Wallow Fire 2011

Large Scale Event Recovery

Rapid Assessment Team

Fisheries Report

Apache-Sitgreaves National Forests

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July 31, 2011

FISHERIES

Overview:

The Wallow fire was the largest recorded fire in Arizona history and burned over 500,000 acres of the Apache-Sitgreaves National Forest. During containment, the Forest initiated a Burned Area Evaluation and Restoration (BAER) group to identify values at risk and initiate emergency protection of these values. The Forest also recognized that it had a need to evaluate and protect these values over a longer time frame. They asked for a Rapid Assessment Team (RAT) to identify actions still needed for emergency and longer term projects. They asked the RAT team to use the Large Scale Event Recovery (LaSER) process to identify these actions. This report is a Fisheries specialist report that is a sub report of the Wallow Fire Rapid Assessment Team report. This fisheries specialist report briefly discusses the present condition and risks to resources, identifies restoration goals, identifies actions, and estimates cost of the actions by fiscal year.

The Wallow Fire started May 29, 2011 within the Bear Wallow Wilderness Area located along the southern boundary of the Alpine Ranger District. The fire quickly spread south; with containment declared five weeks later on July 8, 2011 after the fire had burned 557,000 acres. The majority of the fire occurred on National Forest System lands, covering approximately 504,000 acres on the Forest. Approximately 17 percent of the fire was classified as having high soil burn severity, 14 percent moderate soil burn severity, 47 percent low soil burn severity, and 22 percent within the fire perimeter was unburned (Data as of June 24, 2011 BARC map).

Present Condition:

Native aquatic species in the southwest United States were imperiled before the fire. The Wallow Fire burned area encompasses occupied and critical habitat for six threatened and endangered species (TES), one candidate, and four Forest Sensitive fish species. The historic distribution of many aquatic species included multiple populations scattered throughout several drainages and connected through major drainages. These interconnected populations (metapopulations) were important for species that may be locally extirpated. Metapopulations provide a source for recolonization following localized extirpations resulting from fire, post-fire effects, or other perturbations. In almost all cases for TES aquatic species in the southwest, these metapopulation connections no longer exist.

Native fish populations in the fire area exist as isolated populations in fragmented habitats and are at great risk of localized extirpation. If the local populations are lost their former habitat cannot be recolonized naturally. In most aquatic systems, fish populations can recolonize quickly after a fire (Gresswell 1999). However, in the southwest United States this lack of connectivity among populations can lead to loss of entire populations of fish after a fire (Propst

et al. 1992, Rinne 1996). Loss of any of these local populations may be devastating to recovery of the species as a whole due to the loss of unique genetic material.

Prevention of invasion by exotic fishes is essential for long term sustainability of these native fish populations. This prevention of exotics is normally done through barrier construction that isolates the natives above the barrier with exotic fishes below. These barriers are work intensive, and difficult to design for large watersheds. Therefore, all existing barriers have been put in smaller upland watersheds (17,000 acres maximum) where often time native trout are the only species. There are sixteen fish barriers on the Forest all of which protect Apache trout habitat. A larger barrier is planned on the West Fork of the Black that will protect a larger watershed (31,000 acres) and a wider community of fishes. The construction design for this barrier is almost completed but may have to be redesigned for higher flows.

The scale of impact to native fishes in this area is massive. Almost 600 miles of stream were impacted by the fire; this is 81% of the streams on the Apache side of the forest. Three watersheds (Black, Little Colorado, and San Francisco) had over 100 miles of perennial streams impacted by the fire (Table 1). The BAER Team has identified ten population of threatened and endanger fishes that at are a high to very high risk due to the fire. Fish populations will be impacted due to direct mortality, changes in habitat and reinvasion by exotic aquatics.

Table 1. Miles of perennial stream either within or downstream of the fire perimeter by watershed and proportion affected.

Watershed	Miles of perennial stream impacted by the fire	Miles of perennial stream not impacted by the fire	Proportion affected by fire (%)
Black River	233	7	97
Gila River	38	16	70
Little Colorado River	130	60	68
San Francisco River	196	53	78
TOTAL	597	136	81

There will be mortality to the fishes due to the fire. The rain events after the fire will cause sediment and ash flows into the streams that are toxic and cause heavy mortality and perhaps extirpation of isolated populations (Propst et. al 1992, Rinne 1996). There have already been documented reports of fish kill throughout and downstream of this fire in all major watersheds (Black, Little Colorado, and San Francisco). It is impossible to know the extent of this kill at this time, due to the magnitude of this event, the lack of people on the ground, and the short residence time of fish carcasses in the stream. Even though there is massive direct mortality, there is the chance individual fish will survive. A survey of South Fork LCR in early July found fish carcasses in the stream and three surviving Apache trout in two miles of sampling.

There will be substantial changes in the stream habitat. Some potential impacts are increased peak flow, increased water temperature, changes in stream substrate, increased siltation, loss of pools, changes in food availability, scouring of riparian/aquatic vegetation and altered coarse woody debris delivery and storage (Gresswell 1999). These streams will be very unstable after this event and we may see yearly changes in the stream habitat over the next one to three years or more (Jim Snyder personal communication). These changes in habitat can impact aquatic organisms at all life stages including eggs, juveniles and adults. Eggs are especially susceptible to smothering from excessive sedimentation in aquatic habitats. This could be very important as some of these TES species are short lived with a live span of three to four years. Therefore, efforts should be made to reduce chronic inputs of silt upstream of critical population of fishes. Special concern needs to be addressed to siltation from roads as they can be the largest source of chronic siltation after a fire (Nobel and Lundeen 1971 as quoted by Gresswell 1999).

Immediately after the fire, there will be a loss of large pools in streams due to scouring, dislodging of large woody debris, and siltation. These large pools are important to cool the water after loss of riparian vegetation and to provide over wintering habitat for adults. Any additional pools will have to be well designed to handle the increase in water flows post fire. Additionally, the South Fork of the Little Colorado River has approximately ten log stream structures perpendicular to the stream that were installed in the 1930s. These structures are now gradient controls on the stream. Loss of these structures would cause instability in the stream and create cutting upstream.

In the longer time period (of five to eight years) the amount of pools in the streams will be variable depending on the stream reach. There will be some sections of stream that will have no pools due to high scouring flows and no further recruitment of woody debris. There will be other streams that will have high tree mortality and extensive input of woody debris. Therefore, it will be important to monitor the amount of pools and provide woody debris if needed. These efforts should be concentrated on the nine third order streams affected by the fire (120 miles). Streams smaller than third order can get structure from smaller woody debris that is available, streams larger than third order will have the debris carried through the system and are not suitable for large woody debris.

Reinvasion by exotic fishes will have a large impact on the native fish communities. There is a good chance that some of the more widespread native fishes (suckers and dace) that can recolonize from metapopulations may increase in proportion to exotic fishes after the fire. The threatened and endangered fish may also respond positively if enough adults survive the post fire ash flows. Meffe (1984) found that native fishes in the southwest responded positively in comparison to nonnative fishes in the presence of large floods. The change in the hydrograph post fire is consistent with large floods. Timely assessment of these TES populations is critical; there may be opportunities to reintroduce or augment populations of native fishes post fire to take advantage of these changed conditions and habitat.

Reinvasion is especially important where we already have barriers. Of the sixteen Apache trout barriers on the Forest, fourteen are within the perimeter of the fire. These barriers are protecting three established populations (50 kilometers of stream) and two streams (12 kilometers) where Apache trout could be stocked (Table 2.). We are already seeing stream channels move and increased flows at the barrier sites. Many of these barriers were not designed for these higher flows and exotic trout may be able to bypass these barriers at greater flows. Once these fish get upstream of the barrier they can become established and out compete or hybridize with the Apache trout.

Table 2. Apache trout barriers within the burn, amount of kilometers of habitat above the barrier, and status of the Apache trout population before the fire.

Stream (number barriers)	Stream length (kilometers)^	Apache trout population and if established before fire.
West Fork LCR (2)	12.48	established
East Fork LCR (2)	14.31	Exotics/ established 5 miles above barrier
South Fork LCR (2)	9.38	established
Stinky (1)	4.30	Ready to stock
Hay Creek (1)	4.41	exotics
Fish Creek (1)	27.32	established
Conklin (1)	8.38	Ready to stock
Bear Wallow (2)	19.93	Hybridized/exotics

^lengths from Apache trout recovery plan

There were eight sports fisheries at risk due to the fire; five reservoirs and three stocked streams. The sports fisheries contribute 155,000 angler days and over 20 million dollars to the local economy (Table 3). At this time, four of the sports fisheries (West and East Fork Black, Hulsey and Little Colorado River at Greer) have been closed (except for a small portion within the town of Greer). These fisheries will probably remain closed throughout at least 2013 due to the potential for flooding and risks to public safety.

Table 3. Sports Fisheries affected by the Wallow Fire including angler use days and economic value to the local communities as identified by Pringle (2004)

	Angler use days	Economic value	Closed
East Fork Black River	33,334	$4.1 million	Yes
West Fork Black River	20,546	$2.5 million	Yes
Little Colorado River at Greer	16,691	$2.1 million	Yes (85%)
Crescent	13,564	$1.7 million	No
Hulsey	11,077	$1.4 million	Yes
River	19,012	$3.4 million	No
Nelson	16,214	$2.0 million	No
Luna	24,600	$3.1 million	No
Total	155,036	20.5 million	

There were nine reservoirs within the boundary of the fire; of which six of them will be affected to varying degrees (Ackre, Crescent, Hulsey, Luna, Nelson, and River Reservoirs). Four of these reservoirs (Hulsey, Luna, River and Nelson) will be impacted by increased sedimentation that will reduce the size of the reservoirs (Table 4). Those reservoirs as well as Ackre and Crescent will have increased inputs of nutrients that will impact summer and winter water quality. Water quality is impacted by high nutrients that can cause anoxic conditions; this has already led to a substantial fish kill at Nelson Reservoir. These conditions increase the chance for summer and winter kills for the next five years. Ranalli (2004) reviewed research on elevated nutrients post fire, and generalized that phosphorus is elevated 1 to 2 years post fire and nitrogen is elevated 3 to 5 years post fire. Therefore, assuming there is no significant nutrient input in the sediment, the risk of elevated nutrient loading will be minimized five years after the fire.

Table 4. Additional sediment that will be removed from the watershed per year, by reservoir, and proportion of the reservoir to be filled with sediment.

Reservoir	Cubic yards/year	Proportion of lake filled by sediment after 3 years
Ackre	2	0.03
Big	0	0.00
Bunch	0	0.00
Crescent	15	0.00
Hulsey	2,296	14.23
Luna	25,758	5.81
Nelson	67,221	17.48
River	17,113	2.89
Tunnel	0	0.00
TOTAL	122,406	

This table makes the following assumptions; soil to be lost at 7.2 tons, 5 tons and 3 tons per acre for high, medium and low severity. All soil in the watershed, will reach the reservoirs.

Actions taken:

The Baer team has initiated an emergency response with the goal to protect human safety and protect genetics of at risk populations of aquatic species. These actions included:

1) Draining Hulsey completely and lowering the water in Nelson to mitigate high flow events
2) Closure of the forest especially near stream with gradual reopening as safety issues are addressed
3) Salvage of aquatic species from populations that were at risk from high mortality from ash flow and had valuable genetic material. Some of these fish are designated to be returned to the host stream as soon as the risk of ash flow has passed. (Table 5).

Table 5. Aquatic species salvaged in June 2011 from within or downstream from the Wallow fire. Whether they will be returned and where they are now held.

Species	Number/ host stream	Adults to be returned?	Where held
Apache trout	? / Soldier Springs	No	Undisclosed stream on Reservation
Little Colorado Spinedace	175/ Rudd creek 32/ Nutrioso Creek 194/ LCR at Winema 23/ LCR at Becker	Yes Yes Yes Yes	Grassland pond 1
Loach minnow	25/ Blue River	No	Bubbling pond native fish facility
Three springs snail	200/ Boneyard Creek PT2 800/ Boneyard Creek PT4 100/ Boneyard Creek PT1	Yes	Pinetop Hatchery Phoenix Zoo T Myers Eagar
Roundtail chub	139/ Black River	No	Ash creek
California Floaters	12/ Three forks	Yes	Pinetop Hatchery Phoenix Zoo
Little Colorado sucker	64/ Wenima 31/ Becker	Yes Yes	58 Dr Pew's tank (St Johns) 35 Grassland #2
Bluehead sucker	41/ Wenima 49/ Becker	Yes Yes	Grassland #2

Fisheries goals:

- Provide the resources for the Forest to set up a monitoring plan for fish populations and habitat to assess recovery and needs of aquatic systems after the fire.

- Concentrate upland watershed and riparian treatments in high value watersheds for native aquatic communities.
- Provide for the continuation and enhancement of native fish populations and communities.
- Provide for recovery of desirable native and non native recreational fishing in waters where those opportunities are not in conflict with the recovery of native species.

Recommended actions:

Recommended actions were determined by the RAT team with consultation with local forest staff. Recommended actions for fisheries are summarized in Table 6. These actions listed by fisheries priority are:

1) Monitor critical fish population and habitat
2) Conduct upland watershed restoration to protect threatened and endangered fishes
3) Monitor Apache trout barriers
4) Restock and augment fishes in streams
5) Restore pools for Apache trout
6) Restoration of reservoir fisheries

Table 6. Recommended actions to restore fisheries resources after the Wallow fire, listed by priority. The table includes reference number, priority and expenditure by year. Detailed project descriptions follow this table

Actions	Priority	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015 to 2018	Total
Monitor critical fish population and habitat	High		$ 261,000	$ 29,000	$ 29,000	$ 68,000	387,000
upland treatment on priority watersheds	High		$ 2,064,000	$ 1,851,000	$ 549,000		4,464,000
Monitor Apache trout barriers	High		$ 28,000	$ 23,000	$ 23,000		74,000
Restock and augment streams	High		$ 250,000				250,000
Restore pools for Apache trout	High		$ 2,000	$ 150,000		$ 14,500	166,500
Restoration of Reservoir fisheries	Medium	$ 75,000			$ 163,000		238,000
			$ 2,605,000	$ 2,053,000	$ 764,000	$ 82,500	5,579,500

Lastly, there are other proposed actions in other sections of the report that are critical to restoring fishery resources. These sections and actions are summarized in Table 2 (Project Cost Estimates by Program Area and Fiscal Year) of the main report:

1) Under NEPA
    a. Comprehensive restoration assessment and analysis; money to hire biologist and hydrologists for NEPA and implementation of all actions
2) Under Range
    a. Condition assessment and replace range improvement; reconstruction of tanks will trap sediment and minimize silt
3) Under Hydrology
    a. Bank stabilization;
    b. Riparian planting & channel structures;
    c. Channel restoration;
    d. Baseline and monitoring equipment; purchase of sediment and temperature monitors to determine when watersheds are stable
4) Under Roads, almost all actions are critical as they will serve to reduce sedimentation

Action Descriptions:

Monitor critical fish population and habitat. An assessment and monitoring plan will be developed to look at habitat and remaining fish populations in the ten at risk populations. Other sites will be selected for population and habitat assessments for the following reasons:

1) Provide information throughout the geographical area of the 597 miles of stream affected by the fire.
2) Assess other aquatic species that are impacted by the fire (spikedace, roundtail chub, Sonoran sucker, desert sucker, bluehead sucker, LCR sucker, California floater, and Three Forks springsnail).
3) Assess effectiveness and need for land management and riparian treatments post fire.
4) Assess how much change in habitat and fish population is due to the fire and what change is due to other variations (control sites).

The fire will have made major modifications to habitat for these populations. This habitat needs to be monitored in conjunction with the population numbers. Habitat that can be measured includes pool complexity, substrate, stream width, macro invertebrates, riparian condition, channel stability and temperature. Existing protocols and standard methods will be used where possible.

Population numbers will be surveyed immediately this fall if possible, but will not be analyzed until staff can be found.

Contract out with University of Arizona to get a PhD student to monitor for three years or more the success of scheduled riparian, bank stabilization, stream channel, and upland watershed treatments and give recommendation on further treatments.

Which resource or issue area(s) does it address?

Wildlife, Fish, and Rare Plants

How does the action relate to damage or changes caused by the event?

Threatened and endangered aquatic species and their habitat were directly affected by fire. Two fish kills occurred from heat related mortality during the fire. Post-fire floods and debris flows already have and will cause mortality and potentially drastic habitat alteration. The at-risk TES populations need to be monitored this fall and next spring to determine if these populations survived the fire and to evaluate the success of the BAER treatments. The monitoring is also essential to determine subsequent management actions that may be required. This monitoring is needed to determine when to return native threatened and endangered fish and aquatic species back into their original streams.

What are the consequence(s) of not implementing the action?

Assessment of aquatic threatened and endangered species will be vital to determining the new baseline within the burned area. This information will be required for upcoming NEPA and consultations for Plan Revision, TMR, Timber Salvage, etc. The effectiveness of BAER implementation on protecting these watersheds and aquatic habitats will be unknown. Lack of this information could potentially slow environmental compliance of timber salvage and restoration needs. Future management could be hindered by lack of information on the effects of fire, effects of the BAER implementation, and aquatic/watershed response. The Forest will lack an adequate understanding of the impact of the fire on these species, and will be unable to make informed and timely decisions related to needed fire recovery actions. The longer the delay in returning TES fishes to streams the more mortality that could occur with the salvaged aquatics and the greater loss of genetic diversity. The Forest populations and environmental baseline for the Forest would not be improved without the assessment and reintroduction efforts.

A doctoral student at the University of Arizona is especially important to look at the effectiveness of scheduled treatments. This report has recommended almost 10 million dollars toward riparian restoration, channel and bank stabilization and upland treatments to protect sensitive species. A multiyear monitoring effort is essential to determine cost effectiveness of these treatments and to identify the best watersheds for these treatments.

What is the cost of the action?

Costs are submitted assuming there is a biologist on hand for the first year to write the program of study, buy the initial supplies and hire and train and oversee the summer technicians. Another alternative for this money is to contract this work.

Table 7. Labor, equipment, material and treatment costs for Forest surveys

category	explanation	year	cost
Personnel	GS-9 or 11 biologist for 3 years refer to	12-14	0
	6 technician GS-3 to5 for 3 months	12-14	18,000 ea yr
	3 technician GS-3 to 5 for 3 months	15 and on	9,000 ea yr
equipment	2 truck @ 3 month @ 325/month and .35/mile	12-14	6,000 ea yr
	1 truck @ 3 month @ 325/month and .35/mile	15 and on	3,000 ea yr
Material and supplies	1 GPS units @$300	12	17,000
	1 digital cameras @$300	13-14	5,000 ea yr
	3 sets personal protective equipment @ $450	14	
	1 shocker @ $10,000	15	
	Invertebrate samples (60 over 3 years) @$200		
total		12	41,000
		13	29,000
		14	29,000
		15 and on	17,000

Table 8. Labor, equipment, material and treatment costs for PhD student

category	explanation	year	cost
Personnel	Salary for student	12-16	125,000
	1 technician for three to four summers	13-15	20,000
miscellaneous	Travel, tuition, fieldwork	12-16	75,000

Conduct upland watershed restoration to protect threatened and endangered fishes.
Watersheds will fall into two priorities: 1) watersheds that protect communities of native fishes including at least one federally listed species and 2) watersheds that are protecting only one population of federally listed fish. This upland watershed restoration could include:

1) Monitoring and improving roads to minimize silt including armoring culverts, installing rolling dips, armoring the road near crossings and other activities.
2) Monitor and cleaning out tanks in the uplands.
3) Upland soil treatments as recommended by the hydrologist to minimize silt such as lop and scatter in low gradient slopes, contour falling under favorable conditions, and mulch.

According to the Hydrologist, these treatments will have the most cost effective benefits for the watershed. The watersheds of first priority are: Black River at Three Forks, The upper and lower West Fork of the Black, and Campbell Blue and Coleman (by priority).

We propose treating 20% of the high and moderate severity burn in the high priority watershed in 2012, and 10% of the high and moderate severity burn in the second priority watershed in 2013. Range is proposing to clean all the tanks in 2012, but we are proposing to clean the tanks in this watershed in 2013 and 2014. This recommendation is predicated on using a decision memo to initiate these upland treatments. It would be preferable to do all the upland treatments in 2012 as the sooner we can get the treatments done the less silt the watershed will produce. However, for planning purposes we have spread the treatment over two years.

Table 9. Highest priority watersheds for upland treatment including acres to be treated, cost, and species protected. The amount of acreage treated is 20% of the high to moderate acerage burned in the watershed.

	acreage	cost		Species protected
Boneyard Creek	928	Upland treatments ($300/acre)	278k	Chiricahua leopard frog, California floater, three forks snail, loach minnow, suckers, dace,
Upper and lower West fork Black	2,292	Upland treatments ($300/acre)	688k	Apache trout metapopulation, roundtail chub, suckers, dace,
Campbell Blue and Coleman	3,662	Upland treatments ($300/acre)	1099k	Loach minnow, spikedace, suckers, dace, Chiricahua leopard frog
	6,883	Total	2065K	

Table 10. Other priority watersheds for upland treatment including acres to be treated, cost, and species protected. The amount of acreage treated is 10% of the high to moderate acreage burned in the watershed.

	acreage	cost		Species protected
Nutrioso Creek	2,751	Upland treatments ($300/acre)	825k	Little Colorado Spinedace, suckers, dace
South Fork Little Colorado River	594	Upland treatments ($300/acre)	178k	Apache trout recovery stream replicate Big Bonito Creek
Fish Creek	1,006	Upland treatments ($300/acre)	302k	Apache trout recovery stream replicate East Fork White
	4351	Total	1,305k	

Which resource or issue area(s) does it address?

Wildlife, Fish, and Rare Plants

How does the action relate to damage or changes caused by the event?

The fire will cause large inputs of silt, scouring and widening of stream bank and higher temperatures. A watershed based approach will mitigate these effects and give the most benefit to native fishes. Almost all fishes in the southwest are at risk. It makes sense to try to protect the areas that have multiple species of native fishes and aquatics. Boneyard Creek is the only known location for springsnails and California floaters. The West Fork of the Black has been selected as a metapopulation of Apache trout. The concept of metapopulation is to have a large enough section of habitat that if a catastrophic event happens than there is a good chance that Apache trout will survive. This, in fact, happened as there are Apache trout remaining in the upper drainage that can colonize the stream. The Campbell Blue/Coleman watershed has both loach minnow and spikedace.

What are the consequence(s) of not implementing the action?

The Wallow Fire burned area encompasses occupied and critical habitat for six federally listed, one candidate, and four Forest Sensitive fish species. Lack of treatment of the upper watershed will increase the risk of habitat degradation (especially siltation) in the drainages with the most important aquatic resources on the Forest. This degradation has the potential to eliminate populations of TES. Some of these populations of aquatic species have genetics that are irreplaceable. Protection and restoration of critical aquatic Threatened and Endangered Species watersheds will be vital to species persistence and resiliency post-fire. Some of these species are currently listed as threatened with proposals for uplisting to endangered.

What is the cost of the action?

In the past, we have concentrated on single species management. By looking at communities of fishes we are more likely to get a better return on our investment, An added value of these treatments is these activities will also improve the soils, watershed, wildlife, range, and riparian communities.

Table 11. Labor, equipment, material and treatment costs, year round personnel costs are covered in

category	explanation	year	cost
Personnel	Project manager hydrologist GS 9 for six months	12	0
	Project manager hydrologist GS 9 for six months	13	0
Contract	Upland treatment (6883 acres @$300/acre)	12	2,064 k
	Upland treatment (4351 acres @$300/acre)	13	1,305 k
	Tank clean outs (95 @ $5875 each)	13	549 k
	Tank clean outs (95 @ $5875 each)	14	549 k
total		12	2,064 k
		13	1,851 k
		14	549 k

Monitor Apache trout barriers. Develop and implement plan for monitor and repair of Apache trout barriers. There are sixteen manmade Apache trout barriers on the Forest of which fourteen are within or downstream of the fire. A plan needs to be developed that incorporates changes in flow regimes, predicted changes in barrier design, monitoring, and reconstruction of barrier if warranted. We also need to install a remote sensor at the barrier sites to monitor siltation events; this will give us information on the watershed's rate of recovery and risk to barriers.

Which resource or issue area(s) does it address?

Wildlife, Fish, and Rare Plants

How does the action relate to damage or changes caused by the event?

The hydrologist report predicts peak flows to increase from 35 to 100% depending on the severity of burn. This increase in flow is above the design capacity of barriers. Already we are seeing changes in the watercourse (lower East Fork of the Little Colorado River) and flows that allow the fish to pass the barrier. Therefore, we will need modification of barriers to handle increase flows and changes in the watercourse.

What are the consequence(s) of not implementing the action?

There is a substantial investment of time and money in these barriers. The last four barriers cost $150,000 each, not to mention additional costs of $50,000 each in maintenance and repair after initial construction. These barriers are also protecting 60 kilometers of stream from exotics. The cost to remove exotics is about $2,000 per kilometer. Seven of these barriers are currently protecting four populations of Apache trout that have been identified as essential for the recovery of the species. Finally, there is some resistance to use of chemical for renovation. If we lose these populations (especially in the larger streams) than we will lose at least five years of work, more, if we are unable to use chemical.

What is the cost of the action? Cost of this project will be covered by existing staff in the hydrologist position. It is critical that actions 102 (restoration) is funded for the is project to be successful.. This information will be invaluable in managing maintenance and reconstruction of the Apache trout barriers. The infrastructure of the 14 barriers and cost to recover the stream above them is close to 3.0 million. There is also 50 kilometers of stream currently protected and suitable for Apache trout as well as four current populations.

Table 12. Labor, equipment, material and treatment costs, year round personnel costs

category	explanation	year	cost
Personnel	Project manager hydrologist GS11/12 30 days`	12	0
	(2)seasonal crews as needed 10 people for 8 days	12	20,000
	(2)seasonal crews as needed 10 people for 8 days	13	20,000
	(2)seasonal crews as needed 10 people for 8 days	14	20,000
Material and supplies	Gabion baskets	12	8,000
	Rip rap for baskets	13	3,000
	miscellaneous	14	3,000
total		12	28,000
		13	23,000
		14	23,000
		all	74,000

There will be additional costs involved with modification of these barriers. Most barrier modifications average about $10,000 in labor and $2,000 in material but some can be much more expensive. Costs could be substantially higher if we are required to relocate the barrier.

Restock and augment native fishes.

Actions are:

1) Identify populations of native fishes that would be most suitable for restocking into streams that have had massive mortalities. There are up to nine species of native fishes that could be restocked

2) Do fish health on source populations, estimate fish numbers at source population, collect fishes, mark with coded wire tags, transport to new sites and stock into depopulate reaches of streams. These fish may have to be stocked multiple times as survival and breeding opportunities may be limited the first couple of years.
3) Initiate a study on responses of these populations after stocking.

Numbers of fish to be stocked will be 120 adults or more. In the case where it is a threatened or endangered species (loach minnow) than adults may be captured and spawned in captivity with the progeny being stocked. Money can be used for population assessments in host streams before transport, capture and transport of fishes or captive breeding.

Which resource or issue area(s) does it address?

Wildlife, Fish, and Rare Plants

How does the action relate to damage or changes caused by the event?

There has already been loss of Apache trout in South Fork LCR due to ash flows post fire. There have also been reported fish kills all the way downstream to Morenci and the Black River Pump Station. These kills are directly related to the fire.

What are the consequence(s) of not implementing the action?

There will be a loss of some native fish populations including South Fork Apache trout population. Other populations will likely be lost because there are no source populations of natives to breed and restock the stream.

We will also lose an opportunity to shift species composition toward native fishes. The change in hydrograph and episodic pulses of silt should favor the warm water natives over the exotic fishes. If we can make sure we have the adult native fish in the system we may have an opportunity to increase the proportion of native fishes.

What is the cost of the action?

The White Mountain Apache tribe has the best source of fishes for the Black River drainage. If they are unwilling to provide fish than the state can provide fishes from lower in the Salt River drainage, they can take the money upfront and spread the commitment over three years. The State of Arizona Game and Fish would have the best source of fishes for the other watersheds. The University of Arizona could do a research project to look at response of these native fishes after the fire, if stocking had a positive affect and recommend stocking best management practices to be more effective. The University has the capability to take the money up front but the commitment needs to be spread over two years.

Contract

White Mountain Apache Tribe to provide fishes for the Black River drainage and Apache trout for the LCR drainage from year 2012 to 2014 year 2012 150k

University of Arizona (masters program) to look at response of native fishes to stocking after the fire event year 2012 100k

Arizona Game and Fish to provide fishes for the other drainages and do fish health from year 2012 to 2014. Free

Restore pools for Apache trout.

Actions are:

1) Provide large pools using rip rap in areas accessible by roads. Apache trout streams that are accessible by road include West Fork and main stem LCR and West Fork of the Black. These pools would be constructed as soon as possible to provide thermal protection
2) Maintain South Fork LCR pools. Heavy rocks need to be placed by hand upstream of these structures at the stream bank to protect these structures from failure.
3) Do inventory five years post fire and count the large woody debris. If the stream is in a timbered area and has less than 20 pools per mile and a median depth of less than 15 inches than woody debris can be added. An inventory of four other third order streams shows a density of 30 pools per mile with a median maximum depth of 20 inches. Streams that have the highest need will be identified in the fourth year and some trees will be dropped in the stream to measure efficiency. In the fifth year trees will be dropped at a density of to create 30 pools per stream mile.

Which resource or issue area(s) does it address?

Wildlife, Fish, and Rare Plants

How does the action relate to damage or changes caused by the event?

The fire will be impacting the stream in many ways. The loss of riparian area and increased flows will dislodge woody debris, silt in pools, and increase water temperatures. These pools will provided more diverse habitat for fishes, thermal cover, and over wintering habitat.

What are the consequence(s) of not implementing the action?

There will be a loss of pool dependent species. This is especially of concern in Apache trout streams. The purpose of the stream on the Forest is to serve as replicate streams that can provide genetic material to the host stream. To preserve genetic material we need to have close to 1000 adult fish in the population. If we do not have these large pools and we drop below 1,000 adults we are at risk of losing genetic material. These third order pools are also important for other species of native fishes and reptiles.

What is the cost of the action?

The maintenance at South Fork is minor and should only cost $2,000 in 2012. The installation of the pools using heavy equipment is $150,000 and will take place in 2013. The assessment and application of woody debris to the stream would only cost 15,000 and take place in 2015 and 2016.

Table 13. Labor, equipment, material and treatment costs

category	explanation	year	cost
Personnel	2 technician GS-3 to 5 for two weeks	12	1,500
	Project manager GS7/9 $260/day at 20 days`	13	0
	3 technician GS-3 to 5 for 3 months	15	8,000
	2 technician GS-3 to 5 for two weeks	16	1,500
equipment	1 truck @ 1 month @ 325/month and .35/mile	12	500
	1 truck @ 3 month @ 325/month and .35/mile	15	3000
	1 truck @ 1 month @ 325/month and .35/mile	16	500
Material and supplies	2 GPS units 2 digital cameras 2 sets personal protective equipment	15	1500
Contract	Installation of ten pools at 15,000 each	13	150,000
Total		12	2,000
		13	150,000
		15	12,500
		16	2,000

Restoration of Reservoir Fisheries. Purchase mobile fish aerators to provide short term relief of anoxic conditions and prevent summer and winter kills. Mobile aerators consist of an aspirator, a solar array, and a trailer that can be moved to the water that exhibits anoxic conditions. In the winter time, two of these will be left at Crescent Lake over the winter to prevent winter kill.

Seven reservoirs within the boundary of the fire (Crescent, Luna, Nelson, and River) will be monitored for nutrients and biological oxygen demand over the next three years to determine the impact of the nutrients on the lake. After identification of the problems, the Forest will apply any of the following actions to improve the long term water quality of these lakes:

1) Dredge lakes that have filled with sediment (Hulsey and upper part of Nelson)
2) Install and maintain settling pools upstream of lakes to minimize sedimentation

3) Apply nutrient binders (alum) where necessary
4) Install siphons for hypolimnic withdrawal (Luna)
5) Remove of noxious aquatic macrophytes
6) Treat uplands or riparian areas to reduce siltation in lakes

Priority will be given to Hulsey Lake as this fire as the potential to eliminate this fishery

Which resource or issue area(s) does it address?

Wildlife, Fish, and Rare Plants

How does the action relate to damage or changes caused by the event?

Hulsey Lake has been identified as the BAER hydrologists of being likely to fill up with sediment causing loss of the fishery, more recent calculations show the lake having a volume reduction of 14%. The other three lakes at high to very high risk (Luna, Nelson, and River) reservoirs will get large influxes of ash the first year which will likely cause fish kills. The longer term problems for these lakes are increases in sediment and nutrients that are likely to cause summer or winter kills. The increase in nutrients will cause algae blooms that make the lake anoxic on cloudy days. Luna and Crescent Lake are already considered impaired by Arizona Department of Environmental Quality due to large amount of nutrients. Both these lakes have already had either summer or winter kills within the last two years. The increase of nutrients will exacerbate those problems.

What are the consequence(s) of not implementing the action?

There is a potential loss of 85,000 angler days. Pringle (2004) has estimated that anglers spend $124 per day of angling in Apache County. Therefore this angling use would have an economic impact of close to 12 million dollars to the local economy.

Table 14. Angler use days and economic values for reservoirs at risk within the Wallow Fire perimeter.

	Angler use days	Economic value
Crescent	13,564	$1.7 million
Hulsey	11,077	$1.4 million
River	19,012	$3.4 million
Nelson	16,214	$2.0 million
Luna	24,600	$3.1 million
Total	85,000	$11.6 million

What is the cost of the action?

Total cost of sports fish improvement is $75,000 to buy three mobile aerators and $163,000 which will be enough funds to dredge Hulsey Lake. This expenditure of $238,000 will protect an income of $11.6 million to the local economy. This is a return of $48.73 to the community each year for a one time investment of one dollar.

Table 15. Labor, equipment, material and treatment costs.

activity	explanation	year	cost	Benefit/cost $ each year /$ spent
aerators	(3) Mobile aerators at $25,000 each	2011 or 2012	$ 75,000	$150.00
Monitor water quality	On Luna, Nelson and River Reservoirs	2012 to 2014	0^	
Hulsey	Dredge 72,600 cubic yards @$2.25/cu yard	2014	$163,000	$8.57
total			$238,000	$48.73

^Water quality to be monitored by Arizona Game and Fish

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GIS layers used; Wallow Fire Burn Perimeter, Soil Burn Severity BARC Image, Streams and Riparian Areas, Range Improvements,

Native fish species in area of concern:

Gila chub	Gila intermedia	endangered
Apache trout	Oncorhynchus gila apache	threatened
Gila trout	Oncorhynchus gila gila	threatened
Little Colorado River spinedace	Lepidomeda vittata	threatened
loach minnow	Tiaroga cobitis	threatened
spikedace	Meda fulgida	threatened
roundtail chub	Gila robusta	candidate
Sonora sucker	Catostomus insignis	Forest sensitive
Desert sucker	Catostomas clarki	Forest sensitive
Little Colorado River sucker	Catostomus species	Forest sensitive
Bluehead sucker	Catostomus discobolus	Forest sensitive