Short-Term Effects of Wildfires on Fishes in the Southwestern United States, 2002: Management Implications[1]

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Abstract

Summer 2002 was a season of markedly increased wildfire in the southwestern United States. Four fires affected landscapes that encompassed watersheds and streams containing fishes. Streams affected in three of the four fires were sampled for multiple factors, including fishes, to delineate the impact of fires on aquatic ecosystems in the -Southwest. All fishes were lost in one stream, Ponil Creek, affected by the Ponil Complex fire. In two streams, Rio Medio and West Fork of the Gila River, 60 to 80 percent reductions in fish populations occurred following combinations of ash and flood flows. In 2002, information on fires effects on fishes was dramatically increased for mostly native, non-salmonid species of fishes. Results of these short-term studies suggest that the impacts of fire on fishes in lower order montane streams are extensive and negative. Because of the listed status of many (70 percent) of southwestern fishes, land and resource managers must be vigilant of opportunities to protect these species following wildfire

Introduction

Prior to the 1990s, there was little information on the effects of wildfire on aquatic ecosystems and their inhabitants. With the Yellowstone fires of 1988, increased effort to study these impacts was initiated. Since that time, information on fire effects on aquatic ecosystems has increased dramatically. Notwithstanding, most of the information is on forested ecosystems in the northern Rockies. In spring, 2002, a workshop was held in Boise, Idaho to address emerging issues, experiences, and theory relative to the effects of fire and its management on aquatic ecosystems. The results of this workshop were published in spring 2003 in *Forest Ecology and Management*. This effort is the most comprehensive to date addressing these issues and should be referenced by all interested in this topic.

In the Southwest, little information is available on the effects of fire on fishes. Propst and others (1992) first discussed the impacts of fire on a native endangered trout, the Gila trout (*Oncorhynchus gilae),* in headwater streams in southwestern New Mexico affected by the Divide Fire, 1989. Soon after, Rinne (1996) reported on the effects of fire on rainbow (*O. mykiss)* and brook (*Salvelinus fontinalis)* trout in three streams affected by the Dude Fire in central Arizona in 1990. Rinne and Neary (1997) summarized and assessed the probable affects of wildfires on streams in the Southwest.

In summer 2002, fires were once again extensive and intensive across the drought-stricken West. In Forest Service Region 3, Arizona-New Mexico, 440 kha

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(1.1 million ac) or about three times the average over the past decade were consumed by wildfire in 2002. We took opportunity to examine the short-term effects of these fires on aquatic ecosystems and their inhabitants, primarily fishes. A primary purpose of our efforts was to expand our data base on fish species other than salmonids. Most of the information that is available on fire effects is on species of salmon and trout (Rieman and others 2003, Dunham and others 2003). In addition, we were interested in determining which factors; species of fish, fire size and intensity across landscapes, changes in stream habitat and hydrological regimes (Rinne 2003a) have the greatest post fire impact on fish survival in the Southwest.

This paper will present only the short-term effects of wildfire on fish populations in three of the four fires. Additional information on habitat, post-fire hydrology (changes in flow), water quality, and fire size and intensity will be presented elsewhere. Most importantly, information were obtained on a dozen, mostly non-salmonid fishes in three separate stream affected by wildfire. Because the southwestern fish fauna is primarily a cypriniform assemblage (Rinne 2003b) several of these fishes are special status (threatened, endangered or sensitive) species. Although these are short term, immediate (< 4 months) post-fire effects, when combined with previous information on both introduced and native trout, they have management implications. Finally, the regionality of fire impacts on fishes in southwestern aquatic ecosystems will be briefly addressed.

The Fires

The three fires sampled that affected watersheds encompassing streams with surface water and fishes extant were the Borrego, Ponil Complex, and Cub Mountain. All were lightening-caused fire ignited during the building of the monsoon season characteristic of the Southwest. The Ponil Fire was contained at over 90,000 ac; the Boreggo and Cub Mountain fires were smaller, both burning about 13,000 acres.

Streams Affected

Middle Ponil Creek was the primary stream draining the fire-impacted area. Sample points were in second and third order stream channels. Rio Medio, affected by the Boreggo Fire, is a second order stream, and the West Fork of the Gila River (Cub Mountain) is a third order stream at points of sample. With exception of Ponil Creek, all had surface water at time of immediate post-fire sampling. Ponil Creek was intermittent and in extreme drought condition during late June sampling and sample locations in Ponil Creek were determined by presence of surface water during initial sampling effort. Limestone and Carizzo creeks were in low flow conditions (approximately 0.1 m^3 sec^{-1}; 1 cfs) at points of sample. Corduroy Creek had reduced, modest (0.3 m^3 $min.^{-1}$; 3 cfs) surface flow at time of initial sampling. Rio Medio had the greatest base flow (17 to 25 m^3 $min.^{-1}$, 10 to 15 cfs), with the West Fork of the Gila being much reduced in flow (<5 m^3 $min.^{-1}$; 5 cfs).

The Fishes

A dozen new species of fishes were sampled in the streams affected by the wildfires in the Region three of the U. S. Forest Service. In Ponil Creek, information was obtained on densities and biomasses of three cypriniform species: creek chub,

Semotilus atromaculatus, white sucker, *Catostomus commersoni,* and blacknose dace, *Rhinichthys cataractae.* These three species comprised the major portion (98 percent) of the fish assemblage (*table 1*). Rainbow trout (*Oncorchynchus mykiss)* also were present in low numbers.

Table 1—*Total fish numbers at eight sample points, Ponil Creek, June 29 to July 1, 2002. Site 1 was above the fire influence zone, site 4 was affected by a small ash flow, and site 6 was affected by an ash/flood event by time of late June sampling.*

	Fish Species			
Site	**Longnose dace**	**White sucker**	**Creek chub**	**Rainbow trout**
1	15	8	6	18
2	71	10	30	5
3	42	45	291	0
3a	58	142	208	0
4	78	42	164	13
5	159	46	135	0
6	0	0	0	0
7	91	95	138	0
total	514	388	972	36

Only brown trout, *Salmo trutta,* were present in Rio Medio; however, this represented a new species of trout for which fire effects was determined. In the West Fork of the Gila River, data were collected on a half a dozen native species of the Gila River basin: longfin dace, *Agosia chrysogaste*; speckled dace, *Rhinichthys osculus*; Sonora sucker, *Catostomus insignis*; roundtail chub, *Gila robustus*; desert sucker, *Catostomus clarki*; and the threatened spikedace, *Meda fulgida*. This reach of river also contains the threatened loach minnow, *Rhinichthys cobitis*; however, this species has only been collected downstream a kilometer. These downstream reaches were intermittent during regular, annual sampling exercises in May and therefore were not usable in delimiting the effects of wildfire. Spikedace have been collected at tan established, long term sample point (Rinne and others 2005). In summary, in summer 2002, a dozen new species were collected in reaches of six streams that potentially could be affected by post wildfire impacts.

Effects of Wildfires on Fishes, Summer 2002

Ponil Complex Fire, Ponil Creek

Eight sample sites were established in June on mainstream Ponil Creek, which was in extreme drought condition. Only site 1 was positioned in what was determined above the influence of the fire. A single ash/flood event already had occurred on the North Fork of Ponil Creek by the time of initial sampling and had affected the lowermost site, 7. Waters were highly turbid and blackened in pools, and the stream was low in flow, as subsurface recharge had only commenced. Similarly, a much smaller (<1 cms) ash flow event had issued from Horse Canyon and affected the immediate, downstream sample site 4. Water was brown and tannic in appearance at time of sampling in June, but all species, including rainbow trout, were present (*table 1*). The other sites were unaffected at the time of initial June sampling because of location and stream intermittency.

Almost 2,000 individual fishes were collected at the eight sample sites in late June/early July (*table 1*). Creek chub comprised half of total fishes collected. By comparison, longnose dace made up 27 percent, white sucker 20 percent, and rainbow trout only 3 percent of total fishes sampled at the eight areas. Rainbow trout were collected at only three of the eight sample areas, the two uppermost sites and the less open, aspect-shaded, canyon-bound site 4 at Middle Ponil Camp. All cypriniform species were present at all sites except site 7, which was previously (1 week prior) affected by a post-fire flood and ash event. All species including trout were present and abundant at site 4, affected by the minute post-fire flow event. In general, the cypriniform species displayed healthy populations, with young-of-year being present. In contrast, trout were mostly greater than 125 mm total length (TL) and averaged near 180 mm TL.

Sampling on August 7-9 at all eight sites resulted in fish being present at site 1 only. Water quality was poor, and two ash flows on August 7-8 were sampled and affected sites 3 through 8. A flood event (estimated 250 m^3 sec^{-1}; 1,500 cfs) occurred in mid July and affected all sites but 1. Numbers of fishes in a single pool at site 1 were not observed to be different than those estimated in initial sampling. Re-sampling site 1 in its entirety again on 20 October further documented the lack of change in fish populations (*table 2*). Rainbow trout and white sucker were similar in numbers, longnose dace doubled in numbers since June sampling, and only two creek chub were collected. Total numbers of fishes were nearly identical for the two sampling events.

Table 2—*Comparison of fish species abundance and total fish numbers in Ponil Creek, site one, at initial (June) and final autumn (October) sampling, 2002.*

Species	June	October
Site 1		
Rainbow trout	18	13
White sucker	8	5
Creek chub	6	2
Longnose dace	15	29
Totals-Site 1	47	49
Sites 2-8	1910	0

Boreggo Fire, Rio Medio

Three sites within the fire-influence zone were established and sampled in June on the Rio Medio. Only brown trout were present in the stream, which represents a new species of trout potentially impacted by wildfire. Total numbers of trout 50 m^{-1} section of stream were near identical in sites 1 and 2 and almost doubled at the most upstream site, 3 (*table 3*). Sites 2 and 3 were not sampled in early August.

Table 3—*Pre- and post-fire comparison of brown trout densities per 50 m of stream at three sites in Rio Medio. Percent reductions between June and October are in parentheses. Sites 2 and 3 were not sampled in August.*

Site	June	August	October
1	74	33	21(74)
2	77	-	19(75)
3	127	-	18 (86)

Near identical numbers of brown trout were present at sites 1 and 2 during initial, June sampling. By contrast, almost twice that number was estimated to be present at site 3. Brown trout at site 1 were reduced by 50 percent during early August sampling and greater than 70 percent by final, autumn sampling in October. Similarly, estimates of brown trout numbers at sites 2 and 3 were reduced by 70 percent or greater by final sampling. No size specific loss was present in data.

Cub Mountain Fire, West Fork of the Gila River

Two sample sites were established and sampled in early and late July and again in early October. The sites were located on the West Fork of the Gila River immediately above the Cliff Dwellings National Monument. One site was about 200 m below a regular monitoring site on the West Fork (Rinne and others in press), and the other about a half kilometer above that site. Five of the six cypriniform species native to the Gila River basin were most common in initial early July samples (*table 4*). A single brown trout, yellow bullhead (*Amerius natalis*), and smallmouth bass (*Micropterus dolomieui)* were collected in the late July sampling.

The response of native Gila River fish populations is shown in *table 4*. Several ash flows occurred between mid and late July sampling events. A flood event (210 m^3 sec^{-1}, 1,300 cfs) occurred in early September after the ash flows and between the second (31 July) and last or autumn (5 October) sampling. Total fish numbers were reduced 60 to 80 percent at the two sites between July and October.

Table 4—*Total numbers of fishes in 50 m reaches of stream in the West Fork of the Gila River, July and October, 2002.*

Date	Site 1	Site 2
Early July	168	560
Late July	278	481
October	50	118

Discussion

Post-fire impacts on fishes in all streams sampled were apparent. Most dramatic was the loss of all species at all sites in the fire-affected reaches of Ponil creek (*table 2*). The effects were already evident at site 7 during initial sampling in late June. The combined ash, flood event issuing from the North Fork of Ponil Creek a week prior had apparently already been fatal to all fishes (*table 1*). Several were found dead in fine sediments deposited by this flow. By contrast, the small ash flow from Horse Canyon was not fatal to fishes at site 4.

Brown trout were dramatically (>70 percent loss) reduced at all three sample sites in the Rio Medio following the Boreggo Fire. Based on the sample from site 1 in August populations of this salmonid species appeared to gradually decline through the summer. Warnecke and Bayer reported a 90 percent loss of trout in Canyon Creek, also affected by the Rodeo-Chedeski Fire. Similar reductions in native cypriniform fishes were recorded in the West Fork of the Gila River.

Management Implications

Data collected on the short-term effects of fire on the dozen species of fishes in a half dozen streams corroborate previous findings by Propst and others (1992) and Rinne (1996). Because the majority of southwestern native fishes are threatened,

endangered or Forest Service sensitive species, managers must be vigilant of opportunities to remove fishes from streams whose watersheds are affected by wildfire. Efforts such as those conducted for Gila trout following the Divide Fire (Propst and others 1992) may be considered a fundamental management approach to address native fish sustainability in the Southwest following wildfires. Because most populations of rare, southwestern fishes are isolated and unique genetically they indeed become evolutionary significant units. As such, they cannot be replaced once lost. Further, the climate and landscapes of the Southwest result in fragmentation of aquatic habitats (Rinne 1995). Such fragmentation precludes natural repatriation that occurs more readily and frequently with primarily salmonid species in the more mesic northern Rockies and Pacific Northwest (Rieman and others 2003, Dunham and others 2003).

Finally, 2002 was a year characterized by an increase in fire activity in Region 3 of the U. S. Forest Service (Arizona and New Mexico). The Southwest is currently in a period of extreme drought. Continued drought combined with the massive outbreak of bark beetles across forested landscapes has resulted in thousands of acres of dead and dying trees in the national forests of the southwestern region. The potential is high for even greater wildfire activity in summer 2003. In parallel, the probability likewise increases that additional streams containing rare and endangered fishes will be impacted by the aftermath of these fires. Land and fishery resources managers must be prepared to take strategic, coordinated, and timely responses to these events as they potentially affect the invaluable, often locally irreplaceable resource, native southwestern fishes.

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