repeatedly demonstrated that fish introductions dramatically alter native vertebrate and invertebrate communities, often resulting in the extirpation of native fishes, amphibians, zooplankton, and benthic macroinvertebrates (Anderson 1972; Stoddard 1987; Bradford and others 1998; Carlisle and Hawkins 1998; Tyler and others 1998; Knapp and Matthews 2000). However, these studies have typically focused narrowly on the direct impact of fish introductions on the native fauna and ignored the possible disruption of ecosystem processes (but see Leavitt and others 1994) as well as indirect landscape-scale impacts transmitted beyond the boundaries of those habitats subject to fish introductions. Perhaps as a result, the efforts by managers attempting to lessen the impact of introduced fishes have also been narrowly focused. For example, in California's Sierra Nevada, where these fish introductions have been shown to have severe deleterious impacts on amphibians (Bradford 1989; Bradford and others 1993, 1998; Knapp and Matthews 2000), some managers have recently agreed to stop stocking lakes that serve as habitats for particular amphibian species. Although this policy change is an important step in reducing the ecological impact of fish introductions, it still represents the continuance of a narrowly focused lake-specific and species-specific approach that does not take potential larger-scale impacts into account.

The papers in this issue were motivated by a 3-day workshop on fish stocking in wilderness areas held in October 1998 at the Flathead Lake Biological Station, Polson, Montana (Corn and Knapp 2000). The purpose of the workshop was to promote a dialogue between managers and scientists by exposing the managers to current research while also making the scientists aware of the concerns and constraints of managers. In this special feature, we highlight (a) the history and political framework for fisheries management in protected areas, and (b) recent advances in our understanding of the ecosystem and the landscape-scale effects caused by the introductions of fish into naturally fishless mountain lakes.

We begin with a historical overview by **Pister** that provides a perspective gained during his several decades experience of managing a wilderness fishstocking program for the California Department of Fish

Page 11 of 5344

and Game. He concludes that in the face of increasing public support for protecting natural processes, the continued stocking of fish into wilderness ecosystems is no longer justified.

Landres, Meyer, and Matthews examine the controversy over fish stocking from the perspective of the 1964 Wilderness Act, focusing on the judicial interpretation of the act, the policies of the US federal agencies charged with implementing the act, and formal agreements between federal and state agencies. They conclude that although US federal policy currently grants the authority for fish stocking to the states, case law allows the federal agencies to be directly involved in decisions regarding fish stocking in wilderness areas. This type of cooperation could improve the often adversarial relationship between state and federal agencies and create an environment in which both state and federal agencies share the responsibility for managing aquatic resources within wilderness.

Following these two overview/policy papers are 4 papers that describe the ecosystem and landscapescale effects of fish introductions into naturally fishless mountain lakes. **Adams, Frissell, and Rieman** present a landscape analysis of the spread of introduced trout through stream networks. This work shows that the introduction of salmonid fishes into headwater lakes can result in disproportionately larger effects on native fishes than introductions lower in drainages. In many river basins, remaining populations of native fishes are concentrated in headwater refugia where they are protected by natural barriers from introduced fishes that are already established at lower elevations. However, introductions of nonnative fishes into headwater lakes provide point sources capable of invading all downstream habitats, as the fish surmount barriers that normally hinder upstream-directed invasions. The extent of such a potential invasion from headwater lakes depends on the geography of the stream network, and particularly on the density and distribution of headwater lakes and their locations relative to barriers inhibiting upstream dispersal.

Schindler, Knapp, and Leavitt use a fish bioenergetics model to evaluate the effect of trout introductions on nutrient cycles in naturally fishless oligotrophic lakes. To support the importance of this increased nutrient subsidy to pelagic algae, they present paleolimnological evidence that algal production increased approximately 10-fold following trout introductions and show that this increased production was maintained for the duration of fish presence. These results suggest that widespread fish stocking has caused substantial changes to nutrient cycles in hundreds of lakes throughout montaneprotected areas of western North America, with impacts being greatest in lakes stocked with high densities of trout.

Pilliod and Peterson use data on the distributions of native amphibians and nonnative trout in several drainages in the northern Rocky Mountains to evaluate the local and landscape effects of trout introductions. They report that at a local scale, after accounting for habitat differences between fishcontaining and fishless water bodies, the abundance of all life stages of long-toed salamanders and spotted frogs was lower in water bodies containing nonnative trout than in water bodies remaining in a fishless condition. At the landscape scale, the presence of fish in some water bodies had important influences on the abundance of amphibians in the remaining fishless water bodies. These landscape- scale effects may be the result of a loss of source populations and overwintering sites when fish are introduced into the larger, deeper lakes and amphibians are therefore restricted to shallower, more ephemeral habitats.

Parker, Schindler, Donald, and Anderson describe changes in ecosystem structure in a lake in the Canadian Rocky Mountains following the removal of the entire trout population with gill nets. Of the two large zooplankton species believed to have been present in the lake prior to fish introductions, one reappeared while another failed to do so, apparently because the egg bank of this latter species had been depleted during the 30 years of fish presence. Overall zooplankton biomass remained unchanged following removal of the fish population. Contrary to predictions based on trophic cascade theory, no changes in phytoplankton biomass or chlorophyll-*a* concentration were observed. Nutrient concentrations also remained unchanged. These results add to the growing body of studies that evaluate the recovery of mountain lake ecosystems following the removal of nonnative trout (Parker and others 1996; McNaught and others 1999; Funk and Dunlap 1999; Drake and Naiman 2000; Knapp and others 2001).

Collectively, these papers indicate that the effects of widespread trout introductions into wilderness landscapes are not limited simply to direct effects on prey taxa, but instead can be transmitted throughout lake food webs and even beyond the shorelines of fish-containing lakes to fishless lakes. In addition, following fish removal, full recovery of ecosystem structure and function may not occur. These results pose a difficult challenge for fisheries and wilderness managers interested in better balancing the conflicting goals of maintaining nonnative fisheries in wilderness areas while also minimizing the effects of these fisheries on natural processes. If managers are to truly balance these often opposing goals, it is imperative that current fisheries management practices be evaluated in the context of their effects on ecosystem and landscape processes. It is our hope that this special feature will provide the impetus for such an evaluation

Page 12 of 5344

and for the adoption of new management strategies to reduce the ecological impacts of nonnative fisheries in protected areas.

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37.b22

COMMENTARY

Wilderness Fish Stocking: History and Perspective

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ABSTRACT

The stocking of trout in wilderness lakes of the western United States began in the 1800s. This practice was followed for nearly a century with the singular goal of creating and enhancing sport fishing and without any consideration of its ecological ramifications. Following the advent of a new environmental awareness in the 1960s, and thanks to new research that revealed negative impacts on the biota attributable to introduced fishes, traditional fish-stocking practices came under question first at federal land management agencies and later at their counterparts within the states. The highly utilitarian ethic that drove resource management until well into the 1960s was gradually replaced by one that acknowledges the value of all life forms and their ecological complexity, a view currently supported even by many anglers. The necessity for wilderness fish stocking is now the subject of widespread debate, especially in view of changing social values and priorities. Options for future generations cannot be preserved if introductions continue to erode the biodiversity of mountain lake ecosystems.

CONCLUSION AND FUTURE DIRECTION

Based on the management practices and policies currently in use in the West, Bahls (1992) made 12 recommendations that constitute a desired future direction for state agencies. To his paramount observation concerning the need for greater funding support for lake surveys and biotic inventories, I would add another highly important item. Research into the value (in terms of contribution to the angler) of backcountry lake stocking badly needs to be conducted. The western states are collectively involved in a massive and expensive wilderness stocking program, the value of which has never been conclusively demonstrated, and which is known to be destructive to native fauna and not in accordance with generally accepted wilderness values. Such a program should never be conducted in perpetuity without a proven scientific basis. The status quo therefore remains indefensible.

I have found through the years that when such controversies as wilderness fish stocking come under discussion, application of a corollary to Aldo Leopold's famous land ethic provides a very good answer: "A thing is right when it tends to preserve the beauty, integrity, and stability of the biotic community. It is wrong when it tends otherwise" (Leopold 1949). The question at hand obviously becomes fully as much a matter of ethics as biology. Inevitably, good ethical practice translates into good biological practice.

The philosopher George Santayana observed with great accuracy that those who cannot remember the past are condemned to repeat it. This thought may then be combined with a reconstruction of John F. Kennedy's famous admonition: Ask not what your biota can do for you; ask what you can do for your biota. Future management of waters that already contain introduced trout must be directed toward overall ecosystem health and stability, with biodiversity and ecosystem integrity as a paramount objective. Waters that have heretofore been spared from the introduction of trout must be vigorously protected, along with endemic life forms that exist in a complexity that will continue to transcend our absolute comprehension. Options for future generations cannot be preserved if introductions continue to erode the biodiversity of mountain lake ecosystems. This should be our greatest concern.

37.b24
37.B23

The Wilderness Act and Fish Stocking: An Overview of Legislation, Judicial Interpretation, and Agency Implementation

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Abstract

Many high-elevation lakes in designated wilderness are stocked with native and nonnative fish by state fish and game agencies to provide recreational fishing opportunities. In several areas, this practice has become controversial with state wildlife managers who support historical recreational use of wilderness, federal wilderness managers who assert that stocking compromises some of the ecological and social values of wilderness, and different public groups that support one or the other position.

Herein we examine this controversy from the perspective of the 1964 Wilderness Act, its judicial interpretation, the policies of the federal agencies, and formal agreements between federal and state agencies. Although some state stocking programs restore native fish populations, other programs may compromise some of the ecological and social values of wilderness areas. Further, although current federal regulations recognize state authority for fish stocking, judicial interpretation gives federal agencies the authority for direct involvement in decisions regarding fish stocking in wilderness. Where there are differences of opinion between state and federal managers, this judicial interpretation strongly points to the need for improved cooperation, communication, and coordination between state wildlife managers and federal wilderness managers to balance recreational fishing opportunities and other wildlife management activities with wilderness values.

Conclusions

Untangling the problems caused by concurrent federal and state authority requires an understanding of the origin of traditional states rights views, historical and current judicial interpretation, and agency regulations and policies. Unfortunately, these all seem to point in different directions: federal legislation supports concurrent state and federal authority, judicial interpretation clearly supports federal involvement in wildlife management decisions in wilderness, federal agency regulations and policies largely support a traditional states rights view, and the IAFWA agreement strongly supports wilderness values and asserts the need for cooperation between state and federal agencies.

Fish stocking does compromise certain wilderness values, and wilderness designation does impose restrictions on the types of wildlife management actions that are appropriate in wilderness areas. In some cases, these compromises and restrictions have led to an "either/or" dichotomous view that pits state fish stocking programs against federal responsibility for protecting wilderness values. Differences in agency missions, traditions, and cultures also tend to exacerbate "us vs them" attitudes. Examining state and federal interactions over fish stocking in wilderness, Fraley (1996), for example, concluded that agency personnel need to "rise above the bureaucracy and egos, work together, and share responsibility for managing all wilderness resources." In these cases, managers need to be reminded that "it is not a question of what level of government shall have the basic authority but, rather, how a shared authority can be made most productive" (Gottschalk 1978).

Fortunately, divisive attitudes are giving way to better understanding, communication, and cooperation in the face of extraordinarily complex social and ecological problems. Cooperation among state and federal managers will be increasingly important as research continues to reveal subtle and complex ecological interactions between stocked fish and native aquatic biota (see the other papers in this special feature). Changing social values and ecological complexities guarantee that what works in one area may not work in other areas, and that well developed and persistent communication and cooperation between state and federal managers will be necessary in crafting effective management solutions on a case-by-case basis.

Backed by Supreme Court decisions, federal managers can be involved in wildlife management decisions to defend wilderness values. Continuing to improve communication and cooperation between state and federal managers will ensure that wilderness contributes to the protection and preservation of wildlife, just as wildlife contributes to the value of wilderness.

Page 15 of 5344

37.b24

Geography of Invasion in Mountain Streams: Consequences of Headwater Lake Fish Introductions

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ABSTRACT

The introduction of fish into high-elevation lakes can provide a geographic and demographic boost to their invasion of stream networks, thereby further endangering the native stream fauna. Increasingly, remaining populations of native salmonids are concentrated in fragmented headwater refugia that are protected by physical or biological barriers from introduced fishes that originate in the pervasive source populations established at lower elevations. Although fish introduced near mainstem rivers frequently encounter obstacles to upstream dispersal, such as steep slopes or falls, we found that brook trout (*Salvelinus fontinalis*) dispersed downstream through channel slopes of 80% and 18-m-high falls. Thus, headwater lake stocking provides source populations that may be capable of invading most downstream habitats, including headwater refugia of native fishes. The extent of additional area invasible from lakes, beyond that invasible from downstream, depends on the geography of the stream network, particularly the density and distribution of headwater lakes and their location relative to barriers inhibiting upstream dispersal. In the thermal and trophic environments downstream of lakes, fish commonly grow faster and thus mature earlier and have higher fecundity-at-age than their counterparts in other high-elevation streams. The resulting higher rates of population growth facilitate invasion. Larger body sizes also potentially aid the fish in overcoming barriers to invasion. Trout introductions to high-elevation headwater lakes thus pose disproportionately large risks to native fishes— even when the place of introduction may appear to be spatially dissociated from populations of the native species. Mapping the potential invasible area can help to establish priorities in stocking and eradication efforts.

Management Implications

The demand for recreational fishing in high-mountain lakes is the primary motivation for stocking nonnative fishes such as brook trout. It is important to consider, however, that stocking of a mere handful of lakes could allow nonnative fishes access to nearly an entire stream network. Consideration of the invasion geography could be useful in prioritizing lakes to protect or rehabilitate. For example, when a nonnative species already occurs downstream of a migration barrier, stocking lakes that are a short distance upstream of the barrier (assuming that other barriers occur farther upstream) will risk less than stocking lakes far upstream of the barrier (Figure 1). Similarly, the stream area negatively affected by nonnatives could be minimized by stocking multiple lakes in one tributary basin instead of one lake each in multiple basins. Similar analyses could help in prioritizing lake-stream networks for the eradication of nonnative fishes (see Knapp and Matthews 1998). Systems where nonnative fishes have emigrated from headwater lakes and occupy, but have not successfully colonized, the outlet streams should be considered good candidates for eradication projects. For example, Ice Lake is the only lake known to contain brook trout within a large area of the North Fork Clearwater River, Idaho, and as of 1996, the species had colonized little of Elizabeth Creek, the outlet stream (Appendix A). Brook trout eradication from Ice Lake would remove the one extant population with potential for invading a large drainage area. We believe systematic landscape-level analyses will reveal opportunities for defusing invasion threats in the montane regions of western North America and for reducing conflict between fisheries management and native species conservation programs.

37.b25

Alteration of Nutrient Cycles and Algal Production Resulting from Fish Introductions into Mountain Lakes

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Abstract

The introduction of salmonid fishes into naturally fishless lakes represents one of the most prevalent environmental modifications of aquatic ecosystems in western North America. Introduced fish may alter lake nutrient cycles and primary production, but the magnitude and variation of these effects have not been fully explored. We used bioenergetics modeling to estimate the contributions of stocked trout to phosphorus (P) cycles across a wide range of fish densities in lakes of the Sierra Nevada, California. We also assessed the larger effects of fish-induced changes in phosphorus cycling on primary production using paleolimnological analyses from lakes in the southern Canadian Rockies. Our analyses showed that total P recycling by fish was independent of fish density but positively related to fish biomass in the Sierra Nevada. In lakes with fish populations maintained by continued stocking, fish recycled P at over twice the rate of those in lakes where introduced fish populations are maintained by natural reproduction and stocking has been discontinued. We estimate that P regeneration by introduced fishes is approximately equivalent to atmospheric P deposition to these lakes. Paleolimnological analyses indicated that algal production increased substantially following trout introductions to Rocky Mountain lakes and was maintained for the duration of fish presence. The results of our modeling and paleolimnological analyses indicate that introduced trout fundamentally alter nutrient cycles and stimulate primary production by accessing benthic P sources that are not normally available to pelagic communities in oligotrophic mountain lakes. These effects pose a difficult challenge for managers charged with balancing the demand for recreational fisheries with the need to maintain natural ecosystem processes.

Implications for Current Stocking Practices in Mountain Wilderness Areas

Although the largest perturbations to lake communities and ecosystem processes probably occur soon after fishless lakes are stocked for the first time, our analyses show that continued stocking only serves to exacerbate the original effects. For example, some large invertebrate species (for example, *Hesperodiaptomus* spp.) may coexist with low densities of introduced trout, especially in large and deep lakes (Donald and others 1994). However, many Sierra Nevada lakes with self-sustaining trout populations are still being stocked (R. A. Knapp unpublished), thereby increasing populations above densities that would normally result from natural reproduction. Such increased densities can increase predation intensity and further reduce the number of lakes in which *Hesperodiaptomus* occur. In addition, our analyses of fish nutrient regeneration rates suggest that the contributions of introduced trout to nutrient cycles are approximately double the level estimated for lakes that have not been stocked for several decades (Figure 7).

Therefore, to truly minimize effects of introduced fish on mountain lake ecosystems, all stocking should be halted. This would allow the lakes that lack sufficient spawning habitat to revert to a fishless condition, while reducing the density of fish in lakes with self-sustaining trout populations. Because many currently stocked lakes are likely to harbor self-sustaining trout populations (Bahls 1992; R. A. Knapp unpublished), a moratorium on trout stocking in all lakes would provide fisheries managers a simple means by which to reduce the effects of introduced fish on native invertebrate communities and ecosystem processes while still providing ample recreational fishing opportunities. It remains to be seen whether native faunal assemblages and ecosystem processes in mountain lakes can be restored simply by eliminating fish populations (Funk and Dunlap 1999; McNaught and others 1999). This question is the focus of current whole-lake fish removal experiments in the Sierra Nevada (R. A. Knapp and O. Sarnelle unpublished).

Page 17 of 5344

37.b26

Local and Landscape Effects of Introduced Trout on Amphibians in Historically Fishless Watersheds

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ABSTRACT
Introduced trout have often been implicated in the decline of high-mountain amphibian populations, but few studies have attempted to understand whether fish stocking also influences the distribution and abundance of amphibians throughout entire mountain basins, including the remaining fishless lakes. We examined this relationship using the relative abundance of long-toed salamanders (*Ambystoma macrodactylum*) and Columbia spotted frogs (*Rana luteiventris*) in fish-containing and fishless lentic sites in basins with varying levels of historic fish stocking. All lentic waters were surveyed for fish and amphibians in 11 high-elevation basins in the Frank Church–River of No Return Wilderness, Idaho, between 1994 and 1999. We found introduced trout (*Oncorhynchus clarki, O. mykiss, O. m. aguabonita*) in 43 of the 101 sites, representing 90% of the total surface area of lentic water bodies available. At the scale of individual water bodies, after accounting for differences in habitat characteristics between fish-containing and fishless sites, the abundance of amphibians at all life stages was significantly lower in lakes with fish. At the basin scale, densities of overwintering life stages of amphibians were lower in the fishless sites of basins where more habitat was occupied by trout. Our results suggest that many of the remaining fishless habitats are too shallow to provide suitable breeding or overwintering sites for these amphibians and that current trout distributions may eventually result in the extirpation of amphibian populations from entire landscapes, including sites that remain in a fishless condition.

Restoration

Conserving natural biodiversity and maintaining functioning ecosystems is a goal of protected area management. The results of this study suggest that wildlife managers need to consider restoring a few deep lakes in each basin to create fishless breeding and overwintering habitat for amphibians (Knapp 1996; Knapp and Matthews 1998; Pilliod and Peterson 2000). Given that some amphibian reproduction is occurring, even in heavily stocked basins (see Figures 5A and 6A), we suspect that amphibian populations could recover quickly if a few deep lakes were restored to a fishless state (Bro¨nmark and Edenhamn 1994; Knapp 1996; Funk and Dunlap 1999; Knapp and others 2001). However, because amphibian populations in mountain basins are widely isolated from each other (Howard and Wallace 1981; Call 1997; Tallmon and others 2000), recolonization following the extirpation of amphibians from entire basins could take decades.

37.b27

The Effects of Stocking and Removal of a Nonnative Salmonid on the Plankton of an Alpine Lake

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ABSTRACT
Bighorn Lake, a fishless alpine lake, was stocked with nonnative brook trout, *Salvelinus fontinalis*, in 1965 and 1966. The newly introduced trout rapidly eliminated the large crustaceans *Hesperodiaptomus arcticus* and *Daphnia middendorffiana* from the plankton. In July 1997, we began to remove the fish using gill nets.

Page 18 of 5344

The population comprised 261 fish that averaged 214 g in wet weight and 273 mm in fork length. Thereafter, zooplankton abundance increased within weeks. Early increases were caused by the maturation of *Diacyclops bicuspidatus*, few of which reached copepodid stages before the removal of the fish because of fish predation. *Daphnia middendorffiana*, absent when fish were present, reappeared in 1998. *Hesperodiaptomus arcticus*, which had been eliminated by the stocked fish, did not return. The proportion of large zooplankton increased after fish removal, but their overall biomass did not change. Algal biomass was low and variable throughout the 1990s and correlated with water temperature but not with nutrient concentrations or grazer densities. Diatoms were the most abundant algal taxon in the lake, followed by Dinophyceae. Chrysophyceans and cryptophyceans were eliminated after the fish were removed. Chlorophyll *a* concentrations were unaffected. Gill netting is a viable fish eradication technique for smaller (less than 10 ha, (25 acres)), shallow (less than 10 m (33 feet) deep)) lakes that lack habitable inflows and outflows or other sensitive species. Further work is required to define appropriate removal methods for larger lakes and watersheds.

Gill Netting as a Management Tool

Given the effort employed to eliminate trout from Bighorn Lake and other small lakes (Knapp and Matthews 1998), we speculate that removal of nonnative trout with gill nets alone may be impractical for large lakes. However, we believe that the 3.0-ha size limit suggested by Knapp and Matthews may be too conservative, particularly if more and larger commercial-weight gill nets are used. Intensive commercial fishing with gill nets eliminated lake trout from Lesser Slave (1160 km_2) and Touchwood lakes (29 km_2) in Alberta earlier in the 20th century, although massive effort applied over several decades was required in both cases (Mitchell and Prepas 1990). We believe that shallower lakes (less than 10 m deep) of up to 10 ha should be amenable to gill net eradication of nonnative fishes over reasonably short periods, without resorting to rotenone or other poisons.

We propose that where good access is available, the intermittent deployment of gill nets, as practiced by Knapp and Matthews (1998), should be adopted to minimize gill net avoidance by salmonids in clear lakes. We have directly observed that salmonids started to avoid gill nets within a few hours after nets were set in clear alpine lakes. Thus, a series of net sets conducted days or weeks apart may remove fish more quickly than our continuous netting program.

If the restoration of substantially larger or deeper lakes is proposed, alternate methods of fish removal including, but not limited to, electrofishing, trap netting on spawning grounds, disturbing spawning habitat, creating under-ice anoxia by the addition of nutrients (see Brunskill and others 1980 for a possible method), lake drawdown, and/or the application of piscicides should be given consideration in addition to, or as a replacement for gill nets. These alternate methods will be controversial, but they may be more practical for removing fish from certain lakes. Canadian national parks managers have previously used chemical agents in their attempt to eradicate fish from dozens of lakes.

The Bighorn Lake restoration work does not address several important issues associated with the removal of nonnative fish from lakes. For example, for lakes with habitable inlets and outlets (Bighorn Lake has neither), the removal of nonnative fish from inflowing waters and the installation of barriers to prevent their reinvasion from outflow creeks will be required. Also, selective removal of introduced fish from lakes that have one or more populations of native fish may be desirable. Further, nontarget species such as Harlequin Ducks (*Histrionicus histrionicus*) and even bears might be adversely affected by restoration activities on some water bodies. Diving birds may become entangled in gill nets and drown, and bears may lose a food resource if spawning runs of fish into shallow creeks are eliminated. Last, because organisms such as *Gammarus* may be extirpated but leave no trace of their prior existence, it will be difficult to ascertain that full food web restoration has been achieved for the many lakes that lack prestocking records of their original invertebrate communities.

Further experimental restoration work is needed to better define the practical limits of gill netting as a management tool and to provide alternate solutions for larger or otherwise "difficult" stocked lakes. A better understanding of our few remaining pristine ecosystems is also needed if we wish to undo a century of past fisheries management practices and return a small suite of lakes to their natural state.

Page 19 of 5344

37.b28

Naturalness and Wildness: The Dilemma and Irony of Managing Wilderness

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Abstract—This paper summarizes a dialogue session that focused on two concepts that strongly influence nearly all wilderness management: wildness and naturalness. The origin and value of these concepts are discussed, as well as the dilemma and irony that arises when wilderness managers contemplate manipulating the environment to restore naturalness at the risk of reducing wildness. To illustrate this irony, a case study of a proposed large-scale manipulation to stop the loss of cultural resources in the Bandelier Wilderness is discussed. It is concluded that large scale wilderness restoration based on manipulating the environment will always cause a dilemma and entail the irony of balancing wildness against naturalness. One of the biggest hurdles facing wilderness policy-makers and managers today, as well as the concerned public, is how to reconcile these views and manage wilderness for both wildness and naturalness.

Two independent but related concepts are intertwined in the idea of wilderness. In the 1964 Wilderness Act, wilderness is defined in Section 2.(c) as "...an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain." Later in this same section, wilderness is further defined as an area "retaining its primeval character and influence...which is protected and managed so as to preserve its natural conditions." The key words in these quotes are *untrammeled* and *natural*. When the Wilderness Act was passed, these key words undoubtedly were intended to be complementary because untrammeled areas were certainly natural. Today, however, we are witnessing regional ecological impacts to areas that are untrammeled in every other way, as well as new understanding of the long-term ecological consequences of natural resource management. As a result, we now have divergent philosophical views of what wilderness is and what it should be. These views are encapsulated by the words untrammeled and natural in a way that was likely unforeseen by wilderness proponents as they crafted legislative wording. This dialogue session explored the management dilemmas and social ironies resulting from these divergent views and presented a case study that brings these diverging views into sharp focus.

Terms and Concepts

In one of the first and clearest explanations of the word untrammeled, Zahniser (1956) wrote "...there is in our planning a need also to secure the preservation of some areas that are so managed as to be left unmanaged—areas that are undeveloped by man's mechanical tools and in every way unmodified by his civilization." Synonyms for untrammeled include unimpeded, unhampered, uncontrolled, self-willed and free. We suggest that the word "wildness" strongly connotes this sense of an area free from human control or manipulation. Use of this word is also supported by Zahniser's statement before a committee of the New York State legislature in 1953 that "We must remember always that the essential quality of the wilderness is its wildness" (Zahniser 1992). Synonyms for natural include native, aboriginal, indigenous and endemic, and we suggest that the term "naturalness" be used to capture this biological sense of wilderness.

While these concepts of wildness and naturalness differ from one another, both are essential elements of wilderness (Aplet 1999; Barry 1998; Worf 1997) and are highly valued in our society (Cordell and others 1998; Manning and Valliere 1996). As shown in figure 1, wilderness is the idea and place where the concepts of wildness and naturalness reach their highest expression. These concepts strongly influence, either directly or indirectly, virtually all of the decisions and actions taken in wilderness management.

An Emerging Dilemma

In each of these cases, the naturalness of the area has been compromised by broad-scale human actions, and some form of manipulation of the environment is proposed to restore this naturalness. The crucial issue this raises is whether large-scale manipulation, however undesirable, should be used to restore natural conditions, thereby sacrificing wildness for naturalness (Cole 1996). In these situations, where human-caused impacts have caused wholesale changes to ithe wilderness environment, should the wildness of present day wilderness be compromised to restore naturalness? In other words, should an undesirable means, such as manipulation of wilderness, be used to achieve a desirable end, such as restoration of natural conditions in wilderness?

Different people hold strong views on this issue, which goes to the heart of whether wilderness is, or should at least remain from this point on, wild or natural. Some people think the provision in the 1964 Wilderness Act that "...these [areas] shall be administered...so as to provide for the protection of these areas, the preservation of their wilderness character..." is a clear mandate for restoring natural conditions in wilderness to overcome a myriad of human caused insults. Indeed, restoration of these areas is ~~oftenexpressed~~often expressed in terms of an obligation and responsibility to correct human-caused problems (Windhager 1998). Others, citing the Wilderness Act definition of wilderness as "...an area where the earth and its community of life are untrammeled by man," claim that the fundamental character of

Page 20 of 5344

wilderness is to be free of human manipulation (Worf 1997). Here, wilderness is the one and only place on our ever more crowded planet that is left free from our conscious manipulation, and these areas yield important and vital benefits to people and society because they are untrammeled.

The Central Dilemma of Wilderness Management: When to Take Action?

Deciding when to take action in wilderness was described by Landres and others (1998) as the central dilemma in wilderness management. Proposals to manipulate ecological conditions in wilderness to restore naturalness bring this dilemma to new heights, as well as raise significant and difficult questions: Does manipulation compromise the very values that are protected and preserved in wilderness? Is there sufficient technical knowledge to use large-scale manipulation to restore wilderness landscapes? What are the consequences and risks of taking action versus not taking action? Does the public sufficiently trust the agency to allow such large-scale actions? Does the desire to restore the ecological value of naturalness outweigh the social value of wildness? How much trammeling is necessary and tolerable in wilderness? Is it appropriate to even define a target for desired future ecological conditions in wilderness? Must we accept, albeit reluctantly, the human "gardenification" of wilderness, as suggested by Janzen (1998)?

Separating the concepts of wildness from naturalness helps clarify and partially resolve this management dilemma of when to take action. A two-way matrix of wildness and naturalness (figure 2) illustrates when a proposed action is not appropriate, when it is appropriate and when it entails weighing wildness against naturalness. Briefly, some proposed management actions, such as manipulating habitat to increase a wildlife species' density above natural levels, decrease both wildness and naturalness and should not be pursued. Conversely, proposed actions that support wildness or at least do not reduce it while increasing naturalness should be pursued. Closing and restoring a campsite, for example, doesn't manipulate the environment in away that impedes wildness on a large scale, and restoring native plants increases naturalness.

Management dilemma and irony can be seen when either wildness or naturalness must be compromised to enhance the other (figure 2).

		WILDNESS	
		Decrease	Support
NATURAL-	Decrease	NO ACTION	DILEMMA AND IRONY
NESS	Increase	DILEMMA AND IRONY	ACTION

Figure 2—A two-way matrix showing suggested outcomes when proposed management actions support or decrease wildness and increase or decrease naturalness. Proposed actions that both decrease wilderness and naturalness should not be considered, while actions that both support wildness and increase naturalness should be considered. Proposed actions that compromise either wildness or naturalness create management dilemmas and social irony forcing wildness to be weighed against naturalness.

If the degraded area and restoration actions are localized, if the actions taken today will allow managers to reduce their interference with the "will of the land" in the future, and if there are good reference sites to know what the undisturbed condition is, manipulative actions are probably justified. In contrast, if restoration actions are being considered over a large area and there is uncertainty about the effects of these actions or about the target conditions, much more caution and scrutiny is warranted.

Understanding the differences between wildness and naturalness doesn't provide a definitive answer to solve this central dilemma of wilderness management. These concepts do help clarify when proposed actions are clearly inappropriate and when they are appropriate. Furthermore, they clarify what issues need to be discussed and weighed in determining whether proposed manipulative actions should be taken.

Understanding and Reconciling the Social Irony

The dilemma we face—whether to err on the side of wildness by stressing the nature/culture dichotomy, or to err on the side of naturalness by restoring nature whenever possible — is rooted in the ongoing ambiguity of a wilderness policy and other environmental policies that are rooted both in the preservationist and organic views of nature and

Page 21 of 5344

culture. Where we fall on the spectrum from dichotomy to convergence is often rooted in our view of risk and uncertainty: Do we dare trust science? Do we dare not? If we trust scientists to make wise, informed judgments about what "nature" would be without human intervention, we are more likely to approve of manipulations intended to produce those conditions. Alternatively, if we're concerned about the possibility of restoration going awry, we may be too risk-averse to allow restoration in wilderness.

Seen another way, if we believe that wild nature is doomed, we may be more likely to want to restrict further manipulation in order to save whatever's left in the least "damaged" condition possible. Alternatively, we may believe that leaving things alone will only make matters worse, as may be the case in systems we've simplified through fire suppression, so that the only justifiable action is to try to reverse the trends.

Our trust is not only in science, however, but in the people who apply it: scientists and managers. When people oppose manipulative restoration, is it the science they distrust or is it us? These are questions that we need to confront if we are to make reasoned decisions about whether to allow restoration of naturalness or protect wildness at all costs.

~~Terms and Concepts~~

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Conclusions

Large-scale wilderness restoration based on manipulating the environment will always cause a dilemma and entail the irony of balancing wildness against naturalness. In one way, this dilemma is good because it forces us to carefully consider our actions and their consequences. "Doing the right thing" for wilderness used to be fairly straightforward. Today, with our increased knowledge of regional-scale human impacts, coupled with our desire to restore areas known to be degraded, "doing the right thing" is no longer a simple path because it is based on a philosophical choice between wildness and naturalness. Two people or groups may differ, sometimes strongly, about what they perceive is "right" for wilderness, and both views are valid. If there are significant doubts about a proposed action, one view would err on the side of protecting wildness, while the other view would err on the side of naturalness. One of the biggest hurdles facing wilderness policy-makers and managers today, as well as the concerned public, is how to reconcile these views and manage wilderness for both wildness and naturalness.

Page 22 of ~~53~~44

37.b29

Evaluating Effects of Fish Stocking on Amphibian Populations in Wilderness Lakes

David S. Pilliod
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Abstract—To balance wilderness lake use between recreational fisheries and protected habitat for native species, managers need to understand how stocking non-native predaceous fish affects amphibian populations within a landscape. The goal of this paper is to help managers design and conduct studies that will provide such information. Desirable study characteristics include multiple- visit surveys of all wetlands within a watershed to provide information on amphibian distribution, abundance, breeding, recruitment and seasonal variation in habitat use. By identifying the distribution of critical amphibian habitat and source populations, this approach should enable managers to target specific lakes for protection or restoration as fishless amphibian habitat without overly compromising wilderness fishing opportunities.

Wild areas, large or small, are likely to have values as norms for land science. Recreation is not their only, or even principal utility.
—Aldo Leopold, Sand County Almanac

6. How Can This Information Be Used to Evaluate Potential Management Actions?

Like many ecological problems, the anthropogenic effects of trout stocking on amphibians can vary for different species and even different populations of the same species under a variety of conditions. This variability makes it difficult to make general management recommendations that will adequately protect all species and their habitats. However, research can greatly improve the evaluation and implementation of effective management actions that may balance the needs of the recreational public with conservation of native species. Ideally, any alterations in stocking practices should strive for the lowest cost-benefit ratio in terms of decreasing threats to amphibian persistence with the fewest changes to current recreational fishing opportunities.

Possible management actions include: (1) ceasing stocking in all lakes, (2) ceasing stocking and possibly removing fish from some lakes, (3) reducing stocking frequency and density, (4) reducing naturally reproducing populations of fish by restricting access to spawning areas and/or gill netting, (5) changing species stocked (cutthroat may be less predatory than rainbow or brook trout), (6) stocking sterile fish, or (7) making no changes in stocking practices if fisheries threats to amphibian persistence are negligible.

Cessation of stocking in all wilderness lakes would most likely benefit amphibians and reduce threats to persistence (fig. 3). Undoubtedly, this action would be extremely unpopular for many anglers and could result in less support for wilderness. Economic impacts on outfitters and guides may also occur. Despite the potential socioeconomic costs of this management strategy, some wilderness proponents argue these costs will be minimal and will not overly jeopardize public support for wilderness (Murray and Boyd 1996). This view appears to be supported by resolutions from potentially opposing groups like the Society for Conservation Biology (SCB) and Trout Unlimited. The SCB recommends "phas[ing] out incongruent stocking practices and restor[ing], where appropriate and feasible, previously damaged ecosystems" (SCB 1995). Trout Unlimited states that it "oppose[s] salmonid stocking in historically documented non-salmonid waters where scientific evaluation indicates that such stocking would be likely to adversely affect native biodiversity" (Trout Unlimited 1998).

An example of the potential costs and benefits of restoring wilderness lakes through the cessation of fish stocking comes from the National Park Service, which recommended phasing out and eventually terminating all fish stocking (NPS 1975). In Sequoia, Kings Canyon and Yosemite National Parks, fish stocking was curtailed in the 1970's and completely halted in 1991. This management decision resulted in the loss of recreational fisheries from 29% to 44% of previously stocked lakes (Knapp 1996). Due to a reduction in the proportion of lakes containing fish, as well as historic differences in stocking intensity, the mountain yellow-legged frog currently has a greater distribution in Kings Canyon

National Park, compared with the neighboring John Muir Wilderness, where lakes have continued to be stocked and frog persistence is at risk (Matthews and Knapp 1999).

A similar pattern was observed in the Bitterroot Mountains, Montana where six of 18 stocked lakes (33%) no longer supported trout populations in 1996, following cessation of stocking in 1984 (Funk and Dunlap, in press). Funk and Dunlap (in press) found that long-toed salamanders recolonized five of these currently fishless, but previously stocked lakes within two decades, even in lakes over 5 km from the nearest salamander populations. These studies indicate that widespread cessation of stocking does not result in the loss all trout populations and that amphibians will recolonize lakes after fish disappear.

Cessation of fish stocking, and even removal of fish, in some but not all lakes may be more amenable to recreational anglers. If conducted properly, this management strategy could provide the necessary amphibian habitat for species recovery. The success of this management action, however, is dependent on which lakes are selected for fish elimination. Choosing lakes to be restored to a fishless condition based solely on anthropogenic variables, such as difficulty of access and amount of angler use, may have little effect on reducing threats to amphibian persistence (fig. 3). However, restoring fishless lakes based on their potential for amphibian recolonization and their importance as amphibian habitat should improve the success of this action.

For fish elimination, we recommend targeting: (1) stocked lakes that already have some amphibian breeding occurring, (2) lakes that appear to provide deep-water overwintering habitat for amphibians in surrounding shallow, fishless lakes, (3) lakes that have the potential for fish elimination (low or no natural reproduction), and (4) lakes that are the least important for recreational anglers. Of these recommendations, the first three should take priority over the last. In our study, over 40% of the stocked lakes had at least some frog reproduction, yet few of these lakes had any frog recruitment. Eliminating fish from a lake where frogs are already breeding should result in faster frog recovery than eliminating fish in a lake that has no amphibian reproduction. Furthermore, restoring lakes that provide over-wintering habitat for amphibians can benefit amphibians both locally and potentially across a watershed. Finally, when selecting a lake for fish elimination, choosing a lake that will require the least amount of invasive management (fish removal) is important. Nonreproducing fish can be eliminated from a lake by simply removing that lake from the stocking schedule. However, if fish removal is required, techniques such as gill netting (Knapp and Matthews 1998), coupled with blocking spawning habitat, are preferable to piscicides, such as rotenone and antimycin A. Both of these chemicals may harm other aquatic vertebrates, including amphibians (Fontenot and others 1994; Schnick 1974), and their use in wilderness is controversial.

The relatively easy, potentially risky, and yet untested management strategies include reducing the frequency, density, species, and/or fertility of fish stocked (fig. 3). This action has the potential to benefit both anglers and amphibians. In the best circumstance, densities of trout could be

Figure 3—Diagram illustrating the effects of different management actions on recreational fishing and amphibian conservation. 1. Cessation of stocking in wilderness lakes can only help amphibians, however this will be unpopular with anglers. 2a. Restoring some lakes to their fishless state may increase amphibian persistence if lakes provide critical amphibian habitat, but have little affect if not (2b). 3. Reducing fish densities may benefit both frogs and fish, but this remains to be tested.

reduced, even to the point of providing fishless or near fishless habitats for short intervals of time (several years). This strategy may be attractive to the angling public, if larger trout are caught during periods of low fish density (when lakes are designated as "trophy waters"). If amphibians could produce a successful cohort during these intervals, this action could help sustain populations of those amphibians that are long-lived. However, this strategy does not take into consideration the stochastic variables that can greatly influence amphibian recruitment, namely weather.

In addition, larger fish have a greater gape and may prey on adult amphibians that were invulnerable to smaller fish (Semlitsch and Gibbons 1988; Zaret 1980). In amphibian populations, threats to older, reproductively mature individuals may be the most damaging to a population's persistence (Green 1997). In yet other circumstances, natural fish reproduction may reduce the effectiveness of this strategy at changing the density or size structure of fish populations. Clearly, further investigation of this strategy is warranted.

Finally, managers should keep in mind that most systems are not isolated, and fish stocking practices in adjacent regions can significantly affect restoration efforts. For example, fish dispersal from upstream locations may colonize wetlands that are actively managed as fishless habitats. In addition, fish predation in streams may act as barriers to migration, dispersal and hence colonization of amphibians (Bradford and others 1993).

Despite the range of possible management actions, we believe the best management strategy is to use species and watershed-specific biological information to make management decisions. This information can be obtained only through carefully designed and conducted studies that provide adequate information about the distribution, abundance and life history characteristics of amphibian species across local landscapes. Hopefully, using appropriate information at the watershed scale will enable managers to restore critical amphibian habitat and the biological integrity of wilderness lakes. Creating a few fishless lakes to provide the necessary habitat requirements of amphibians in a watershed may disproportionately reduce the threats of fish stocking on amphibian persistence. For example, having two amphibian source populations in a watershed, instead of one, may increase the probability of amphibian persistence in that watershed by an order of magnitude. With proper management, we believe amphibian populations can be recovered and protected while maintaining recreational fishing opportunities in many wilderness lakes.

Page 24 of 5344

37.b30

Fish Stocking in Protected Areas: Summary of a Workshop

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Abstract—Native and nonnative sport fish have been introduced into the majority of historically fishless lakes in wilderness,
generating conflicts between managing wilderness as natural ecosystems and providing opportunities for recreation. Managers faced
with controversial and difficult decisions about how to manage wilderness lakes may not always have ready access to research
relevant to these decisions. **To address this problem, and to expose scientists to the concerns and constraints of managers and**
wilderness users, a workshop was held in October 1998 at the Flathead Lake Biological Station in Polson, Montana. Participants
included 43 scientists, state and federal managers, wilderness users and advocates and students. Four subject areas were addressed:
federal, state, tribal and user perspectives, community and ecosystem effects, species effects and management recommendations.
Papers from the workshop are being developed for an issue of the journal *Ecosystems*.

The conflicts between managing wilderness as "natural" ecosystems and providing opportunities for recreation are
especially acute in fisheries management. Native and nonnative sport fish have been introduced into the majority of
historically fishless lakes in wilderness (Bahls 1992), usually to the detriment of the native biota (Bradford and others
1993; Chess and others 1993; Tyler and others 1998). Alpine lakes are the primary target for recreation in wilderness
(Hendee and Schoenfeld 1990), and fishing opportunities may further concentrate use in these areas, resulting in
resource damage and compromising solitude in the wilderness experience.
Fish stocking, especially using aircraft, is also considered to conflict with wilderness values (Duff 1995).

However, fish stocking in mountain lakes long predates the Wilderness Act of 1964, and fishing is the objective of a
sizable proportion of wilderness visitors (Fraley 1996; Hendee and Schoenfeld 1990). Language in the Wilderness Act,
reserving the rights of the States with respect to management of fish and wildlife, is often cited as justification for
continued active management of fisheries in wilderness (Duff 1995; Fraley 1996). Conversely, other language in the
Wilderness Act promoting the preservation of natural systems, and increasing emphasis on wilderness as a reference
point for the study and management of ecosystems (Hendee and others 1990; Kaufmann and others 1994) are difficult
to reconcile with many of the current practices of fisheries management.

Consequently, managers are faced with controversial and difficult decisions about how to manage wilderness lakes,
and they do not always have ready access to research relevant to these decisions. Considerable research has been
conducted recently on the biological effects of fish stocking on resident biota. Many managers tend to minimize these
effects, however, instead promoting untested alternative hypotheses (Fraley 1996). **Thus, we organized a workshop,**
held for three days in October 1998 at The University of Montana Flathead Lake Biological Station.

The objectives were to present wilderness managers with the latest research results and management
recommendations on the effects of fish introductions on wilderness lakes; to encourage discussion of issues, areas of
agreement, conflicts and recommendations for future management and research among managers, scientists and
wilderness and recreation users; and to publish a compilation of research results and management recommendations
that will be useful for scientists and managers, alike.

The workshop was organized into four sessions, which included formal presentations and a block of time for group
discussion. The workshop began with an overview of fish stocking in wilderness from federal, state, tribal and user
perspectives, including summaries of key legislation, policy and description of current management practices. A
session on community and ecosystem effects included effects of fish stocking on lake nutrient cycling, algal dynamics
and invertebrates and interactions between predators, hydroperiod and amphibians. The third session focused on effects
on vertebrate species and included discussions on effects of stocking on native fish and amphibians. The final session .
described restoration and management. **This paper briefly describes the presentations and summarizes the findings and**

Page 25 of 5344

comments from the discussions. The complete agenda and abstracts can be found at the Aldo Leopold Wilderness Research Institute's web site (www.wilderness.net/leopold/ bulletin.htm).

37.b31

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IMPACTS OF TROUT STOCKING ON AMPHIBIAN POPULATIONS

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Keywords: fish stocking, long-toed salamanders, Columbia spotted frogs, western toads, cutthroat trout, rainbow trout, golden trout

Background & Management Issues: Trout and other non-native sport fishes have been introduced into high-elevation lakes in western North America to provide recreational opportunities in the backcountry. Many of these lakes were historically fishless, and consequently, fish stocking has been implicated in the decline of native amphibian populations. Previous research has either examined spatial distributions of amphibian populations within individual water bodies decades after stocking occurred or focused on the effects on single species. Life history traits vary among amphibian species, however, and fish stocking may affect species differently. In addition, amphibian population structure may be affected at a broad scale when a portion of lakes and streams in a watershed are stocked. This habitat fragmentation may isolate amphibian populations and result in increased extinction rates.

Project Objectives:

To evaluate the effects of introduced trout on two species of amphibians with different life-history characteristics: the long-toed salamander, a species in which larvae overwinter two years before metamorphosing; and the Columbia spotted frog, a species in which the larval stage is completed in one summer.

To examine the broad-scale effects of fish stocking on amphibian populations within drainage basins.

Project Description: **Fish and amphibian surveys were conducted in the Bighorn Crags region of the Frank Church River of No Return Wilderness. Historical and**

state records, hook-and-line angling, gill netting, and visual observations were used to determine the presence of fish. Visual encounter surveys were used to determine the distribution and abundance of amphibians. Observers searched the perimeters of lakes, ponds, and entire flooded meadows, and recorded life stages of individuals encountered. Snorkel surveys in 11 lakes were used to evaluate the accuracy of visual encounter surveys for salamanders, and mark-recapture population estimates from 39 lakes permitted evaluation of frog surveys. In addition, the physical, chemical, and biological characteristics of lakes and wetlands were recorded.

Results: Historical records indicated that Idaho Fish and Game stocked over 60,000 cutthroat and rainbow trout into 12 to 30 previously fishless lakes in 1937 and 1938 in the Bighorn Crags area. Beginning in the 1960s, fish were restocked every three to six years. In total, 37 lakes were stocked with 300,000 fry or fingerlings.

Cutthroat, rainbow, and golden trout and their hybrids were found in all 11 basins searched. Overall, fish occupied 43% of sites. Large, deep lakes (greater than 1 ha in surface area and more than 4 m deep) were more likely occupied than small, shallow wetlands. As a result, fish occupied 90% of the available surface area of water in the basins. More importantly, only two basins had more than one deep, fishless lake.

Densities of both long-toed salamanders and Columbia spotted frogs were lower in sites with fish than in those without fish. Indeed, when site characteristics of deep lakes were held constant, fewer amphibians of all stages were found in stocked lakes than in lakes without fish. Moreover, densities of salamander larvae at least two years old, and both adult and juvenile frogs in *fishless* sites decreased as the proportion of wetlands in the basin occupied by trout increased.

Management Implications:

Survival of salamander larvae and juvenile frogs may depend on deep lakes (>2 m), yet few of these habitats are not stocked with fish.

Negative effects of stocked lakes may extend across a landscape. Lakes with fish may have insufficient juvenile recruitment to compensate for adult mortality. Amphibians with extended larval periods may be forced to breed in shallower wetlands where the risk of extirpation due to desiccation, anoxia, and freezing are higher than in the deep, lentic environments. Likewise, amphibians that complete their life cycle in one summer may breed in shallow wetlands but may be forced to immigrate to deep lakes to overwinter. If those lakes are stocked with fish, the progeny may be completely eradicated.

Information necessary to evaluate the effects of fish stocking in high-elevation lakes should include knowledge of:

(1) **the amphibian and fish species in the area** – Because little information is available about distributions of many amphibian species, surveys should be based on what species are potentially in the wilderness area and the life histories of those species. Different types of surveys conducted at various times of the year may be needed to assess abundances and life stages.

(2) **the extent of area impacted** – Surveys of entire watersheds provide the most unbiased information to determine production, habitat use, and potential interaction between fish and amphibians and allow the most accurate assessment of management actions. Because watershed sampling requires considerable time and effort, the number of watersheds in a wilderness that can be sampled may be limited. Surveying a subset of wetlands in different watersheds using stratified sampling may broaden the scope if all wetland types can be adequately represented. Integrating fish and amphibian surveys may also expand sampling ability. photo by Steve Corn

(3) **the effect of management actions** – Because the basin-wide effects of fish stocking have only recently been identified, information on the results of specific management actions is unavailable. Potential management actions include: cessation of stocking and/or removal of fish, which reduce the number of lakes supporting fish; reduction in stocking frequency/density/fertility (stocking sterile fish or limiting access to spawning habitat), which may result in fishless habitats for short periods; and alteration of the species stocked (e.g. cutthroat trout may be less predatory than brook or rainbow trout).

Project dates: The project was initiated in August 1994 and completed in January 2000.

Publications / Products / Presentations:

Pilliod, David S.; Peterson, Charles R. 2000. Evaluating effects of fish stocking on amphibian populations in wilderness lakes. *In*: Cole, David N.; McCool, Stephen F.; Borrie, William T.; O'Loughlin, Jennifer, comps. Wilderness Science in a Time of Change Conference–Volume 5: Wilderness Ecosystems, Threats, and Management; 1999 May 23-27; Missoula, MT. Proceedings RMRS-P-15-VOL-5. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station: 328-335. **Leopold Publication Number 406**. Read it here!

Pilliod, David S.; Peterson, Charles R. 2001. Local and landscape effects of introduced trout on amphibians in historically fishless watersheds. *Ecosystems* 4(4): 322-333. **Leopold Publication Number 446**. For ordering information...

For additional information…

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Page 28 of 5344

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This summary was prepared by
A. E. H. Perkins 7/01.

Citation for publication number 424:

37.b32

Corn, Paul Stephen 2000. **Amphibian declines: review of some current hypotheses** In: Sparling, Donald W.; Linder, Greg; Bishop, Christine A., eds. Ecotoxicology of Amphibians and Reptiles. U.S. Geological Survey, Midwest Science Center. Columbia, MO: 663-696
Leopold Publication Number **424**
publication not available for download
order form (free)

Abstract:

Declines of varying severity in the size of amphibian populations have been observed for many years (Bragg 1960; Gibbs et al. 1971; Cooke 1972; Beebee 1973; Bury et al. 1980; Andren and Nilson 1981; Hammerson 1982; Corn and Fogleman 1984; Hayes and Jennings 1986; Heyer et al. 1988), but concern among conservation biologists increased dramatically after the First World Congress of Herpetology in 1989 at Canterbury, UK. Several papers and posters at the meeting presented evidence of recent declines, and discussions among the attendees heightened concern about the status of amphibians globally. Continuing dialogue led to a workshop in February 1990 at Irvine, California, sponsored by the National Research Council Board on Biology. The consensus of the participants of that meeting was that amphibian populations declines were real but documentation was largely anecdotal, and much work was needed on the causes of population declines (Barinaga 1990; Blaustein and Wake 1990). The Irvine meeting received considerable media attention, with reporters from print media and National Public Radio in attendance. The initial coverage of the problem (e.g., Booth 1989; Tugend 1990) even caught the attention of the supermarket tabloids (Stern 1990), and the problem of disappearing frogs occupied agents Scully and Mulder in one episode of the television show The X-Files (Newton 1996). Belying amphibians' usual status as uncharismatic microfauna, public interest in these animals and their status remains high, sustained by continuing, more serious coverage in the popular media (e.g., Yoffe 1992; Quammen 1993; Argo 1996; Luoma 1997).

Page 29 of 5344

37.b38

Citation for publication number 425:

Corn, Paul Stephen 2001. **Perspectives from the Aldo Leopold Wilderness Research Institute: amphibians and wilderness** International Journal of Wilderness 7(2): 25.
Leopold Publication Number **425**
publication not available for download
order form (free)

Abstract:

Diversity of amphibians varies among wildernesses, from high in the Southeast to low in high-elevation Wilderness Areas and backcountry areas of National Parks in the western United States. Knowledge about the status of amphibians is important, because amphibians occupy important ecological niches and a high proportion of western amphibian species have undergone recent declines, often in protected habitats.

Citation for publication number 446:

See 37.b26

Pilliod, D.S.; Peterson, C.R. 2001. **Local and landscape effects of Introduced trout on amphibians in historically fishless watersheds** Ecosystems 4:322-333.
Leopold Publication Number **446**
publication not available for download
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Abstract:

Introduced trout are often implicated in the decline of high mountain amphibian populations, but few studies have attempted to understand whether the effects of trout in lakes where they have been introduced may also influence the distribution and abundance of amphibians throughout entire mountain basins, including in remaining fishless lakes. We examined this relationship using the relative abundance of long-toed salamanders (Ambystoma macrodactylum) and Columbia spotted frogs (Rana luteiventris) in fish-containing and fishless lentic sites in basins with varying levels of historic fish stocking. All lentic waters were surveyed for fish and amphibians in 11 high-elevation basins in the Frank Church - River of No Return Wilderness, Idaho between 1994 and 1999. We found introduced trout (Oncorhynchus clarki, O. mykiss, O. m. aguabonita) in 43 of the 101 sites, representing 90% of the total available lentic water surface area. At the scale of individual water bodies, after accounting for differences in habitat characteristics between fish-containing and fishless sites, the abundance of all life stages of amphibians was significantly lower in lakes with fish. At the basin scale, densities of over-wintering life stages of amphibians were lower in fishless sites in basins with more habitat occupied by trout. Our results suggest that many of the remaining fishless habitats are too shallow to provide suitable breeding or over-wintering habitat for these amphibians, and that current trout distributions may eventually result in the extirpation of amphibian populations from entire landscapes, including from sites that remain in a fishless condition.

Page 30 of 5344

37.b38

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CURRENT WILDLIFE RESEARCH PROJECTS

Amphibian Research and Monitoring Initiative

WHO: Steve Corn, Blake Hossack, and David Pilliod - Leopold Institute; Chuck Peterson - Idaho State University; Chris Funk, Bryce Maxell, Andrew Sheldon, and Aimee Wyrick - University of Montana

WHAT: In Fiscal Year 2000, the Department of the Interior (DOI) initiated a major national initiative to detect trends in amphibian populations and conduct research into causes of declines, the Amphibian Research and Monitoring Initiative (ARMI). Objectives include:

- Initiate long-term monitoring to determine trends in amphibian populations
- Conduct research into causes of amphibian declines and malformations
- Make use of relevant expertise within USGS and DOI
- Make the information available to cooperators, land managers, the scientific community, and the general public

ARMI projects are being conducted nationally. In the Northern Rocky Mountains, long-term monitoring of amphibian populations is being initiated at several National Parks, and surveys are being conducted on National Forests in Montana in cooperation with Region 1 of the Forest Service. ARMI funding is being used to help fund research on amphibian population dynamics.

Page 31 of 5344

WHEN: 2000 to 2004

WHERE: Glacier National Park, Grand Teton National Park, Theodore Roosevelt National Park, Yellowstone National Park, National Forests in western Montana, National Wildlife Refuges in Montana and Idaho

WHY: Approximately 230 species of frogs, toads, and salamanders make up the amphibian fauna of the continental United States. Their aquatic and terrestrial life stages and sensitivity to environmental conditions make them ideal sentinels of environmental stress and a possible model for human health studies. Declines have been observed in many parts of the world, including the United States. Habitat alteration and destruction have long been major causes of amphibian declines. More recently, significant declines have occurred in protected areas in the western United States that have not shown obvious changes in habitat. These unexplained declines may be caused by contaminants, non-native species, or disease. Under ARMI, concern about amphibian populations isp laced within the larger context of measuring trends in amphibian populations and a variety of environmental parameters.

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LEOPOLD INSTITUTE'S WILDLIFE PUBLICATIONS (1991-2002)

- WILDLIFE MANAGEMENT ACTIVITIES IN WILDERNESS
- RECREATION IMPACTS - GENERAL
- EFFECTS OF HUMAN INTRUSIONS ON BIRDS
- AMPHIBIAN CONSERVATION AND FISH STOCKING

To view abstracts for all of the following publications, go to the Leopold Institute's searchable publication database and search the wildlife category and sub-categories, OR view a specific abstract by selecting the publication number.

Wildlife management activities in Wilderness:

37.b38

Landres, Peter; Meyer, Shannon; Matthews, Sue 2001. The Wilderness Act and fish stocking: an overview of legislation, judicial interpretation, and agency implementation. *Ecosystems* 4(4): 287-295.
Leopold Publication Number 426

Page 32 of 5344

Krausman, Paul R.; Czech, Brian. 2000. Wildlife management activities in wilderness areas in the Southwestern United States. *Wildlife Society Bulletin* 28(3): 550-557.
Leopold Publication Number 412

Amphibian conservation and fish stocking:

Bury, R.B.; Major, D.J.; Pilliod, D.S. 2002. Responses of Amphibians to Fire Disturbance in Pacific Northwest Forests: a Review. The role of fire in nongame wildlife management and community restoration: traditional uses and new directions. Edited by W.M. Ford, K.R. Russell, and C.E. Moorman U.S. Department of Agriculture, Forest Service, Northeastern Research Station, Newtown Square, PA. Gen. Tech. Rep. NE-288: 34-42. 37.b38
Leopold Publication Number 447

Pilliod, D.S.; Peterson, C.R. 2001. Local and Landscape Effects of Introduced Trout on Amphibians in Historically Fishless Watersheds. *Ecosystems* 4:322-333.
Leopold Publication Number 446

Corn, Paul Stephen 2001. Fish Stocking Impacts to Mountain Lake Ecosystems: The Introduction of Nonnative Fish into Wilderness Lakes: Good Intentions, Conflicting Mandates, and Unintended Consequences. *Ecosystems* 4(4): 275-278.
Leopold Publication Number 427

Landres, Peter; Meyer, Shannon; Matthews, Sue 2001. The Wilderness Act and Fish Stocking: An Overview of Legislation, Judicial Interpretation, and Agency Implementation. *Ecosystems* 4(4): 287-295.
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Corn, Paul Stephen 2001. Perspectives from the Aldo Leopold Wilderness Research Institute: Amphibians and Wilderness. *International Journal of Wilderness* 7(2): 25.
Leopold Publication Number 425

Corn, Paul Stephen 2001. Perspectives from the Aldo Leopold Wilderness Research Institute: Amphibians and Wilderness. *International Journal of*

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Corn, Paul Stephen 2000. Amphibian Declines: Review of Some Current Hypotheses. *In*: Sparling, Donald W.; Linder, Greg; Bishop, Christine A., eds. Ecotoxicology of Amphibians and Reptiles. U.S. Geological Survey, Midwest Science Center. Columbia, MO: 663-696.
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Muths, Erin; Corn, Paul Stephen. 2000. Boreal Toad. *In*: Reading, Richard P.; Miller, Brian., eds. Endangered Animals; A Reference Guide to Conflicting Issues. Westport, CT: Greenwood Press: 60-65.
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Pilliod, David S.; Peterson, Charles R. 2000. Evaluating Effects of Fish Stocking on Amphibian Populations in Wilderness Lakes. *In*: Cole, David N.; McCool, Stephen F.; Borrie, William T.; O'Loughlin, Jennifer, comps. 2000. Wilderness science in a time of change conference - Volume 5: Wilderness ecosystems, threats, and management; 2000 May 23-27; Missoula, MT. Proceedings RMRS-P-15-VOL-5. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 328-335.
Leopold Publication Number 406

Corn, Paul Stephen; Knapp, Roland A. 2000. Fish Stocking in Protected Areas: Summary of a Workshop. *In*: Cole, David N.; McCool, Stephen F.; Borrie, William T.; O'Loughlin, Jennifer, comps. 2000. Wilderness science in a time of change conference - Volume 5: Wilderness ecosystems, threats, and management; 2000 May 23-27; Missoula, MT. Proceedings RMRS-P-15-VOL-5. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 301-303.

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Muths, Erin; Corn, Paul Stephen. 1997. Basking by adult boreal toads (Bufo boreas boreas) during the breeding season. *Journal of Herpetology* 31(3): 426-428.
Leopold Publication Number 310

37.b39

NON-NATIVE FISH STOCKING IN LAKES READING LIST

Back to Workshop Overview   Program & Abstracts

This reading list provides an introduction to the issue of fish stocking in lakes. Rather than a comprehensive list, it is a compilation of references that scientists currently working on the issue have suggested may be relevant to managers, policy makers, and other scientists. Here the issue is separated into the following categories:

- **General Overview**
- **Amphibian Impacts**
- **Native Fish Impacts**
- **Ecosystem and Community Impacts**
- **Management and Restoration**

Comments/updates to the list can be sent to the Leopold Institute.

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Page 37 of 5344

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Back to List

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AMPHIBIANS

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Back to List

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Back to List

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Back to List

37.b35

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Back to List

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Please send comments or additional citations of new or pertinent papers to above address and write "series comments" in the subject line.

3 November 1998

~~These are quotes from the research paper summaries that follow. It is perfectly clear that there is so much more to recreational fishing of westslope cutthroat trout in Wilderness Lakes. Wilderness values, effects on the original non-fish species, and disruption of natural processes have as much weight, if not more, then a potentially threatened fish species being considered to be stocked in originally barren, fishless lakes in the Wilderness.~~

~~Because they have the potential to provide the best remaining standards of relatively unmodified landscapes, protected areas in North America (such as wilderness areas and national parks) have tremendous ecological and scientific value (Cole and Landres 1996). Although the montane ecosystems of western North America are particularly well represented in this complex of protected lands, aquatic habitats within these protected areas are often subject to management practices that are inconsistent with the goal of maintaining natural processes. The most prevalent of these practices is the introduction of salmonid fishes (such as trout) into historically fishless ecosystems to create recreational fisheries.~~

~~—These stocking programs have dramatically transformed the formerly fishless aquatic ecosystems within protected areas of western North America. For example, of the estimated 16,000 naturally fishless mountain lakes in the western US, the majority of which are located within national parks and wilderness areas, 60% of all lakes and 95% of larger, deeper lakes now contain nonnative trout (*Oncorhynchus* spp., *Salmo* spp., *Salvelinus* spp.) (Bahls 1992).~~

~~—The management of nonnative trout populations in protected areas is highly controversial due in large part to increased awareness of the ecological effects of introduced fishes on naturally fishless ecosystems (Duff 1995; Fraley 1996). Although the state agencies charged with managing aquatic ecosystems within protected areas have historically focused on providing recreational fishing while placing little emphasis on ensuring the maintenance of natural processes, fisheries managers are increasingly being asked to justify their stocking programs in light of a growing body of literature that documents the effects of fish introductions into naturally fishless lakes. These studies have repeatedly demonstrated that fish introductions dramatically alter native vertebrate and invertebrate communities, often resulting in the extirpation of native fishes, amphibians, zooplankton, and benthic macroinvertebrates (Anderson 1972; Stoddard 1987; Bradford and others 1998; Carlisle and Hawkins 1998; Tyler and others 1998; Knapp and Matthews 2000). However, these studies have typically focused narrowly on the direct impact of fish introductions on the native fauna and ignored the possible disruption of ecosystem processes (but see~~

Page 45 of 5344

Leavitt and others 1994) as well as indirect landscape-scale impacts transmitted beyond the boundaries of those habitats subject to fish introductions.

He concludes that in the face of increasing public support for protecting natural processes, the continued stocking of fish into wilderness ecosystems is no longer justified.

They conclude that although US federal policy currently grants the authority for fish stocking to the states, case law allows the federal agencies to be directly involved in decisions regarding fish stocking in wilderness areas.

This work shows that the introduction of salmonid fishes into headwater lakes can result in disproportionately larger effects on native fishes than introductions lower in drainages

However, introductions of nonnative fishes into headwater lakes provide point sources capable of invading all downstream habitats, as the fish surmount barriers that normally hinder upstream-directed invasions.

These results suggest that widespread fish stocking has caused substantial changes to nutrient cycles in hundreds of lakes throughout montaneprotected areas of western North America, with impacts being greatest in lakes stocked with high densities of trout.

They report that at a local scale, after accounting for habitat differences between fishcontaining and fishless water bodies, the abundance of all life stages of long-toed salamanders and spotted frogs was lower in water bodies containing nonnative trout than in water bodies remaining in a fishless condition. At the landscape scale, the presence of fish in some water bodies had important influences on the abundance of amphibians in the remaining fishless water bodies.

Of the two large zooplankton species believed to have been present in the lake prior to fish introductions, one reappeared while another failed to do so, apparently because the egg bank of this latter species had been depleted during the 30 years of fish presence.

—Collectively, these papers indicate that the effects of widespread trout introductions into wilderness landscapes are not limited simply to direct effects on prey taxa, but instead can be transmitted throughout lake food webs and even beyond the shorelines of fish-containing lakes to fishless lakes. In addition, following fish removal, full recovery of ecosystem structure and function may not occur

If managers are to truly balance these often opposing goals, it is imperative that current fisheries management practices be evaluated in the context of their effects on ecosystem and landscape processes.

. The highly utilitarian ethic that drove resource management until well into the 1960s was gradually replaced by one that acknowledges the value of all life forms and their ecological complexity, a view currently supported even by many anglers. The necessity for wilderness fish stocking is now the subject of widespread debate, especially in view of changing social values and priorities. Options for future generations cannot be preserved if introductions continue to erode the biodiversity of mountain lake ecosystems.

Future management of waters that already contain introduced trout must be directed toward overall ecosystem health and stability, with biodiversity and ecosystem integrity as a paramount objective.

Options for future generations cannot be preserved if introductions continue to erode the biodiversity of mountain lake ecosystems. This should be our greatest concern.

. Further, although current federal regulations recognize state authority for fish stocking, judicial interpretation gives federal agencies the authority for direct involvement in decisions regarding fish stocking in wilderness.

Page 46 of 5344

—Fish stocking does compromise certain wilderness values, and wilderness designation does impose restrictions on the types of wildlife management actions that are appropriate in wilderness areas. In some cases, these compromises and restrictions have led to an "either/or" dichotomous view that pits state fish stocking programs against federal responsibility for protecting wilderness values. Differences in agency missions, traditions, and cultures also tend to exacerbate "us vs them" attitudes.

—Backed by Supreme Court decisions, federal managers can be involved in wildlife management decisions to defend wilderness values.

, headwater lake stocking provides source populations that may be capable of invading most downstream habitats, including headwater refugia of native fishes.

Trout introductions to high-elevation headwater lakes thus pose disproportionately large risks to native fishes—even when the place of introduction may appear to be spatially dissociated from populations of the native species.

It is important to consider, however, that stocking of a mere handful of lakes could allow nonnative fishes access to nearly an entire stream network.

Similarly, the stream area negatively affected by nonnatives could be minimized by stocking multiple lakes in one tributary basin instead of one lake each in multiple basins.

Systems where nonnative fishes have emigrated from headwater lakes and occupy, but have not successfully colonized, the outlet streams should be considered good candidates for eradication projects.

. Introduced fish may alter lake nutrient cycles and primary production, but the magnitude and variation of these effects have not been fully explored.

The results of our modeling and paleolimnological analyses indicate that introduced trout fundamentally alter nutrient cycles and stimulate primary production by accessing benthic P sources that are not normally available to pelagic communities in oligotrophic mountain lakes. These effects pose a difficult challenge for managers charged with balancing the demand for recreational fisheries with the need to maintain natural ecosystem processes.

Implications for Current Stocking Practices in Mountain Wilderness Areas

Although the largest perturbations to lake communities and ecosystem processes probably occur soon after fishless lakes are stocked for the first time, our analyses show that continued stocking only serves to exacerbate the original effects.

In addition, our analyses of fish nutrient regeneration rates suggest that the contributions of introduced trout to nutrient cycles are approximately double the level estimated for lakes that have not been stocked for several decades (Figure 7).
—Therefore, to truly minimize effects of introduced fish on mountain lake ecosystems, all stocking should be halted. This would allow the lakes that lack sufficient spawning habitat to revert to a fishless condition, while reducing the density of fish in lakes with self-sustaining trout populations. Because many currently stocked lakes are likely to harbor self-sustaining trout populations (Bahls 1992; R. A. Knapp unpublished), a moratorium on trout stocking in all lakes would provide fisheries managers a simple means by which to reduce the effects of introduced fish on native invertebrate communities and ecosystem processes while still providing ample recreational fishing opportunities. It remains to be seen whether native faunal assemblages and ecosystem processes in mountain lakes can be restored simply by eliminating fish populations (Funk and Dunlap 1999; McNaught and others 1999).

At the scale of individual water bodies, after accounting for differences in habitat characteristics between fish-containing and fishless sites, the abundance of amphibians at all life stages was significantly lower in

Page 47 of 5344

lakes with fish. At the basin scale, densities of overwintering life stages of amphibians were lower in the fishless sites of basins where more habitat was occupied by trout. Our results suggest that many of the remaining fishless habitats are too shallow to provide suitable breeding or overwintering sites for these amphibians and that current trout distributions may eventually result in the extirpation of amphibian populations from entire landscapes, including sites that remain in a fishless condition.

Restoration

Conserving natural biodiversity and maintaining functioning ecosystems is a goal of protected area management. The results of this study suggest that wildlife managers need to consider restoring a few deep lakes in each basin to create fishless breeding and overwintering habitat for amphibians (Knapp 1996; Knapp and Matthews 1998; Pilliod and Peterson 2000).

Gill netting is a viable fish eradication technique for smaller (less than 10 ha, (25 acres)), shallow (less than 10 m (33 feet) deep)) lakes that lack habitable inflows and outflows or other sensitive species. Further work is required to define appropriate removal methods for larger lakes and watersheds.

We believe that shallower lakes (less than 10 m deep) of up to 10 ha should be amenable to gill net eradication of nonnative fishes over reasonably short periods, without resorting to rotenone or other poisons.

If the restoration of substantially larger or deeper lakes is proposed, alternate methods of fish removal including, but not limited to, electrofishing, trap netting on spawning grounds, disturbing spawning habitat, creating under-ice anoxia by the addition of nutrients (see Brunskill and others 1980 for a possible method), lake drawdown, and/or the application of piscicides should be given consideration in addition to, or as a replacement for gill nets. These alternate methods will be controversial, but they may be more practical for removing fish from certain lakes. Canadian national parks managers have previously used chemical agents in their attempt to eradicate fish from dozens of lakes.

Further, nontarget species such as Harlequin Ducks (*Histrionicus histrionicus*) and even bears might be adversely affected by restoration activities on some water bodies.

Last, because organisms such as *Gammarus* may be extirpated but leave no trace of their prior existence, it will be difficult to ascertain that full food web restoration has been achieved for the many lakes that lack prestocking records of their original invertebrate communities.

Further experimental restoration work is needed to better define the practical limits of gill netting as a management tool and to provide alternate solutions for larger or otherwise "difficult" stocked lakes. A better understanding of our few remaining pristine ecosystems is also needed if we wish to undo a century of past fisheries management practices and return a small suite of lakes to their natural state

Naturalness and Wildness: The Dilemma and Irony of Managing Wilderness

The origin and value of these concepts are discussed, as well as the dilemma and irony that arises when wilderness managers contemplate manipulating the environment to restore naturalness at the risk of reducing wildness

It is concluded that large scale wilderness restoration based on manipulating the environment will always cause a dilemma and entail the irony of balancing wildness against naturalness. One of the biggest hurdles facing wilderness policy-makers and managers today, as well as the concerned public, is how to reconcile these views and manage wilderness for both wildness and naturalness.

Two independent but related concepts are intertwined in the idea of wilderness. In the 1964 Wilderness Act, wilderness is defined in Section 2.(c) as "...an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain." Later in this same section, wilderness is further defined as an area "retaining its primeval character and influence...which is protected and managed so as to preserve its natural conditions." The key words in these quotes are *untrammeled* and *natural*. When the Wilderness Act was passed, these key words undoubtedly were intended to be complementary because untrammeled areas were certainly natural. Today, however, we are witnessing regional ecological impacts to areas that are untrammeled in every other way, as well as new understanding of the long-term ecological consequences of natural resource management. As a result, we now

Page 48 of 5344

have divergent philosophical views of what wilderness is and what it should be. These views are encapsulated by the words untrammeled and natural in a way that was likely unforeseen by wilderness proponents as they crafted legislative wording. This dialogue session explored the management dilemmas and social ironies resulting from these divergent views and presented a case study that brings these diverging views into sharp focus.

Synonyms for untrammeled include unimpeded, unhampered, uncontrolled, self-willed and free. We suggest that the word "wildness" strongly connotes this sense of an area free from human control or manipulation.

Synonyms for natural include native, aboriginal, indigenous and endemic, and we suggest that the term "naturalness" be used to capture this biological sense of wilderness.
—While these concepts of wildness and naturalness differ from one another, both are essential elements of wilderness, wilderness is the idea and place where the concepts of wildness and naturalness reach their highest expression. These concepts strongly influence, either directly or indirectly, virtually all of the decisions and actions taken in wilderness management.

—Large-scale wilderness restoration based on manipulating the environment will always cause a dilemma and entail the irony of balancing wildness against naturalness. In one way, this dilemma is good because it forces us to carefully consider our actions and their consequences. "Doing the right thing" for wilderness used to be fairly straightforward. Today, with our increased knowledge of regional-scale human impacts, coupled with our desire to restore areas known to be degraded, "doing the right thing" is no longer a simple path because it is based on a philosophical choice between wildness and naturalness. Two people or groups may differ, sometimes strongly, about what they perceive is "right" for wilderness, and both views are valid. If there are significant doubts about a proposed action, one view would err on the side of protecting wildness, while the other view would err on the side of naturalness. One of the biggest hurdles facing wilderness policy-makers and managers today, as well as the concerned public, is how to reconcile these views and manage wilderness for both wildness and naturalness.

To balance wilderness lake use between recreational fisheries and protected habitat for native species, managers need to understand how stocking non-native predaceous fish affects amphibian populations within a landscape. The goal of this paper is to help managers design and conduct studies that will provide such information. Desirable study characteristics include multiple- visit surveys of all wetlands within a watershed to provide information on amphibian distribution, abundance, breeding, recruitment and seasonal variation in habitat use. By identifying the distribution of critical amphibian habitat and source populations, this approach should enable managers to target specific lakes for protection or restoration as fishless amphibian habitat without overly compromising wilderness fishing opportunities.

Wild areas, large or small, are likely to have values as norms for land science. Recreation is not their only, or even principal utility.
—Aldo Leopold, Sand County Almanac

6. How Can This Information Be Used to Evaluate Potential Management Actions?

—Like many ecological problems, the anthropogenic effects of trout stocking on amphibians can vary for different species and even different populations of the same species under a variety of conditions. This variability makes it difficult to make general management recommendations that will adequately protect all species and their habitats. However, research can greatly improve the evaluation and implementation of effective management actions that may balance the needs of the recreational public with conservation of native species. Ideally, any alterations in stocking practices should strive for the lowest cost-benefit ratio in terms of decreasing threats to amphibian persistence with the fewest changes to current recreational fishing opportunities.
—Possible management actions include: (1) ceasing stocking in all lakes, (2) ceasing stocking and possibly removing fish from some lakes, (3) reducing stocking frequency and density, (4) reducing naturally reproducing populations of fish by restricting access to spawning areas and/or gill netting, (5) changing species stocked (cutthroat may be less predatory than rainbow or brook trout), (6) stocking sterile fish, or (7) making no changes in stocking practices if fisheries threats to amphibian persistence are negligible.
—Cessation of stocking in all wilderness lakes would most likely benefit amphibians and reduce threats to persistence (fig. 3). Undoubtedly, this action would be extremely unpopular for many anglers and could result in less support for wilderness. Economic impacts on outfitters and guides may also occur. Despite the potential socioeconomic costs of this management strategy, some wilderness proponents argue these costs will be minimal and will not overly jeopardize public support for wilderness (Murray and Boyd 1996). This view appears to be supported by resolutions from potentially opposing groups like the Society for Conservation Biology (SCB) and Trout Unlimited. The SCB recommends "phas[ing] out incongruent stocking practices and restor[ing], where appropriate and feasible, previously damaged ecosystems" (SCB 1995). Trout Unlimited states that it "oppose[s] salmonid stocking in historically documented non-salmonid waters where scientific evaluation indicates that such stocking would be likely to adversely affect native biodiversity" (Trout Unlimited 1998).

Page 49 of 5344

An example of the potential costs and benefits of restoring wilderness lakes through the cessation of fish stocking comes from the National Park Service, which recommended phasing out and eventually terminating all fish stocking (NPS 1975). In Sequoia, Kings Canyon and Yosemite National Parks, fish stocking was curtailed in the 1970's and completely halted in 1991. This management decision resulted in the loss of recreational fisheries from 29% to 44% of previously stocked lakes (Knapp 1996). Due to a reduction in the proportion of lakes containing fish, as well as historic differences in stocking intensity, the mountain yellow-legged frog currently has a greater distribution in Kings Canyon National Park, compared with the neighboring John Muir Wilderness, where lakes have continued to be stocked and frog persistence is at risk (Matthews and Knapp 1999).

A similar pattern was observed in the Bitterroot Mountains, Montana where six of 18 stocked lakes (33%) no longer supported trout populations in 1996, following cessation of stocking in 1984 (Funk and Dunlap, in press). Funk and Dunlap (in press) found that long-toed salamanders recolonized five of these currently fishless, but previously stocked lakes within two decades, even in lakes over 5 km from the nearest salamander populations. These studies indicate that widespread cessation of stocking does not result in the loss all trout populations and that amphibians will recolonize lakes after fish disappear.

Cessation of fish stocking, and even removal of fish, in some but not all lakes may be more amenable to recreational anglers. If conducted properly, this management strategy could provide the necessary amphibian habitat for species recovery. The success of this management action, however, is dependent on which lakes are selected for fish elimination. Choosing lakes to be restored to a fishless condition based solely on anthropogenic variables, such as difficulty of access and amount of angler use, may have little effect on reducing threats to amphibian persistence (fig. 3). However, restoring fishless lakes based on their potential for amphibian recolonization and their importance as amphibian habitat should improve the success of this action.

For fish elimination, we recommend targeting: (1) stocked lakes that already have some amphibian breeding occurring, (2) lakes that appear to provide deep-water overwintering habitat for amphibians in surrounding shallow, fishless lakes, (3) lakes that have the potential for fish elimination (low or no natural reproduction), and (4) lakes that are the least important for recreational anglers. Of these recommendations, the first three should take priority over the last. In our study, over 40% of the stocked lakes had at least some frog reproduction, yet few of these lakes had any frog recruitment. Eliminating fish from a lake where frogs are already breeding should result in faster frog recovery than eliminating fish in a lake that has no amphibian reproduction. Furthermore, restoring lakes that provide over-wintering habitat for amphibians can benefit amphibians both locally and potentially across a watershed. Finally, when selecting a lake for fish elimination, choosing a lake that will require the least amount of invasive management (fish removal) is important. Nonreproducing fish can be eliminated from a lake by simply removing that lake from the stocking schedule. However, if fish removal is required, techniques such as gill netting (Knapp and Matthews 1998), coupled with blocking spawning habitat, are preferable to piscicides, such as rotenone and antimycin A. Both of these chemicals may harm other aquatic vertebrates, including amphibians (Fontenot and others 1994; Schnick 1974), and their use in wilderness is controversial.

Finally, managers should keep in mind that most systems are not isolated, and fish stocking practices in adjacent regions can significantly affect restoration efforts. For example, fish dispersal from upstream locations may colonize wetlands that are actively managed as fishless habitats. In addition, fish predation in streams may act as barriers to migration, dispersal and hence colonization of amphibians (Bradford and others 1993).

Despite the range of possible management actions, we believe the best management strategy is to use species and watershed-specific biological information to make management decisions. This information can be obtained only through carefully designed and conducted studies that provide adequate information about the distribution, abundance and life history characteristics of amphibian species across local landscapes. Hopefully, using appropriate information at the watershed scale will enable managers to restore critical amphibian habitat and the biological integrity of wilderness lakes. Creating a few fishless lakes to provide the necessary habitat requirements of amphibians in a watershed may disproportionately reduce the threats of fish stocking on amphibian persistence. For example, having two amphibian source populations in a watershed, instead of one, may increase the probability of amphibian persistence in that watershed by an order of magnitude. With proper management, we believe amphibian populations can be recovered and protected while maintaining recreational fishing opportunities in many wilderness lakes.

Abstract—Native and nonnative sport fish have been introduced into the majority of historically fishless lakes in wilderness, generating conflicts between managing wilderness as natural ecosystems and providing opportunities for recreation. Managers faced with controversial and difficult decisions about how to manage wilderness lakes may not always have ready access to research relevant to these decisions

The conflicts between managing wilderness as "natural" ecosystems and providing opportunities for recreation are especially acute in fisheries management. Native and nonnative sport fish have been introduced into the majority of historically fishless lakes in wilderness (Bahls 1992), usually to the detriment of the native biota (Bradford and others 1993; Chess and others 1993; Tyler and others 1998). Alpine lakes are the primary target for recreation in wilderness (Hendee and Schoenfeld 1990), and fishing opportunities may further concentrate use in these areas, resulting in resource damage and compromising solitude in the wilderness experience.

Page 50 of 5344

Fish stocking, especially using aircraft, is also considered to conflict with wilderness values (Duff 1995).
–However, fish stocking in mountain lakes long predates the Wilderness Act of 1964, and fishing is the objective of a
sizable proportion of wilderness visitors (Fraley 1996; Hendee and Schoenfeld 1990). Language in the Wilderness Act,
reserving the rights of the States with respect to management of fish and wildlife, is often cited as justification for
continued active management of fisheries in wilderness (Duff 1995; Fraley 1996). Conversely, other language in the
Wilderness Act promoting the preservation of natural systems, and increasing emphasis on wilderness as a reference
point for the study and management of ecosystems (Hendee and others 1990; Kaufmann and others 1994) are difficult
to reconcile with many of the current practices of fisheries management.
–Consequently, managers are faced with controversial and difficult decisions about how to manage wilderness lakes,
and they do not always have ready access to research relevant to these decisions. Considerable research has been
conducted recently on the biological effects of fish stocking on resident biota. Many managers tend to minimize these
effects, however, instead promoting untested alternative hypotheses

an overview of fish stocking in wilderness from federal, state, tribal and user perspectives, including summaries of key
legislation, policy and description of current management practices. A session on community and ecosystem effects
included effects of fish stocking on lake nutrient cycling, algal dynamics and invertebrates and interactions between
predators, hydroperiod and amphibians. The third session focused on effects on vertebrate species and included
discussions on effects of stocking on native fish and amphibians. The final session described restoration and
management.

Life history traits vary among amphibian species, however, and fish stocking may affect
species differently. In addition, amphibian population structure may be affected at a
broad scale when a portion of lakes and streams in a watershed are stocked. This habitat
fragmentation may isolate amphibian populations and result in increased extinction rates.

Results: Historical records indicated that Idaho Fish and Game stocked over 60,000
cutthroat and rainbow trout into 12 to 30 previously fishless lakes in 1937 and 1938 in the
Bighorn Crags area. Beginning in the 1960s, fish were restocked every three to six years.
In total, 37 lakes were stocked with 300,000 fry or fingerlings.

Cutthroat, rainbow, and golden trout and their hybrids were found in all 11 basins
searched. Overall, fish occupied 43% of sites. Large, deep lakes (greater than 1 ha in
surface area and more than 4 m deep) were more likely occupied than small, shallow
wetlands. As a result, fish occupied 90% of the available surface area of water in the
basins. More importantly, only two basins had more than one deep, fishless lake.

Densities of both long-toed salamanders and Columbia spotted frogs were lower in sites
with fish than in those without fish. Indeed, when site characteristics of deep lakes were
held constant, fewer amphibians of all stages were found in stocked lakes than in lakes
without fish. Moreover, densities of salamander larvae at least two years old, and both
adult and juvenile frogs in *fishless* sites decreased as the proportion of wetlands in the
basin occupied by trout increased.

Management Implications:
–Survival of salamander larvae and juvenile frogs may depend on deep lakes (>2 m), yet
few of these habitats are not stocked with fish.
–Negative effects of stocked lakes may extend across a landscape. Lakes with fish may
have insufficient juvenile recruitment to compensate for adult mortality. Amphibians
with extended larval periods may be forced to breed in shallower wetlands where the risk
of extirpation due to desiccation, anoxia, and freezing are higher than in the deep, lentic
environments. Likewise, amphibians that complete their life cycle in one summer may

Page 51 of 5344

breed in shallow wetlands but may be forced to immigrate to deep lakes to overwinter. If those lakes are stocked with fish, the progeny may be completely eradicated.
-Information necessary to evaluate the effects of fish stocking in high-elevation lakes should include knowledge of:

(1) **the amphibian and fish species in the area**—Because little information is available about distributions of many amphibian species, surveys should be based on what species are potentially in the wilderness area and the life histories of those species. Different types of surveys conducted at various times of the year may be needed to assess abundances and life stages.

(2) **the extent of area impacted**—Surveys of entire watersheds provide the most unbiased information to determine production, habitat use, and potential interaction between fish and amphibians and allow the most accurate assessment of management actions. Because watershed sampling requires considerable time and effort, the number of watersheds in a wilderness that can be sampled may be limited. Surveying a subset of wetlands in different watersheds using stratified sampling may broaden the scope if all wetland types can be adequately represented. Integrating fish and amphibian surveys may also expand sampling ability. photo by Steve Corn

(3) **the effect of management actions**—Because the basin-wide effects of fish stocking have only recently been identified, information on the results of specific management actions is unavailable. Potential management actions include: cessation of stocking and/or removal of fish, which reduce the number of lakes supporting fish; reduction in stocking frequency/density/fertility (stocking sterile fish or limiting access to spawning habitat), which may result in fishless habitats for short periods; and alteration of the species stocked (e.g. cutthroat trout may be less predatory than brook or rainbow trout).

The consensus of the participants of that meeting was that amphibian populations declines were real but documentation was largely anecdotal, and much work was needed on the causes of population declines

Knowledge about the status of amphibians is important, because amphibians occupy important ecological niches and a high proportion of western amphibian species have undergone recent declines, often in protected habitats.

Introduced trout are often implicated in the decline of high-mountain amphibian populations, but few studies have attempted to understand whether the effects of trout in lakes where they have been introduced may also influence the distribution and abundance of amphibians throughout entire mountain basins, including in remaining fishless lakes.

Our results suggest that many of the remaining fishless habitats are too shallow to provide suitable breeding or over-wintering habitat for these amphibians, and that current trout distributions may eventually result in the extirpation of amphibian populations from entire landscapes, including from sites that remain in a fishless condition.

Page 52 of 5344

Amphibian Research and Monitoring Initiative

Initiate long-term monitoring to determine trends in amphibian populations

Conduct research into causes of amphibian declines and malformations

Habitat alteration and destruction have long been major causes of amphibian declines. More recently, significant declines have occurred in protected areas in the western United States that have not shown obvious changes in habitat. These unexplained declines may be caused by contaminants, non-native species, or disease.

Page 53 of 5344

03/23/2004 12:01 406-257-0349 MT FWP R1 PAGE 03

SFFD-038
SEP 0 3 2004

PROFESSIONAL WILDERNESS OUTFITTERS ASSN.

March 15, 2004

MT FWP
Mr. Mac Long
3201 Spurgeon Rd.
Missoula, MT 59804

Professional Wilderness Outfitters Association have concerns on the proposed poisoning of fish in lakes in the upper South Fork of the Flathead River drainage.

38.1 Professional Wilderness Outfitters Association does support a healthy and viable native cutthroat trout population in the upper South Fork of the Flathead River drainage in the Bob Marshall Wilderness Complex.

Our concerns are:

1. 38.2 We question the technique proposed for the poisoning. Such as motorized boats, helicopters and the poison its self. The Wilderness Act states "no motorized equipment" to be use unless in emergency.
   38.3 Also how safe is the poison to human and wildlife?
2. 38.4 The size and scope of this project and the lake sizes is untested in relation to getting a good kill on the existing fish populations.
3. 38.5 There is little evidence that non-native species are infiltrating down the tributaries and into the main river.
4. 38.6 Loss of recreational opportunities for non-outfitted and outfitter public.
5. 38.7 At this time there is there seems to be no imminent threat to the native cutthroat trout in this area.
6. 38.8 Chances of litigation to prevent the restocking of the lakes due to Bonneville Power Assn and Montana Fish, Wildlife and Parks doing separate portions of the project.

PWOA is real concerned about this project and want you to consider re-evaluating your position to go a head on it. Thank you for responding to these concerns.

Sincerely yours,

Ernie Barker

Mr. Ernie Barker, President
Professional Wilderness Outfitters Assn.
PO Box 310
Augusta, MT 59410
Email: triplej@3rivers.net

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SFFD-039
SEP 0 3 2004

August 20, 2004

Colleen Spiering,
Environmental Specialist
Bonneville Power
P.O. Box 3621

To Whom It May Concern:

39.1 Recently I had the good fortune of fishing Sunburst Lake in the Bob Marshall Wilderness. What wonderful fishery that is. Being able to catch Westslope and Yellowstone cutthroat in the same lake is quite a thrill. I hope you don't follow through on your poisoning process we have heard you are considering.

39.2 It just doesn't make any sense to me to poison all of these lakes that provide such successful angling right now. 39.3 Besides, if there are already hybrid fish in these lakes and streams that flow out of them, your not going to be able to reverse that unless you poison everything. And that would be the wrong thing to do.

Please leave this fishery alone.

Sincerely,

Kirk Gentry

Kirk Gentry - Owner/Outfitter
115 Lake Blaine Drive Kalispell, Montana 59901 406-755-7337
www. spottedbear.com email: info@spottedbear.com

SFFW-040

American Fisheries Society
MONTANA CHAPTER

389 Rick Oshay Road
Whitefish, Montana 59937
emuhlfeld@state.mt.us

13 August 2004

Communications
Bonneville Power Administration, DM-7
PO Box 12999
Portland, Oregon 97212

RE: Montana Trout Conservation Project

Dear Colleen Spiering:

This letter provides comments from the Montana Chapter of the American Fisheries Society (MCAFS) in regards to the South Fork Flathead Watershed Westslope Cutthroat Trout Conservation Program Draft Environmental Impact Statement (DOE/EIS-0353), hereafter DEIS. The MCAFS is an organization of professional fisheries scientists and students from multiple agencies, universities and the private sector across Montana. One of our objectives is the conservation, development and wise utilization of Montana's fisheries. We are keenly interested in the conservation of the large, interconnected metapopulation of westslope cutthroat trout (WCT) in the South Fork Flathead River, as well as the reestablishment of natural and wilderness values in the aquatic ecosystems of the South Fork Flathead watershed.

40.1 As a signatory to the Westslope Cutthroat Trout Conservation Agreement, we fully support the goal to preserve the genetic purity of populations in the South Fork of the Flathead River drainage. We also agree with the immediate need to remove hybrid source populations from identified lakes and to replace them with genetically pure and appropriate stocks of WCT in most cases. The proposed activity to remove non-native species from 21 lakes, therefore, is an important conservation action for WCT on which we would like to comment.

40.2 First, we would like to make it clear that MCAFS strongly supports the concept of removing non-native species from the South Fork Flathead River basin. We concur that non-native fish (hybridized cutthroat trout) pose a serious threat to the long-term conservation and persistence of westslope cutthroat trout. We also believe that reestablishment of fishless conditions in some of the high mountain lakes is desirable. We are pleased that the Bonneville Power Administration, 40.3 Montana Fish, Wildlife & Parks (FWP), and the U.S. Forest Service are willing to take on such a bold conservation action. The South Fork Flathead is a rare ecosystem because it is one of the largest sub-basins in the West that supports a native, intact species assemblage, with the glaring exception of hybrid and non-native fish in some of it's high mountain lakes.

40.4 MCAFS also concurs that the only viable method to remove non-native species from these 21 lakes is the application of either antimycin or rotenone. While we appreciate that chemical reclamation can be controversial, we think that the risks to non-target species are acceptable and that FWP has sufficient experience to implement the project. 40.5 The proposed actions implement the chemical reclamation by a variety of means (fixed-wing airplane, helicopter and boats, livestock) based on social, economic, and logistical concerns for each lake. This is a commendable approach and it should help reduce the controversy around working in the Bob Marshall Wilderness or the Jewell Basin Hiking Area.

We think it is wise to gradually phase in the plan in order to learn as you go and not exhaust your resources. Addressing the most critical lakes first would be wise in case the funding or political situation changes in the future. 40.6 However, the DEIS does not contain a matrix upon which to base biological, logistical, political, recreational, and economical prioritization of this phased approach. This matrix should include a detailed analysis of risks and benefits associated with the treatment and subsequent stocking or non-stocking of each lake among others. The matrix should also contain biological information (fish genetics and relative abundance, invertebrate and amphibian communities etc.) for each lake to characterize physical and biological conditions upon which treatment decisions will be made.

40.7 We recommend that the most critical lakes be addressed first in case the funding or political situation changes in the future. Lakes that pose the greatest and most immediate threat to neighboring WCT populations should be given the highest priority, since that is the goal of the project. High priority should be given to lakes located in the Bob Marshal Wilderness and those that contain hybrid populations that have significant non-native contributions (e.g., degree of introgression) and large population sizes. 40.8 In the case of mixed stocks assemblages (i.e., M012s planted on hybrid swarms), we recommend that the degree of introgression should be calculated on those individual fish in the sample that contain non-native rainbow trout genes. This may require collecting additional genetics samples, as sample sizes will likely be reduced.

40.9 We commend your plan to develop an adaptive approach that carefully analyzes risks and benefits to prioritize treatment and non-treatment lakes. However, a sound adaptive management plan should also include a research plan to guide the ensuing treatment phases, and in turn guide a comprehensive long-term adaptive aquatic ecosystem monitoring program. We suggest that prioritization consider the degree of hybridization, the likelihood of maintaining the lake as a pure population (or fishless), the potential for recolonization by native amphibians and zooplankton assemblages, recreational and wilderness values, and the degree of purity of WCT downstream, among others. Each lake should be analyzed independently and then placed in geographic context with neighboring lakes and streams; only then can a wide range of uses and values be accommodated through the proposed actions.

40.10 We recommend that drainage or stream specific donor stocks be used for WCT reintroductions in lakes of the South Fork Flathead River in the Bob Marshal Wilderness. The best available scientific information has clearly shown that using a "nearest neighbor" approach for reintroduction of WCT in the South Fork is the best conservation strategy to ensure the long-term genetic integrity of remaining populations. We recognize that this may conflict with a prioritized schedule based upon degree of introgression, therefore some lakes may need to be deferred until after a "nearest neighbor" brood is developed. Repeat 4x Recent genetics studies have shown that genetic differentiation between populations is a key factor for WCT reintroductions in South Fork lakes:

- 40.11 Leary (2002) concluded: "*Since substantial genetic differences exist between the M012 fish and the westslope cutthroat trout populations in Big Salmon Lake, Gordon Creek, and Danaher Creek, and the supposed middle Wheeler Creek population, continued introduction of M012 fish into these drainages genetically does not represent the best conservation approach. This practice could potentially result in significant genetic changes in the downstream populations. Whether or not these changes will negatively affect the viability of the downstream populations is unknown, but the possibility they may negatively impact viability exists. Thus, from a genetics perspective a less risky conservation strategy would be to use westslope cutthroat trout either collected directly, or descended from those collected directly, from each of these drainages as the source of fish for introductions within each respective drainage.*
- 40.12 Similarly, Dunning and Knudsen (2004) determined the genetic relationships among WCT in the upper Flathead River system and found that samples from the South Fork were significantly differentiated from those of the North and Middle Forks, and that Youngs Creek was the only one that showed significant differentiation between sites in the entire basin.
- 40.13 The Montana Westlope Trout Technical Committee (1998) also recommended using using a "nearest neighbor" strategy for WCT reintroductions and concluded that "*we do not now recommend that WCT be introduced into waters containing or connected to waters that contain a pure WCT population unless the existing pure population is the source of the introduced fish.*" Furthermore the report states: "*The allelic diversity of westslope cutthroat trout also suggests that historically there has been very little gene flow among populations, except possibly at a very local level (Wright 1932). In this situation, even fairly weak natural selection can effectively establish local adaptations. Thus, there is a good possibility that some populations of westslope cutthroat trout may have some degree of local adaptation (e.g. Fox 1993, Phillipp and Clausen 1995) which could be broken down, compromising population viability, if the native fish interbreed with westslope cutthroat trout from other populations.*"

40.14 Thus, the combined information clearly demonstrates the need to implement a "nearest neighbor" approach for reintroduction of WCT in the South Fork. Our comments on this approach are best summarized by Dunning and Knudsen (2004):

"In the case of managing populations using the "nearest neighbor" approach within the Upper Flathead drainage, it is advisable that genetic differentiation between populations be taken into consideration. Management actions that increase the amount of genetic exchange among locally adapted populations, such as transferring fish between streams, could be detrimental if these local adaptations are lost due to outbreeding depression (Allendorf et al. 2001, 2004). Also, given the complex life history of westslope cutthroat in this system, we cannot be certain that migratory forms from one area will thrive in another. However, if a population is actually part of a larger metapopulation, then the threats of transfer of fish to such a population may be overestimated. Management of populations should be done on a case by case basis, depending on the demographic and genetic makeup of the populations at risk."

40.15 Sekokini Springs Natural Rearing Facility provides an ideal opportunity to develop stream-specific donor populations for WCT reintroduction in the South Fork. Donor populations should be selected based on the degree of genetic relatedness using microsatellite or allozyme genetic analyses (Dunning and Knudsen 2004). Again, the document should identify specific lakes that will be reintroduced with pure WCT using the "nearest neighbor" approach. This is a critical component of the rehabilitation process for each lake and needs to be addressed and disclosed in the DEIS.

40.16 Loss of amphibian species and populations are of global concern. In recent years, there has been an increased number of species declines in the United States, from 5 species in 1980 to 33 in 1998. Declines for both endemic and widespread amphibians are believed to be the result of habitat degradation and alteration. A complicating factor is the inexplicable loss of amphibians in "pristine" areas such as wilderness areas and National Parks that generally lack obvious loss or alteration of habitat. These declines in remote areas appear to be the result of pollutants or effects from introduced species, such as trout. Despite widespread declines of amphibians, however, we still do not have a definitive answer with regards to our local species, like the spotted frog, long toed salamander, and boreal toad.

40.17 Fish stocking in the 1.5 million-acre Bob Marshall Wilderness complex appears to be a controversial fisheries management issue due to the potential conflicts with wilderness values and impacts on native fish fauna, invertebrates, and amphibians. 40.18 The basic question is whether to stock all the 21 lakes, or leave some fishless due to potential impacts to invertebrates and amphibians. The DEIS addresses this as an important issue, so we believe that the proposing agencies should consider leaving some lake fishless as a viable alternative. If the fishless issue jeopardizes this project from moving forward, we urge you to consider leaving a couple lakes fishless to ensure that this important project proceeds and achieves our mutual goal.

40.19 Leaving a couple lakes fishless could also provide a scientific framework to evaluate the potential changes to the fish, invertebrate and amphibian communities; fishless lakes could serve as controls and the stocked lakes could serve as experimental treatment groups. This experimental approach would ensure that the best scientific information is used to evaluate the potential impacts of chemical treatments on lake and river systems using an adaptive management approach.

40.20 We suggest that the scientific design and interpretation of the existing data regarding the potential impacts of fish on invertebrates and amphibians in the Flathead are inconclusive. While these data suggest limited impacts, we recommend that more rigorous studies will be necessary to conclusively prove that impacts from fish on invertebrates and amphibians in mountain lakes of the South Fork are inconsequential. We strongly recommend that this uncertainty be disclosed in the DEIS. We believe studies to address these issues should be recommended as part of the adaptive management plan for the South Fork. Ideally, these studies should be designed and implemented so that their results could be published in peer-reviewed journals.

40.21 We encourage FWP to conduct additional research because little is known about high mountain lake ecosystems. Are there unique assemblages of zooplankton or aquatic invertebrates in large, deep, fishless lakes that do not occur in shallower lakes because of potential winterkill? For example, zooplankton communities in high elevation, fishless lakes are dominated by large-bodies species. Introduction of trout results in the rapid elimination of these species and replacement by smaller-bodies forms. Once extirpated from a lake, the large-bodied species may not be able to recolonize, even if fish are removed, due to their limited ability to disperse. How do recolonization rates of amphibians differ between lakes restocked with fish versus those that are not stocked? What happens to re-established amphibian populations when fish are re-stocked on top of that amphibian population? In the past, we have only been able to infer impacts because fish have been present in these lakes for so long. Now we have a chance to actually determine what impacts may or may not occur. The DEIS fails to mention these research opportunities and the proposal to stock all lakes will result in a tremendous loss of opportunity to further our knowledge in this area.

40.22 There is an assumption in the DEIS that a complete fish kill may not be achieved. The effectiveness of the treatment will vary by lake, with the most influential factors being depth and volume. Lakes should be ranked from low to high using these factors on what the expectations are for a complete kill and subsequently monitored to determine if a complete fish kill is achieved. Stocking could be deferred for 1-2 years (at a minimum) in high probability lakes for a complete kill to determine if objectives were met to remove hybrids. If a complete kill is achieved, this may reduce the need to stock a lake to "swamp" the remaining hybrids.

40.23 The potential for future illegal introductions should be elaborated on in the DEIS. Lakes should be rated according to risk of illegal introductions. All the proposed wilderness lakes are remote and the risk is low, whereas outside of the wilderness only one lake (Handkerchief) can be reached by road.

The following are detailed comments on the DEIS:

Section 1.2.

40.24 The DEIS fails to list which lakes were previously "swamped" and to describe the potential genetic effects from the years of "swamping". For example, has inbreeding depression or the potential for changing local adaptations associated with the large amounts of M012 occurred?

Section 1.4.

40.25 During the scoping process, BPA received 71 comments. A summary is presented in this section. It will be important in the FEIS to respond to these comments as to whether they were substantive and lead to alternative development or were beyond the scope of the project. A detailed analysis of the comments (grouped by theme) is desirable.

40.26 Page 1-13. MCAFS questions whether biological integrity will be increased by stocking. Conversely, the aquatic ecosystem and biological integrity of that system is being altered by restocking/perpetuating fish in a previously fishless ecosystem.

40.27 Section 2.3
The ESA and USFWS would look at a reduction of imminent threats range wide for the species. To prevent a listing there would have to be significant efforts range wide. A case could be made if the statement " The No Action alternative could also lead to a WCT ESA listing…" was true why not propose actions in the MF, NF or throughout the Flathead. This statement has little validity, although in concept it may be good. This project is a great conservation measure, however, implemented alone it is unlikely that it would prevent an ESA listing.

40.28 Section 2.4.
Pages 2-5 and 2-8. It is commendable that adaptive management will be applied by using lessons learned from previous treatments. It would be worthwhile to mention what was learned. For example, if previous treatments were 100% successful then restocking to swamp out remaining fish would not be necessary but it may be for recreational angling. It is our understanding that FWP has had a 100% success rate (a complete kill was achieved) on the 6 treated lakes to remove trout over the last 10 years. It is our Chapter's understanding that complete kills for trout are common in lakes when trout are the targeted species. Another option is to design the project for a second treatment as in the case of Cherry Lake. If a second treatment is truly needed then this should be presented up front and the environmental effects analyzed in the FEIS.

40.29 The post treatment plan will be critical to the success of this project as will a pre-treatment plan that would determine if a lake should be stocked and, if yes, with what brood (M012 or nearest neighbor) and at what frequency. Adaptive management learned over the last decade should allow for these decisions to be made in the FEIS rather than post treatment.

40.30 We appreciate the thorough discussion associated with the treatment. The use of antimycin and rotenone being applied by various methods will enhance our knowledge in this field. We appreciate your attention to downstream aquatic organisms such as tailed frogs and bull trout.

40.31 Pages 2-26 and 2-27. There should be some discussion about using nearest neighbor fish and the effects of inbreeding and changes in local adaptations associated with M012. The WCT Tech. Committee recommendations should be noted and followed. It is assumed that M012 will be used in all lakes since stocking will be conducted the following year with a variety of age classes. Once again, here is an opportunity to put together a pre-treatment plan that would have a variety of restocking options. The statement "restocking streams would expedite the restoration of a viable fish population" is confusing. Does this infer that viable populations currently do not exist in streams below these lakes? If portions of stream segments are treated immediately below the lakes down to a barrier, leaving these stream segments unstocked should be harmless for several reasons. 1) they are rarely fished, 2) the hybrid source is removed from the lake, 3) pure M012 would trickle out to "swamp" remaining hybrid stream fish, 4)little spawning habitat seldom exists in these high gradient reaches and 5) pure endemic SF WCT can move up from downstream until that barrier is reached.

Section 2.7

40.33 The MCAFS supports the decision not to use tiger muskies to reduce trout populations and to refrain from creating barriers in wilderness areas.

40.34 We fully agree that rotenone and antimycin provide the best chance of removing non-native trout from these lakes. Impacts associated with the use of these compounds will be limited in duration.

Section 3.2

40.35 Page 3-9. Mention is made of bull trout fishing being re-opened in the South Fork, which we agree is a great opportunity for the angling public. However, the DEIS fails to analyze the socioeconomic affects to outfitters associated with this action. Would this not enhance if at least replace any lost angling opportunities these outfitters may have if a lake was left fishless in their area?

40.36 Page 3-12. We appreciate the efforts that are being made to safeguard bull trout populations. The section on direct and indirect effects fails to mention impacts on WCT, such as the purpose of the project to reduce the likelihood of introgression and direct mortality to hybrids. Furthermore, effects upon sculpins, whitefish, or suckers are not disclosed.

40.37 Page 3-13. The MCAFS agrees that illegal bait bucket biology is a risk in any given water body. Illegal introductions are often driven by the availability of fish and access. We request that a risk assessment is completed for each of the treated lakes that would look at the likelihood of illegal introductions and where the potential source would come from. For example, most wilderness lakes, especially those without trails would have a very low likelihood of illegal introductions due to their remoteness and the closest source would be a neighbor lake or fish downstream in the creek. Illegal introductions with these fish may have less genetic risks associated with them than use of M012. The risk assessment would break this issue down from a programmatic risk that "it could happen anywhere" to a site-specific risk that may be very low on a certain waterbody such as Lick Lake. Many of the issues cited are programmatic in nature and given the scale of the proposal don't necessarily apply to every lake that is proposed.

Section 3.3

40.38 Table 3-5. This table would be much more useful if divided between fish versus fishless lakes. Adding presence, densities, sizes, etc would allow for a better understanding of potential impacts associated with the proposal.

40.39 As you may be aware, many studies have documented the changes associated with zooplankton communities in the presence of fish (see Knapp et al. 2001).

40.40 Page 3-22. There is a good discussion associated with impacts associated with the chemical treatment but no discussion about the effects upon amphibians and zooplankton associated with restocking. We request that the effects of restocking should be analyzed and included in this section.

40.41 Section 3.6
Page 3-40. Cumulative effects on the wilderness resource would vary depending on the number of chemical treatments and if the lakes become self-sustaining versus a rotational stocking. A pre-treatment plan that determines how each lake will be treated, i.e., fishless, one time stocking, rotational stocking, would lead to a better cumulative effects analysis.

Thank you for your interest in conserving westslope cutthroat trout and wilderness aquatic ecosystems. The South Fork Flathead Watershed WCT Conservation Project is a unique
40.42 opportunity to protect existing pure populations and restore genetically pure and appropriate WCT to their former distribution and abundance. We urge your agencies to consider our recommendations to conserve WCT in the South Fork Flathead, as the decisions made now will influence these important conservation areas for many years. We look forward to working with the agencies in restoring genetic integrity to the South Fork Flathead ecosystem.

Sincerely,

Clint Muhlfeld, President
Montana Chapter of the American Fisheries Society

the stewards of our resources it is irresponsible for MWFP's to disregard available information or to proceed with the chemical treatment of these streams without sufficient data to justify their actions.

36.6

As I stated in my initial June 23rd letter, these examples indicate the need for MDFWP's to carefully evaluate and justify the need for chemical treatment of each of the 21 lakes and downstream reaches they are proposing to poison. They must not be allowed to continue to ignore or disregard their own genetic data indicating that the chemical removal of fish from many of these waters is unwarranted.

36.7

As I previously commented, the very first action to be taken prior to any chemical removal of fish from any these systems is to genetically retest the populations, using both allozyme and nuclear DNA techniques to determine the current genetic composition of each lake and downstream reach. Most of these lakes were repeatedly stocked with hatchery fish from the states westslope cutthroat trout broodstock after they were first genetically characterized in the mid 1980's and early 1990's, and before any chemical treatment of these waters is conducted the effectiveness of the genetic swamping needs to be thoroughly evaluated. Based on the genetic information presented above, the assertion that this method of removal of non-native genes doesn't work is not supported. In fact, in the lakes discussed above this method has significantly reduced the percentage of non-native trout genes present.

The benefits to genetically retesting each lake and downstream reach proposed for chemical treatment should also not be overlooked. First, it will determine which lakes and streams may still require chemical removal of hybrid trout, and also assist in the prioritization of lakes and streams to be treated based on their current genetic composition. Second, it will save money by reducing the number of lakes and streams that need to be treated. Third, it will lower disturbance, leave a smaller footprint, and maintain fishing opportunities that would otherwise be temporarily lost from some lakes. Fourth, it would provide hard scientific data on the effectiveness of genetic swamping for many different systems allowing MDFWP's to fully evaluate its potential as a management tool. Finally, and perhaps most importantly, it will provide baseline data on the current genetic composition of the lakes and streams that are ultimately poisoned so MDFWP's can evaluate the effectiveness of chemical removal on each population poisoned.

While the opinions I have stated above are solely my own, the scientific data I used to reach them is available to both MDFWP's and Bonneville Power Administration personnel. I request of you both that you do not ignore this information, to do so would be both irresponsible and unethical.

Sincerely,

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