PETITION TO LIST THE

RIO GRANDE CUTTHROAT TROUT
Oncorhynchus clarki virginalis

AS AN ENDANGERED SPECIES UNDER THE U.S. ENDANGERED SPECIES ACT

February 16, 1998

Southwest Center for Biological Diversity
Endangered Species Petition #37

February 16, 1998

Mr. Bruce Babbitt
Secretary of the Interior
Office of the Secretary
Department of the Interior
18th and "C" Street, N.W.
Washington, D.C. 20240

The Southwest Center For Biological Diversity, Southwest Trout, the Biodiversity Legal Foundation, Carson Forest Watch, Ancient Forest Rescue, Rex Johnson and Kieran Suckling hereby formally petition to list the Rio Grande cutthroat trout *(Oncorhynchus clarki virginalis)* as endangered pursuant to the Endangered Species Act, 16 U.S.C. 1531 et seq. (hereafter referred to as "ESA"). This petition is filed under 5 U.S.C. 553(e) and 50 CFR 424.14 (1990), which grants interested parties the right to petition for issue of a rule from the Assistant Secretary of the Interior.

Petitioners also request that Critical Habitat be designated concurrent with the listing, pursuant to 50 CFR 424.12, and pursuant to the Administrative Procedures Act (5 U.S.C. 553).

Petitioners understand that this petition action sets in motion a specific process placing definite response requirements on the U.S. Fish and Wildlife Service and very specific time constraints upon those responses.

Petitioners

The Southwest Center For Biological Diversity is a non-profit public interest organization dedicated to protecting the diverse life forms of the American Southwest and northern Mexico. It has offices in New Mexico, Arizona, and California.

Southwest Trout is a non-profit public interest organization dedicated to restoring the coldwater fish habitats of the American Southwest and the Sierra Madre Occidental of northern Mexico.

The Biodiversity Legal Foundation is a non-profit public interest organization dedicated to the preservation of all native wild plants and animals, communities of species, and naturally functioning ecosystems in this country. Through visionary educational, administrative, and legal actions, the BLF endeavors to encourage improved public attitudes and policies for all living things.

Carson Forest Watch works to protect and restore the forests, streams and rivers of northern New Mexico where the Rio Grande cutthroat trout lives.

Ancient Forest Rescue is dedicated the protection of the forests, streams and wildlife of southern Colorado.

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I. SPECIES DESCRIPTION

The Rio Grande cutthroat (*Oncorhynchus clarki virginalis*) is a strikingly beautiful fish (see figure one). It is closely related to two other cutthroat subspecies originally found in drainages adjacent to the Rio Grande, to the north and west: the large-spotted greenback cutthroat trout (*Oncorhynchus clarki stomias*), which inhabited the upper Arkansas River system; and the Colorado cutthroat (*Oncorhynchus clarki pleuriticus*), which occupied the headwaters of the Colorado River. Two distinct forms of *virginalis* are known to exist, one from the Pecos River basin (the "Pecos form") and the other from the remainder of the Rio Grande system (the "Rio Grande form"). The trout from the Pecos drainage have extremely large spots up to an inch (30 mm.) in diameter, typical of the *stomias*, and more scales along the lateral line, typically 175. The other form more closely resembles the *pleuriticus* subspecies.

The number of vertebrae of both forms of *virginalis* is usually 61 or 62; pyloric caeca are 30-50, a slightly higher total than found in both *stomias* and *pleuriticus*. Basibranchial, or hyoid teeth are weak or vestigal. Slight hybridization with rainbow trout will cause *virginalis* populations to lose all signs of these teeth in 50 percent or more of the individuals (Behnke, 1979). Hybridization with the Yellowstone cutthroat (*O. c. bouvieri*) causes the hyoid teeth to become more prominent.

Coloration of *virginalis* is similar to *pleuriticus* and *stomias,* though not as intense, with olive to greenish yellow background on the head and back, olive to yellow just below the lateral line, often overlaid with high colors of burnished orange and red on the lower body up to the lateral line, more often on gill covers and ventral fins. The club-shaped spots are highly concentrated on the caudal peduncle, occurring progressively more sparingly forward, above the lateral line. Spots on the forward half of the body are scarce, an unusual pattern among the cutthroat trouts. One peculiar feature of the Rio Grande form of *virginalis* is the black-rimmed border of the adipose fin (Behnke, 1967). Another peculiarity is the bluish tinge in the lining of the mouth and on the membrane under the maxillary (Smith, 1984). The carmine-colored slashes in the gular folds on both sides of the bottom jaw give the cutthroat trout its name. In *virginalis* these markings can extend to cover the entirety of the lower jaw and gill covers (Johnson, personal observation).

Figure One. Rio Grande Cutthroat Trout (*Oncorhynchus clarki virginalis*)

II. TAXONOMY

The first description, *Salar virginalis* by Girard in 1856, was based on specimens collected from the eastern end of the San Luis Valley during a Pacific Railway survey in 1853. The type locality was present-day Ute Creek (mis-named Utah Creek by Girard), then the site of Fort Massachusetts (later Fort Garland), in the Trinchera Creek drainage. In 1872 Cope examined other specimens from nearby Sangre de Cristo Creek, also within the Trinchera drainage, and named them *"Salmo spilurus."* Apparently, he thought they differed from the Ute Creek population in being more slender. On the basis of Girard's misnomer, Jordan in 1891 mistakenly thought that the virginalis population lay in Utah, and identified it with the presently described Bonneville cutthroat trout (*O. c. utahi*), while identifying *spilurus* with the Rio Grande basin. Except for its having fewer scales, he considered the *virginalis* to be "wholly identical" to the Colorado River cutthroat (i. e. *pleuriticus*). Jordan and others believed the *virginalis* to be derived from the greenback cutthroats (*O. c. stomias*) found in and transferred from the Arkansas River drainage to the north, later giving rise to the *pleuriticus* by yet another headwater transfer into the Colorado River basin, but yet the the remaining *virginalis* populations of the intervening Canadian River system more closely resemble *pleuriticus,* while the *virginalis* sub-type from the more southerly Pecos drainage itself very closely resembles *stomias.* This would argue against a direct prehistoric transfer of *stomias* stocks southwards from the Arkansas watershed. At any rate, *stomias, pleuriticus,* and *virginalis* are a very closely linked genetic subgroup, which is in turn affiliated most closely with the Yellowstone cutthroat, *O. c. bouvieri* (Shiozawa and Williams 1992).

III. DISTRIBUTION

Historic Distribution. The first written description of a North American trout dates to 1541, when Pedro de Castañeda de Najera, a member of Coronado's expedition, wrote of "a little stream which abounds in excellent trout and otters". This was in all likelihood Glorieta Creek southeast of present-day Santa Fe- now a barren, ephemeral wash for most its length and in recent years holding a few brown trout within the enlarged boundary of Pecos National Monument (Trotter and Bisson 1988; Pittenger, personal communication 1997). The disappearance of *virginalis* from this stream, and such places as Tijeras Canyon near present-day Albuquerque and the Rio San Jose within today's Acoma Pueblo, typifies the loss of trout habitat in the upper Rio Grande Basin over the past two centuries.

Native *virginalis* populations occurred in mountain ranges in the extreme upper reaches of the Rio Grande system in present-day New Mexico and Colorado. Populations likely inhabited the headwaters of the Canadian River system, for instance in the upper Vermejo River. Due to a scarcity of first-hand accounts, however, a full picture of the historic distribution of the Rio Grande cutthroat has not been definitively established. Stumpff and Cooper (1996) believe the species formerly occurred in "all waters presently capable of supporting trout in the Rio Grande drainage" including the Chama, Jemez, and Rio San Jose Rivers, along with the Bonito-Ruidosos-Hondo and other trout streams of the Pecos system, plus a number of the upper Canadian River drainages. Sublette *et al.* (1990) concur. Stumpff and Cooper suggest it may have inhabited 40 hydrologic sub-basins in Colorado and New Mexico, and possibly streams in northern Mexico as well (see figure two).

Figure Two. Current and Historical Range of the Rio Grande cutthroat trout (excluding Texas).

The contention that *virginalis* once occupied all the waters in the upper Rio Grande and Canadian River basins currently capable of supporting trout is sound, but not comprehensive. The number of trout waters has diminished over the past century, indicating that *virginalis* likely occupied a range larger than that currently capable of supporting trout. This lost habitat is considerable. A good portion of the Rio San Jose watershed in New Mexico's Cibola and McKinley counties, for example, once supported healthy populations of *virginalis*, including Cottonwood, Bluewater, Seboyeta and Seboyetita Creeks, the Rio San Jose, and Water and San Jose Canyons (*vid.* Behnke 1988). Only traces of trout habitat remain in this system today.

Colorado Historic Range. The Rio Grande cutthroat trout formerly occurred within all southern Colorado Rio Grande basin streams capable of supporting trout (Stumpff and Cooper 1996). This would have included the entirely of the mainstem and hundreds of tributaries.

Virginalis currently occupies tributaries to the Canadian River in southern Colorado and northern New Mexico. It is not clear, however, that the Canadian River was within the species' natural historic range, since the Canadian and Rio Grande systems are not connected.

New Mexico Historic Range. The historic New Mexico range of the Rio Grande cutthroat extended over a very broad area, with a great concentration in northern New Mexico where most populations could communicate directly with the Rio Grande, which in Coronado's time retained its coldwater nature perhaps as far south as present-day Albuquerque or Belen. Some populations, such as those of the Rio Hondo system draining from the Sacramento Mountains into the Pecos River, were possibly isolated from their ancestral parent stream by warm summer water temperatures, but still survived in complex watersheds of third or fourth order, immune to the effects of drought or fire.

Ranges in New Mexico which likely held stable populations of *virginalis* include the San Mateo and Zuni Ranges of west central New Mexico, the Manzano and Sandia Ranges east and south of present-day Albuquerque, the Sacramento Mountains of south central New Mexico, and the Black Range of southwestern part of the state. The only river system outside the Rio Grande drainage in which *virginalis* appears to have occurred is the Canadian River. "Wagonloads" of adult *virginalis* were reported to have been taken by anglers from the headwaters of the Canadian River (a tributary of the Mississippi rather than the Rio Grande) in the nineteenth century (Behnke 1967).

Mexico Historic Range. One early report by Cope in 1886 of a trout from southern Chihuahua, Mexico, near the borders of Sinaloa and Durango, may well have been a Mexican golden trout (*Oncorhynchus chrysogaster*), known to occur west of Mexico's Continental Divide. The Rio Conchas forms the major stream system east of this divide draining into the Rio Grande from the south, from which no native trout specimens or sightings of any kind have ever been reported. The Rio Grande has no other major or even permanent Mexican tributary upstream from the Conchas, while the streams draining the interior of Mexico east of the Continental Divide and north of the Rio Conchas drain into closed desert basins. One of these stream systems, the Rio Casas Grandes, does contain a native trout in its extreme headwaters near the Continental Divide, the so-called Yaqui trout (*Oncorhynchus sp.*, undescribed), but it is not in the cutthroat group,

and most likely traces to a headwater, trans-divide transfer from the Rio Yaqui system.

No Rio Grande tributaries downstream from the Rio Conchas above Nuevo Lauredo are extensive enough to reach into the higher elevation mountains to the south which might be capable of supporting trout. The one exception to this pattern is the watershed of the 9000-ft Sierra del Carmen, south of Big Bend National Park in Texas, a high range which nearly adjoins the Rio Grande but from which trout have never been reported. The mountains of the Sierra Madre Oriental south of Nuevo Lauredo are isolated from the western mountains by extensive desert, communicating more closely with the warmwater Gulf of Mexico, and have never shown records of trout.

Texas Historic Range. Though there is a lack of convincing evidence of the occurrence of *virginalis* in Mexico, there have been a number of historic reports of trout found in streams draining into the Rio Grande from the north, in Texas. J. W. Daniel in 1878 wrote that he had caught "speckled trout" in the Devils River in Val Verde County, Texas during the Civil War, and other trout from the nearby San Felipe Springs, and, earlier, from the Limpia River draining the 8,400-ft. Davis Mountains. This recollection was reinforced in 1878, by N. A. Taylor, who conferred with a former Confederate surgeon stationed at Fort Davis and wrote that "brook trout" occurred in the Limpia River in Texas, a "clear, cool, sparkling stream flowing through a region about 5,000 feet elevation," and also in unnamed streams to the north (Behnke 1967). According to Garrett and Matlock, these reports are bolstered by the present-day occurrence of Rio Grande chubs in the Little Aguja Creek, a tributary of the Limpia River. This species is closely associated with populations of *virginalis* in New Mexico and Colorado, and is today found nowhere else in Texas (*vid.* Behnke 1992).

The only self-reproducing population of trout remaining in Texas lives near the New Mexico border in McKittrick Canyon within the Guadalupe Mountains National Park. These are rainbow trout, probably stemming from introductions made in the 1930s.

Current Distribution. Today there are some 520 streams in New Mexico and 230 streams in Colorado feeding the Rio Grande still capable of supporting trout populations. These waters amount to perhaps 4,500-5,000 stream miles (see figure 3). Nearly all are concentrated in extreme northern New Mexico, in the Jemez, Tusas, and New Mexico's portion of the Culebra and Sangre de Cristo Ranges, and in the Culebra, San Juan La Garita, and Cochitopa Mountains of southwestern Colorado.

This figure was higher within the historic past, for many streams in the lower and middle elevations, particularly in New Mexico, have become unsuitable for trout within the past 150 years, causing cutthroat to disappeared from entire mountain ranges. It is virtually certain the *virginalis* occupied streams and stream segments which are not currently trout waters, and that this lost habitat is considerable. Nearly the entire Rio San Jose watershed in New Mexico's Cibola and McKinley counties once supported healthy populations of *virginalis*, including Cottonwood, Bluewater, Seboyeta and Seboyetita Creeks, the Rio San Jose, and Water and San Jose Canyons (*vid.* Behnke 1988).

Among the still substantial number of available trout habitats within its former range, there are 92 known populations of the *virginalis* subspecies, 53 in New Mexico and 39 in

Figure 3. Current Streams Capable of Supporting Rio Grande Cutthroat Trout in New Mexico and Colorado, Current Populations of Rio Grande Cutthroat.

TABLE 2. Total Rio Grande cutthroat trout habitat currently available and currently occupied on selected federal land in New Mexico (from Stumpff and Cooper 1996, percentage columns corrected).

AGENCY	TOTAL AVAILABLE		TOTAL OCCUPIED		PERCENT OCCUPIED	
	STREAM MILES	LAKE ACRES	STREAM MILES	LAKE ACRES	STREAM MILES	LAKE ACRES
BLM	247	5000	0	0	0	0
Carson National Forest	576	81	126	0	21.9	0
Santa Fe National Forest	1100	429	83	0	7.5	0
Cibola National Forest			0	0	0	0
Lincoln National Forest	90	740	0	0	0	0
Gila National Forest	330	70	3	0	0.9	0
TOTAL	2343	6320	212	0	9	0

Colorado (Stumpff and Cooper 1996). All these populations are within the Rio Grande, Pecos, and Canadian River systems. Only three populations occur south of Santa Fe. Most populations are in isolated segments of small, first or second order headwater streams whose total length is perhaps 212 miles in New Mexico (Stumpff and Cooper 1996).

Oncorhynchus clarki virginalis is now absent from up to 95% of its historic range (Stumpff and Cooper 1996).

IV. NATURAL HISTORY

Typical of all members of the cutthroat series, *virginalis* lives in clean, cold mountain streams, preferably of moderate (6 % or less) gradient. It is insectivorous, feeding on the invertebrate drift which is also the typical diet of stream cutthroats found across the American West. *Virginalis* in the Rio Chiquito in Carson National forest were found to feed in June on midge (*Diptera*) larvae, caddisflies (*Tricoptera*), and mayflies (*Ephemeroptera*), according to a New Mexico Game and Fish D. J. project performed in the 1960s (F-22-R-788, February, 1968). Smaller individuals will eat zooplankton; it has been observed in another cutthroat subspecies, *O. c. henshawi*, that trout smaller than 6 centimeters prefer *Daphnia pulex*, a minute freshwater crustacean, while larger individuals focus on the typical benthic invertebrates (Luecke 1986). Terrestrial insects are also consumed during summer months, while other freshwater crustaceans are also supplemental. (vid. Sublette *et al.* 1990). The food chain upon which *virginalis* depends is generally allochthonous (Sublette *et al.* 1990)--that is to say, its ultimate energy source comes from outside the stream itself, generally from deciduous leaves and leaf litter which fall into the stream. Thus, riparian vegetation plays a vital role in providing food for the fish.

Also typical of other stream cutthroats, *virginalis* spawns in the spring during snowmelt (from April to July, depending upon latitude and elevation). Some populations or individual females spawn every other year. This pattern has been thought by some observers to put *virginalis* at a disadvantage to two of its competitors, the brook char and the brown trout, which spawn in the fall when water flows are stable (Hubbard 1976). *Virginalis* lives up to nine years, more often six, maturing sexually at four years, as compared to three years for exotic trout species (McClane 1963). This delay in spawning age and consequent short spawning life is also felt to put *virginalis* at a disadvantage by retarding its natural rate of population increase (Hubbard 1976). Egg production by females depends on their size and varies from 200 to 4000.

Virginalis evolved with minnow species in middle to lower stream elevations --Rio Grande chub and long-nose dace in the Rio Grande, Canadian, and Pecos River drainages, plus the white sucker and creek chub in the Canadian and Pecos River drainages.

Predators included garter snakes, great blue and other herons, otters, and raccoons (Rinne 1995). There is a tendency to piscivorousness as the size of the fish increases (McAffe 1966; Baxter and Simon 1970).

V. HABITAT REQUIREMENTS

Virginalis typically requires high oxygen content in its stream habitat, low summer water temperatures, and clean gravel for its spawning beds. It requires riffle areas for food production and habitat for young, and pools for

overwintering, and summer rest, and the number of pools and riffles should be roughly equal. Vegetation in the riparian zone needs to be abundant enough to provide shade and cover (Propst and McInnis 1975). In the headwater streams, overwintering habitat must include pools of sufficient size, and enough thermal cover to prevent sheet ice in hypercooled water.

In the minds of anglers and biologists alike, the cutthroat trout is synonymous with wilderness, and for good reason. In the Southwest this association is particularly noticeable; there is a definite, positive correlation between roadless areas and *virginalis* populations in New Mexico and Colorado (see below, "Logging and Road Building"). Roadless surroundings appear to be a necessary but not sufficient condition for survival of healthy stream populations of these fish.

VI. RANGE REDUCTION

New Mexico Reduction by Sub-Basin. Stumpff and Cooper (1996) identified 40 hydrologic sub-basins within the historic distribution of the *virginalis* (see Table 1). *Virginalis* is currently absent from 57.5% (= 23) of the historic sub-basins. The actual sub-basin decline is likely greater, however, since Stumpff and Cooper did not list the Limpia River system in Texas as a historically occupied sub-basin.

That the Rio Grande cutthroat trout has been extirpated from over 23 entire sub-basins is alarming. Sub-basin analysis, however, is a corse measure of range reduction. Finer scales which detect additional range loss *within* sub-basins is even more disturbing.

Reduction By Stream Miles and Lake Acres on Selected New Mexico Federal Lands. Stumpff and Cooper (1996) identified 2,343 miles of stream and 6,320 lake acres on selected federal lands in New Mexico as being currently suitable for *virginalis* occupation (see Table 2). Only 9% of this area is currently occupied, including 0 lake acres, 0 BLM stream miles, 0 stream miles on the Lincoln and Cibola National Forests, and only 3 stream miles on the Gila National Forest. Of all occupied habitat on these selected federal lands, 98.6% is in northern New Mexico, 0.9% is in central New Mexico, and 1.4% is in southern New Mexico.

By comparing stream miles currently occupied by *virginalis* on selected federal lands, with total available trout stream miles on those same lands, Stumpff and Cooper conclude that the Rio Grande cutthroat's range has declined by 91%, not only on these lands, but throughout its range in New Mexico. They assume, therefore, that the decline is representative of other lands in New Mexico. The actual decline in New Mexico, however, is likely higher for several reasons:

1. The calculations by Stumpff and Cooper are based on trout stream mile figures in New Mexico which are only readily available for the national forests (*vid.* Tripp and Rockland 1988). Their calculation, however, does not include the Cibola National Forest, National Park Service units, state land, private land, Native American Nations, or private inholdings within the National Forests themselves.

TABLE 1. Historic distribution and current status of the Rio Grande cutthroat trout by USGS hydrologic sub-basin (from Stumpff and Cooper 1996).

SUB-BASIN	USGS HYDRO. UNIT #	OWNERSHIP	OCCUPIED STREAMS	OCCUPIED LAKES	STATUS
COLORADO					
Rio Grande Headwaters	13010001	Rio Grande NF	2	0	At Risk, Stable
Alamosa-Trinchea	13010002	Rio Grande NF	4	1	Secure, Stable
Rio Grande Headwaters	13010003	Rio Grande NF	2	1	At Risk, Stable
Rio Grande Headwaters	13010004	Rio Grande NF	6	0	At Risk, Stable
Conejos	13010005	Rio Grande NF	4	0	At Risk, Stable
Rio Chama	13020102	Rio Grande NF	1	0	At Risk, Stable
Upper Rio Grande	13020101	Rio Grande NF	0	0	Extirpated
Upper Canadian	11080001	Rio Grande NF	0	0	Extirpated
NEW MEXICO					
Upper Canadian	11080001	Carson NF	1	0	At Risk, Declining
Cimarron	11080002	Carson NF	1	0	At Risk, Declining
Mora	11080004	Carson NF	3	0	At Risk, Declining
Conejos	13010005	Carson NF	4	0	At Risk, Stable
Upper Rio Grande	13020101	Carson NF	24	0	At Risk, Stable
Rio Chama	13020102	Carson/Santa Fe NF	9	0	At Risk, Stable
Jemez	13020202	Santa Fe NF	3	0	At Risk, Stable
Rio Puerco	13020204	Santa Fe/Cibola NF	3	0	At Risk, Stable
Pecos Headwaters	13050001	Santa Fe NF	9	0	At Risk, Stable
Rio Grande-Caballo	13030101	Gila NF	1	0	At Risk, Stable
Tularosa Valley	13050003	Lincoln NF	1	0	Unknown
Rio Grande-Albuquerque	13020205	Cibola NF	0	0	Extirpated
Arroyo Chico	13020205	Cibola NF	0	0	Extirpated
Rio San Jose	13020207	Cibola NF	0	0	Extirpated
Rio Salado	13020209	Cibola NF	0	0	Extirpated
Rio Grande-Elephant Butte	13020211	NA	0	0	Extirpated
El Paso-Las Cruces	13030102	Gila NF	0	0	Extirpated
Jornada Draw	13030103	NA	0		Extirpated
Rio Grande-West Estancia	13050001	Cibola NF	0	0	Extirpated
Rio Grande-Sacramento	13050004	Lincoln NF	0	0	Extirpated
Upper Pecos	13060003	NA	0	0	Extirpated
Alamosa Creek	13060004	NA	0	0	Extirpated

SUB-BASIN	USGS HYDRO. UNIT #	OWNERSHIP	OCCUPIED STREAMS	OCCUPIED LAKES	STATUS
Pecos-Artesia	13060007	NA	0	0	Extirpated
Rio Hondo	13060008	Lincoln NF	0	0	Extirpated
Pecos-Rio Felix	13060009	NA	0	0	Extirpated
Rio Penasco	13060010	Lincoln NF	0	0	Extirpated
Upper Pecos-Black River	13060011	Lincoln NF	0	0	Extirpated
Ocate	11080003	Carson NF	0	0	Extirpated
Conchas	11080005	NA	0	0	Extirpated
Tucumcari	11080006	NA	0	0	Extirpated
Ute	11080007	NA	0	0	Extirpated
Plaza Largo	11080008	NA	0	0	Extirpated
TOTAL			78	2	

TABLE 2. Total Rio Grande cutthroat trout habitat currently available and currently occupied on selected federal land in New Mexico (from Stumpff and Cooper 1996, percentage columns corrected).

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	STREAM MILES	LAKE ACRES	STREAM MILES	LAKE ACRES	STREAM MILES	LAKE ACRES
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Carson National Forest	576	81	126	0	21.9	0
Santa Fe National Forest	1100	429	83	0	7.5	0
Cibola National Forest			0	0	0	0
Lincoln National Forest	90	740	0	0	0	0
Gila National Forest	330	70	3	0	0.9	0
TOTAL	2343	6320	212	0	9	0

There is considerable trout habitat on private lands, especially in northern New Mexico and in the Sacramento Mountains. For example, there are 20 to 30 miles of private trout habitat on the Rio Peñasco. There is a good deal of trout habitat on Native American Nations as well. By our calculations (see attached map), there are about 600 miles of available trout habitat in New Mexico and Colorado outside the federal lands tallied by Stumpff and Cooper. Yet these lands are known to support only 7 *virginalis* populations, averaging about three miles stream miles, for a total of 20 to 25 miles. The decline rate on these lands is about 95%, therefore, exceeding the 9% rate calculated by Stumpff and Cooper.

2. Stumpff and Cooper rely on conservative Forest Service records of available trout streams. These were based on surveys conducted with sole emphasis on recreation and sport fisheries. As a result, many smaller streams not considered to have recreation potential but nonetheless containing stable populations of wild trout were omitted from the list. Accordingly, the mileages contained in the Gila and Lincoln National Forests, to cite only two examples, only show roughly two thirds of the stream miles actually occupied by trout (*vid.* Tripp and Rockland 1988). As a result, the calculations overlook numbers and miles of streams currently supporting trout even within the selected federal lands in table 2. While Stumpff and Cooper over-report trout stream miles of historical *virginalis* habitat on the Gila National Forest by including streams west of the Continental Divide, they overlook perhaps 500 additional miles of trout stream habitat on the federal lands (see figure 3). This mileage omission inflates their percentage figure, and as a result they over-estimate the percentage of current trout stream miles currently occupied by *virginalis.*

3. The equation of historic range with current available misses a significant percentage of historical trout habitat that is no longer capable supporting either *virginalis* or any other trout form. For instance, only nine or so miles of the entire Rio San Jose watershed are currently capable of supporting trout- much it marginally. The remainder of this watershed and other lost waters account for perhaps a 20 to 30 percent increase over currently available trout stream miles, possibly even more. Indeed, under natural conditions, nearly every permanent stream of 6,000 feet elevation in the mountain ranges of New Mexico feeding the Rio Grande should have been capable of supporting *virginalis*. A great number of these streams are now ephemeral. A better index would be stream miles currently occupied by *virginalis* versus historical permanent stream miles of 5,500 feet elevation and above within appropriate river basins (including the Rio Limpia in Texas). Such an accounting would reveal declines of well over 91% percent.

4. The stream mileage figure itself is misleading, for one mile of the upper Rio Grande, Vermejo, or Pecos Rivers, all lost to *virginalis* for many decades, would support as many trout as perhaps 20 miles of any of the tiny headwater tributaries where *virginalis* still survives. Even streams of intermediate size, such as the Rio Ruidoso near Cloudcroft, are capable of producing thousands of trout per mile of stream, as compared to 100-300 per mile in the typical headwater tributaries still holding *virginalis* (*vid.* Fish Population Estimates For the Santa Fe National Forest). Some of the first-

order streams hold even fewer *virginalis*. For instance, the entirety of Peralta Creek, roughly three miles of trout habitat and one of the 53 remaining cutthroat populations alluded to by Stumpff and Cooper, was reported to contain just 50 adult *virginalis* in 1973 (New Mexico Game and Fish 1973; Stork and Behnke 1975).

5. There is a distinct possibility that the *quality* and thus *productivity* of most trout habitats has declined significantly in historic times. Numbers of *virginalis* probably have been impacted by this lessening quality as well as by the accounted-for lessened numbers of stream miles. Indeed, it is clear that none of the *virginalis* habitats available today could provide for the "wagonloads" of captured trout referenced by Behnke (1967).

6. A number of the somewhat larger streams still containing *virginalis* also hold competing exotic salmonids, meaning that the *virginalis* only occupy a minor portion of the habitat currently available within the streams themselves. For example, in the Rio Chiquito in 1968, the New Mexico Department of Game and Fish found brown trout to comprise 78 percent of the trout in population samples, while *virginalis* made up only 22 percent (New Mexico Game and Fish 1973). Propst's study of the remaining *virginalis* habitats in the Canadian River headwaters (these are among those referenced by Stumpff and Cooper) found *virginalis* outnumbered by brown trout by ratios as high as 10 to 1 (Propst 1977). Studies reported by Little and McKurdy in 1968 found brown trout to outnumber virginalis by a ratio of more than 9 to 1 in Rito de la Olla, another of the 53 *virginalis* habitats referenced by Stumpff and Cooper. In effect, *virginalis* has lost the use of considerable portions of its original habitat within these streams, which were formerly fully occupied by the native subspecies.

Reductions in Colorado. Stumpff and Cooper (1996) did to not prepare an equivalent analysis for Colorado. Rinne (1995), however, states that *virginalis* might have declined to 5-7 percent of its total historical range, inclusive of Colorado.

Harig and Fausch (1996) documented written accounts of 68 stream populations and 25 lake population from historic and recent records (see table 3). Of the 68 stream populations, 18% (2) have been extirpated, 43% (29) are insecure, 18% (12) are secure[1], and one is of unknown status. Of the 25 lake populations, all are introduced, 32% (8) have been extirpated, 8% (2) are insecure, 60% (15) are unknown, and none are known to be secure. In all, only 13% (12) all historic and recent populations are known to be secure.

VII. HISTORIC POPULATION DECLINE AND CURRENT INSTABILITY

Historic Population Decline. O. c. *virginalis* probably existed in the time of Coronado as a relatively small number of distinct and isolated intra-breeding population groups, each of considerable size. It is likely that nearly all of the *virginalis* stocks from the Rio Grande watershed, at least from the Jemez River mouth to the extreme headwaters in Colorado, were capable of genetic exchange, making one great

[1]Secure is defined by the petitioners as being free of exotics, protected to some degree by natural or artificial barriers, and demographically “stable” as defined by Harig and Fausch (1996).

TABLE 3. STATUS OF 68 RECORDED STREAM AND LAKE POPULATIONS OF RIO GRANDE CUTTHROAT TROUT IN COLORADO. from Harig and Fausch 1969 (69th stream unaccounted for).

POPULATIONS DOCUMENTED SINCE 1990 (25 STREAMS)

STABLE	UNSTABLE	FISH BARRIER PRESENT	EXOTIC TROUT PRESENT	STABLE, BARRIER, NO EXOTICS
15 (60%)	10 (40%)	Most	11 (44%)	10 (40%)

POPULATIONS NOT DOCUMENTED SINCE 1990 (28 STREAMS)

PREVIOUSLY STABLE, STILL PRESENT	PREVIOUSLY UNSTABLE, UNKNOWN TODAY	PREVIOUSLY HAD EXOTICS	HABITAT DEGRADED
5 (17%)	22 (79%)	17 (61%) including 3/5 stable populations	11 (40%)

EXTIRPATED IN LAST 20 YEARS (10 STREAMS)

NATIVE POPULATION	INTRODUCED POPULATION	CAUSE: INVADED BY EXOTIC TROUT	CAUSE: HABITAT DEGRADATION
8	2	7	3

"OTHER" STREAMS (5)

UNSTABLE	UNKNOWN	EXTIRPATED
Archuleta- Stocked in 1970 South Fork Saguache Creek- present in 1984, since stocked with Colorado River cutthroat	Ricardo- Canadian River basin	Rio Grande #2- found 1889, extirpated prior to 1970. La Jara Creek- natural recolonization attempt in 1977 from Torsido Creek; reclaimed, stocked with brook trout in 1996.

25 LAKES: ALL STOCKED, DOCUMENTED SINCE 1990

STILL EXISTING	STABLE OR REPRODUCING		UNSTABLE
17 likely	Unknown		Haypress Lake: yes Lower Dome: likely

genetically fluid population. Populations in the Canadian River system likely formed a second

group, the upper Pecos Region another, perhaps including the Rio Hondo system. The Rio Puerco and possibly the various isolated mountain ranges in southern New Mexico and from the Davis Mountains in Texas, may well have held separate and recently isolated populations.

In New Mexico, roughly 50 of the 53 remaining virginalis populations are physically isolated and cannot recruit new members or interbreed with other populations (Stumpff, personal communication 1997). The situation in Colorado virtually the same. Thus, the broad historic populations of *virginalis* have been reduced in number over the past two centuries, then split into 80 or so discrete, genetically isolated groups, each containing a few hundred to at most a few thousand individuals (Stumpff, personal communication 1997). This isolation, a result of man-caused habitat destruction and introductions of exotic salmonids, is a profound threat to the integrity and continued existence of the subspecies. Prior to such fragmentation, the *virginalis* would have exhibited meta-population structure which is no longer recoverable, for undoubtedly the remaining stocks cannot account for all the original genetic variability of the subspecies. It is irrefutable, however, that the sharp decline in the range of *virginalis* was accompanied by disappearances of original populations as well as tremendous declines in the numbers of individual fish.

Current Population Instability. The U.S. Forest Service conservation assessment for the Rio Grande cutthroat trout (Stumpff and Cooper 1996) is based on responses to a standardized survey sent to wildlife biologists (see Appendix A in Duff 1996). The survey used the status definitions described in Table 4.

Based on the surveys, Stumpff and Cooper (1996) reported 92 extant populations, of which 4 are *secure-expanding*, 29 are *secure and/or stable*, 8 are *declining* and 51 are *unknown*. Stable populations are not necessarily secure, they have simply not experienced recent declines. Stumpff and Cooper (1996) report that most populations are *at risk*, primarily due to presence of non-native trout.

Three of the 17 currently occupied sub-basins are *at risk-declining*, twelve are *at risk-stable*, one is *stable-secure*, and one is *unknown* (see Table 5). Of the occupied sub-basins then, 88.2% are *at risk*, 5.8% are *stable-secure* and 5.8 percent are *unknown*

Genetic isolation. Rinne (1995) states that since most stocks are isolated in headwaters, gene flow among populations is "virtually non-existent." Cutthroat trout do occasionally move downstream from headwater tributaries into larger streams, then ascend other tributaries (Young 1996). This shows how genes might be exchanged in montane stream systems, and underscores the importance of connecting discrete populations. As mentioned above, *virginalis* now exists as roughly 80 small, discrete populations. The possibility of genetic drift and inbreeding must be assumed until the minimum safe number of individuals for populations of *virginalis* has been determined.

Of the 92 existing populations, only 69 are native remnants.

Figure 4. Sub-basin map

Table 4. Population Stability Definitions Used By Stumpff and Cooper (1996)

population-	distinct aquatic system or interconnected drainage basin with no barriers to genetic interchange
stable-	abundance or distribution has remained relatively constant over the last 10 years
secure-expanding-	adults relatively abundant; recruitment occurring; abundance and/or distribution in upward trend; no major threats to habitat quality; no threats from competition or hybridization with exotic fish.
secure-stable-	adults relatively common; recruitment occurring; most recent abundance and distribution trends stable; no major threats to habitat quality; no threats from competition or hybridization with exotic fish.
at risk-stable-	adults relatively common; recruitment occurring; most recent abundance and distribution trends stable; major threats to habitat quality or from competition or hybridization with exotic fish.
at risk-declining-	adults are relatively rare; recruitment not occurring; most recent abundance and/or distribution trends are downward; major threats to habitat quality or from competition or hybridization with exotic fish.
unknown-	information insufficient to classify

TABLE 5. Sub-basin and Population Status (from table 3 & 4).

Status	Colorado				New Mexico			
	Sub-Basins		Populations		Sub-Basins		Populations	
	#	%	#	%	#	%	#	%
Secure-expanding	3	38	4	19	0	0	0	0
Secure-stable	3	38	5	24	4	36	6	11
At risk-stable	1	13	4	19	7	64	16	30
At risk-declining	3	38	5	24	3	27	9	17
Unknown	3	38	4	19	6	54	19	35
TOTAL	13		22		20		50	
Exotic species Present	8	100	13	62	10	91	44	82

VIII. HABITAT FRAGMENTATION

A fragmented landscape is one in which habitat "islands" are separated from one another by marginal or unsuitable habitat. Fragmentation may be caused by biogeographical influences (in the case of *virginalis*, dry stream stretches, waterfalls, etc...), natural disturbances (unusually high *natural* flooding, landslides, etc...), or by human intrusion (livestock grazing, non-native species introduction, road building, logging, etc.). Habitat fragmentation in the Rio Grande basin has been greatly exacerbated through human intrusion.

The very small size of current *virginalis* populations, limited genetic diversity, and their complete isolation from other populations, increases the chances of local extirpation and total extinction of the subspecies (see for example, Propst *et al.* 1992). Human induced events, as well as stochastic processes such as floods and fires, unseasonal weather fluctuations, and disease, could easily decimate any single or many remaining. Anthropogenic problems such as hybridization with introduced non-native trout species also threaten populations with extinction.

If populations were larger, more numerous, and connected to one another, a proportionally larger number of populations would be expected to survive stochastic and systematic threats (though not with hybridization), and be able to recolonize an extirpated or reduced population (see for example, Propst *et al.* 1992). Because of the presence of rainbow and brown trout in nearly all waters between current Rio Grande cutthroat populations, the latter are no longer able to establish new populations in lower elevations outside of their currently occupied isolated tributaries due to hybridization. Simply put, all *virginalis* washed down from the isolated tributaries potentially breed with the non-native trouts, resulting in the loss of the pure strain and the creation a hybridized population.

The total population of a species is often comprised of metapopulations maintained by a dynamic balance of local extinction and colonization (Wilson 1992). By analyzing population dynamics in terms of metapopulation interaction, Levins (1969, 1970) has shown why species may not occupy all available suitable habitat, and why populations may become extinct even though suitable habitat patches are available. Assuming that patches of suitable habitat are randomly or evenly distributed across a large region, but are separated from one another by unsuitable areas, Lande's model (1987) predicts the equilibrium occupancy of suitable habitat by females as a function of the proportion of the landscape which is suitable, and the demographic potential of the species (i.e. life history and dispersal behavior).

Lande (1988) has pointed out several problems with his model which are applicable to *O. g. gilae*. The model "depends strongly" on the assumption that suitable habitat patches are randomly or evenly distributed across a region, that suitable habitat is at equilibrium, that initial populations are large enough to be immune to extinction due to demographic or environmental stochasticity, and that there is no loss of fitness due to inbreeding depression. Lamberson *et al.* (1992) have extended Lande's analysis by developing a model which accounts for environmental stochasticity. To predict long-term population dynamics of northern spotted owls in fragmented landscapes, they determined that populations tend towards stable equilibrium when initial populations are sufficiently large and their search efficiency is relatively high. "If search efficiency was low, however, even very large initial populations

crashed." This is known as the Allee effect: as populations become smaller and more scattered, or as the habitat becomes more fragmented, dispersing males become less successful at finding suitable territories and females become less successful at finding potential mates.

Patterson (1978) has noted that the non-random process of extinction inevitably leads to the extirpation of rare and local species from small habitat "islands". Small habitat patches in the case of birds and mammals, or severely isolated populations in the case of fish, even in great numbers, do not serve the biological needs met by larger patches or connected populations. Specifically, isolation induced impacts to fish species such as the Rio Grande cutthroat, are many times worse due to lack of ability to disperse, and include such impacts as inbreeding depression. Species in small habitat fragments go extinct in a very predictable sequence (Cutler 1991, Patterson 1978). While Patterson is concerned with the sequence rather than the causes of extinction, it is clear that small populations have a very limited genetic pool from which to draw upon in the face of changing environmental conditions. They are also more likely to be wiped out in a single stroke, leaving no regenerative base.

In *Minimum Viable Populations: Coping with Uncertainty*, Shaffer (1987) agrees:

> "...that extinction may often be the result of chance events, and that the likelihood of extinction may increase dramatically as population size diminishes."

But Shaffer goes on to point out that predictable human intrusions greatly increased the chance of extinction. It is probable that the most severe threat to *virginalis* within the foreseeable future are the highly predictable human induced processes of extirpation and extinction which are complementary to stochastic processes. Recent models have shown that extinction occurs much faster than genetic/stochastic models predict due to the addition of non-stochastic causes (Lamberson *et al.* 1992, Pimm 1993) such as grazing.

Were the separate populations of *virginalis* connected to one another by segments of suitable habitat, local extinction due to stochastic and more systematic processes could be overcome by re-colonization from unaffected sites within the same watershed or drainage. Isolated populations are also genetically separated, narrowing the genetic variance necessary to enable dynamic responsiveness to environmental changes. If human induced extinction processes were eliminated, and populations were allowed to recover within an entire watershed, it is likely that there would be ample genetic variation to eliminate or greatly reduce the risk of disease or inbreeding, and greatly reduce the possibility of chance extinction or extirpation of the entire sub-population. But again, those genetic variants must be given a chance at full recovery within separate headwater stream watersheds through reclamation, and elimination of destructive habitat alteration activities.

By not addressing the issue of protection for entire watersheds in the protection or reclamation of *virginalis* habitat, land management agencies such as the U.S. Forest Service have artificially perpetuated the isolation of the subspecies. Replication of remaining indigenous populations is a valid first step towards recovery, but by not eliminating destructive habitat impacts such as grazing of livestock and fire suppression, and by only reintroducing populations to tiny, isolated stream stretches, management agencies have accomplished relatively little towards facilitating the recovery of the subspecies.

IX. HABITAT LOSS- LIVESTOCK

GRAZING

Habitat loss has been and continues to be the primary threat to the Rio Grande cutthroat trout (Stumpff and Cooper 1996). Even non-habitat related threats such as hybridization, competition and predation are exacerbated by habitat degradation which favors exotic, competing and predatory species over *virginalis*. Livestock grazing is the primary factor degrading *virginalis* habitat (Stumpff and Cooper 1996).

Destruction of Trout Populations. The tremendous negative effect of cattle on trout and trout habitat has been documented in dozens of scientific studies.

- New Mexico Game and Fish (1974) determined that cattle grazing was suppressing Rio Grande cutthroat populations on Cañones and East Polvadera Creeks.
- New Mexico Game and Fish issued a report entitled "Status and Future of the Rio Grande cutthroat trout" (Hubbard 1976). It concluded:

  "Since Spanish days, the range and numbers of this trout have probably been declining in New Mexico, as degradation of habitat (e.g. through overgrazing) and use and misuse of water and later the introduction of exotics...streams with limited riparian growth and erosional problems (e.g. degraded banks, rapid run-off form watershed or streambed) tend to lack proper shade (and thereby have higher temperatures), sufficient feeding and shelter areas, and a suitable diversity of invertebrate life. Such streams harbor few or no native trout, whereas streams without these did sustain fish."
- Behnke and Zarn (1976), Sublette *et al.* (1990), and Behnke (1992) concluded that livestock grazing on National Forests and other lands was harming Rio Grande cutthroat trout populations.
- Sublette *et al.* (1990) concluded:

  "Most streams occupied by Rio Grande cutthroat trout have been impacted by overgrazing and livestock. Limited vegetation in the watershed, especially in riparian areas, has led to altered stream nutrient and sediment loads, and has modified flow regimes along with the morphology of the stream course. Trampling of streambanks by livestock has further accelerated habitat destruction. Trout survival in many of these streams is impaired because of the lack of productive riffle areas, suitable spawning sites, undercut banks (to escape predation), pools (for resting, feeding and overwintering), and shade (in proper proportions which reserves cold water temperatures yet allows adequate solar gain essential for primary production)."
- Parson and Wilson (1991) determined that Apache trout were ten times more abundant on ungrazed streams on the Apache-Sitgreaves National Forest and other areas in the White Mountains, AZ than on grazed streams.
- Rinne and LaFayette (1991) found that ungrazed streams on the Tonto and Santa Fed National Forests had twice as many trout, trout populations, and trout biomass than grazed streams.
- Propst and McInnis (1975) found that Santa Fe National Forest streams with little riparian habitat and erosion problems, such as degraded banks or sign of rapid run-off, sustained few or no cutthroat trout. Streams without this deficiency.
- Platts (1991) reviewed 21 studies, finding only one that did not concluded that cattle degrade trout populations and habitat.

Figure 5. Grazing Photo

- Chaney *et al.* (1990) report that degraded cutthroat spawning habitat in Mahogany Creek, ID recovered when cattle were removed from the riparian area.
- Chaney *et al.* (1990) report that populations of cutthroat trout in Huff Creek, Wyoming increased from 36 per mile to 444 per mile when cattle were excluded from the stream area, as a result of better in-stream cover lower water temperature, and decreased sedimentation.
- Chaney *et al.* (1990) also found that cattle exclusion from the riparian zone of Bear Creek in Oregon converted an ephemeral reach of the stream into a permanent flow supporting a wild trout population.
- Twenty years of cattle exclosure on Camp Creek in central Oregon turned an ephemeral wash into permanent stream capable of supporting redband trout (Hunter 1991).
- Behnke and Zarn (1976) concluded that western trout streams cannot be recovered or even stabilized unless livestock impacts are greatly reduced.
- Armour (1977), Marcuson (1977), Crispin (1981), Kennedy (1977), and Duff (1979) found increases in trout population and individual trout size when cattle are fenced out of riparian areas.

Habitat degradation facilitates competition pressure by providing the conditions in which brook and brown trout can dominate the Rio Grande cutthroat. Griffith (1988) states that in optimal habitat, native cutthroat may be able to withstand competition from exotic trout, leading Stefferud (1988) to conclude that "habitat protection and enhancement may be extremely powerful tools in the future maintenance of Rio Grande cutthroat trout stocks." Rio Grande cutthroats have dominated brown trout in remote, coldwater streams such as the Rio Chiquito and Upper Trinchera Creek (USFWS 1973). Logging, road building and livestock grazing, by increasing siltation and raising water temperature, will favor brown trout over *virginalis* (USFWS 1973).

Destruction of Stream Morphology and Vegetation. The mechanics of how domestic livestock harm western trout are described by Clarkson and Wilson (1991):

> "A majority of the ungulate damage to stream banks is undoubtedly caused by the domestic cow. Although we cannot unequivocally assure that our models explain a cause-and-effect relationship between cattle use and trout standing crops, the literature abounds with treatises that document the debilitating effects of livestock use on bank morphology and trout populations (see reviews by Szaro 1989, Marcus *et al.* 1990, Chaney *et al.* 1990, Armour *et al.* 1990, Platts 1991). The avenues of impacts include (Platts and Raleigh 1984): 1) Increased stream temperature due to loss of overhanging vegetation that is less suitable for the biology of trouts; 2) Increased sedimentation from bank and upland erosion that trap and suffocate eggs and fry; 3) Increased channel width due to hoof-induced bank sloughing and consequent erosion that reduces trout cover, decreases winter stream temperatures, and increases susceptibility to formation of anchor ice; 4) Stream channel trenching or braiding that degrades instream habitats and increases the stream's susceptibility to catastrophic floods; and 5) Plant community alteration and/ or vegetation loss that reduce bank cohesiveness, cover attributes, and terrestrial food inputs."

Destruction of Upland Soils and Vegetation. By removing herb and grass cover, and by compacting soils, livestock grazing slows the rate of water infiltration, leading to unnaturally high and frequent runoff events (Dasmann 1972, Holechek *et al.* 1989,). Dasmann, for example, reports that a heavily overgrazed watershed on Utah's Wasatch Front experienced severe flooding, while an adjacent, ungrazed watershed suffered little or no flooding (Dasmann 1972).

Livestock grazing also results in the replacement of native grasses and herbs by non-native grass species, salt-cedar, juniper, mesquite, rabbit brush, and other shallow rooted vegetation less adapted for soil stabilization, thereby increasing runoff. Erosion and unnaturally heavy and frequent flood events destroy trout habitat by silting in pools, uprooting riparian vegetation, widening and aggrading stream channels, and lowering water tables (Bock *et al.* 1992).

The *direct* connection between the health of upland vegetation or habitat conditions, and the health of riparian or aquatic habitat conditions is well illustrated in the Environmental Protection Agency report *Managing Change, Livestock Grazing on Western Riparian Areas* (Chaney *et al.* 1993):

> "Improper grazing of upland vegetation increases the amount, and concentrates and increases the speed of overland runoff to streams. Accelerated runoff from uplands can trigger downcutting by streams with soft bottoms. Downcutting lowers the streambed and water table, dries out the riparian area, destabilizes stream banks, increases erosion, and further accelerates runoff."

In the *Diamond Bar Allotment Management Plan Draft Environmental Impact Statement* (1993), the Forest Service agrees:

> "The amount of residual forage in the uplands and riparian areas is critical for maintaining a healthy watershed. Riparian and upland areas provide ground cover which holds soil in place, cushions the impacts of raindrops, and provides for sediment retention. Cumulative watershed effects are the results of downslope and/or downstream interaction of runoff from the management of activities that reduce the productive land and water base. The primary physical causes of increased peak flow and increased runoff are soil compaction and removal of vegetative cover."

Continued disturbance to soils, vegetation, hydrologic regimes and stream channel morphology often leads to the complete dessication on trout streams.

> "The greatest damage from erosion on range lands occurs where the areas have been overgrazed and the ground cover destroyed or seriously impaired. Before the ranges had been overstocked and the ground cover impaired, erratic runoff and erosion were practically unknown. After the breaking up of the vegetative cover in the early (eighteen) nineties, however, many streams originally of steady year-long flow and teaming with trout became treacherous channels with intermittent flow through which the water from rainstorms was plunged, or rose and fell according to the size and frequency of the storms and carried so much sediment in the water that fish and similar life could not exist." (Weyl, 1918)

X. HABITAT LOSS- WATER DIVERSIONS

Water diversion and withdrawal has severely affected trout habitat in many parts of New Mexico and southern Colorado. For example, water diversions from Rio Bonito for Alamogordo and Holloman Air Force base have caused several miles of stream below Bonito Lake and other reaches below Fort Stanton to become dry regularly during summer months. The city of Ruidoso draws heavily from the watershed of the Rio Ruidoso, causing low summer flows. Several tributaries are now dry below storage dams, due to intake for residential and industrial use. As a result, the Ruidoso-Hondo-Bonito river system no longer has the capability to hold one interconnecting trout population, and trout habitat in the system has become fragmented into several pieces (Smorynski, personal communication). Irrigation diversion accompanying the immigration of early settlers into northern New Mexico resulted in the loss of streams that likely had provided historical *virginalis* habitat (Sublette *et al.* 1990).

XI. FIRE, FLOOD, AND DROUGHT

Since virtually all remaining *virginalis* populations exist in isolated streams, the potential for catastrophic loss of any of these populations and for an accumulation of such losses over time is very great. Once lost, there is no natural means by which any of the populations can recruit new members and return. Such catastrophic losses of populations of other species of trout have occurred repeatedly over the Southwest over the past several decades and continue today. A 1989 fire in the Gila National Forest followed by heavy rains resulted in 100 percent mortality of the Gila trout (*O. gilae gilae*) in Main Diamond Creek, which had held over 50 percent of the world's population of the species (Propst *et al.* 1992). A 1994 fire in the Chiricahua Mountains exterminated the entire trout population of four separate streams. Fires in 1951 and 1954 caused the extinction of trout in McKnight Canyon and Little Turkey and upper Little creeks in the Gila National Forest (Campbell, 1994; Bruce Anderson, personal communication 1990). Flood conditions in the Prescott National Forest in the early 1980s followed by drought in 1989 and 1990 resulted in the disappearance of the introduced population of Gila trout in Gap Creek by 1991 (Propst *et al.* 1992).

Drought and fire, often immediately followed by heavy rain and flooding, are part of the natural scene in the forests of the Southwest. When trout populations exist, find passage, and inter-connect genetically in larger, more complex watersheds, such as the Rio Bonito-Ruidoso-Hondo system in the Sacramento Mountains of Lincoln County New Mexico or the upper Pecos or Chama river systems, trout always remain in some portion of the watershed after drought or fire. These are able to re-colonize the affected areas either by migration or gradual augmentation and encroachment surviving stocks. Isolated populations in first or second order streams can never recover after such stochastic events, however. Thus, over sufficient time, the 92 remaining wild *virginalis* populations can be expected to disappear one by one if left isolated and unaided.

XII. ROAD BUILDING AND LOGGING

Logging and road building are similar in their effects on water quality and trout habitat in that both create extreme local disturbances in the form of unstable bare soil subject to erosion. In fact road building is one of side effects of logging. Both logging and road building activity causes short term sedimentation of trout habitat, which in turn produces similar destruction of trout spawning gravels, riffles, and pools outlined in the above discussion of grazing effects. In the long term, runoff from roads and road deterioration cause sedimentation, while culverts can act as barriers preventing upstream movement which fragments trout habitat.

Aside from the obvious issue of degraded water quality as a result of road building and road rights of way, which affects all species of coldwater fishes, for *virginalis* there is the added issue of increased fishing pressure resulting from increased road access. It must be noted that the great majority of remaining virginalis populations live in streams not directly accessible by roads. There is evidence that when roads are built along such streams, the populations of *virginalis* greatly diminish, while other species seem to take advantage and increase. For instance, shortly after private land was acquired by the Forest Service in 1967 and

Figures 6 & 7: logged and unlogged trout habitat.

opened to fishing along a newly-constructed forest service road, the ratio of *virginalis* to brown trout in a portion of the stream along the new road plummeted from 98 percent \2 percent to 10 percent \90 percent (New Mexico Game and Fish 1973). This may be due to increased fishing pressure, owing to the fact that *virginalis* are exceedingly easy to catch by angling and suffer from increased fishing pressure when stream access is improved; or it may be that *virginalis* suffers another sort of competitive disadvantage when water quality is lessened by the results of road building. At any rate, roads appear to cause steep declines in *virginalis* populations.

Road building in itself appears to be sufficient cause for the eventual local disappearance of *virginalis*, and probably has the most immediate and pronounced harmful effect. It is worth noting that of the 53 remaining *virginalis* populations in New Mexico, only three can be directly accessed by the public in motor vehicles, and the *virginalis* populations in two of these streams have suffered noticeably from invasion and competition provided by exotic brown trout. Among the other fifty populations, twenty flow within officially designated wilderness areas, ten flow within wilderness study areas and proposed wilderness area additions, and the rest are accessible only by foot, pack, or jeep trails, or are on private land restricted from full public use. In Colorado the picture is much the same. Only two of the state's 39 remaining *virginalis* populations are directly accessible to the public by a passable motor road.

Habitat degradation facilitates competition pressure by providing the conditions in which brook and brown trout can dominate the Rio Grande cutthroat. Griffith (1988) states that in optimal habitat, native cutthroat may be able to withstand competition from exotic trout, leading Stefferud (1988) to conclude that "habitat protection and enhancement may be extremely powerful tools in the future maintenance of Rio Grande cutthroat trout stocks." Rio Grande cutthroats have dominated brown trout in remote, coldwater streams such as the Rio Chiquito and Upper Trinchera Creek (USFWS 1973). Logging, road building and livestock grazing, by increasing siltation and raising water temperature, will favor brown trout over *virginalis* (USFWS 1973).

XIII. DISEASE AND PREDATION

Human Predation. The *virginalis* is a popular sport fish (Stumpff and Cooper 1996). Sportfishing always causes at least some decline in populations of cutthroat trout, and this may be exacerbated An Idaho study showed that 32 man hours of angling removed 50 percent of the cutthroat trout above 6 inches in one small, previously unfished stream. Currnet sportfishing regulations in New Mexico allow capture and possession of two *virginalis*., while the number of licensed New Mexico anglers compares unfavorably with the total population of the sub-species. As mentioned above, the inaccessibility of most remaining *virginalis* habitats affords some protection from angling take, but for many streams this inaccessibility can by no means be expected to continue indefinitely. For instance, in 1994 the U. S. Forest Service tried to develop a "flatwater" fishery and high-density recreation area along McCrystal Creek, a *virginalis* habitat (see below). If this effort had been successful, angler impacts along the stream would most likely have increased, along with the possibility of unauthorized stocking of exotic species.

Even under the current regulatory scheme, enforcement of the two-fish limit can be difficult. Stumpff and Cooper (1996) state that "since all subspecies of cutthroat trout seem to

be extremely vulnerable to angling, special fishing regulations to protect populations of Rio Grande cutthroat trout are needed. Regulations may include variations of angling methods, size, bag limit, and season. *Strict enforcement of regulations will be required* "(emphasis ours).

Whirling Disease. Hatchery trout are notorious in the West for spreading whirling disease among wild trout stocks. Recent introduction of the disease eliminated 90 percent of the wild rainbow trout stocks in the Madison River and reduced populations in the Dolores River in Colorado..

XIV. COMPETITION & HYBRIDIZATION

Hybridization and competition are second only to habitat loss as a past and current threat to the *virginalis* (Stumpff and Cooper 1996). Habitat degradation exacerbates non-habitat threats such as hybridization and competition by favoring exotic and competing species over *virginalis.* The continued survival of the Rio Grande cutthroat trout requires the removal of exotic trout from occupied and unoccupied streams (Sublette *et al*. 1990).

Historically, the Rio Grande cutthroat trout was the only trout species present within its range. Beginning in the 1800s, settlers introduced exotic trout species into trout streams in Colorado, New Mexico and Texas. The Game & Fish Departments of New Mexico and Colorado began organized trout-stocking programs in the early 1900s (Stumpff and Cooper, 1996). Exotic trout spread rapidly and are now present throughout the range of the *virginalis*, with the exception of a few small headwater streams.

The most isolated and southerly population of *virginalis,* in the Animas Creek-Holden Prong drainage in the Black Range of southern New Mexico, is currently jeopardized by rainbow trout planted a small pond communicating with the stream just outside the Gila National Forest boundary. The Rio Costilla in northern New Mexico continues to be stocked by the New Mexico Game and Fish Department with exotic rainbow trout, in spite of the fact that three *virginalis* populations lie upstream without obvious barriers to protect them (Stumpff, personal communication 1997). Though contamination of pure stocks generally progresses upstream, studies in Glacier National Park indicate that impure, hybridized or exotic populations of cutthroat trout in headwater lakes can eventually affect the genetic makeup of pure-strain populations downstream (Allendorf and Leary, 1988). This is significant in that many formerly barren headwater lakes in Colorado and New Mexico have been stocked with hybrid or exotic cutthroat, while virtually all remaining *virginalis* stocks extend upstream into high headwater areas.

Hybridization. Rainbow trout and Rio Grande cutthroat trout spawn at the same time and in the same habitat. The two species readily hybridize. Since rainbows are actively stocked by state agencies, are better able to withstand habit degradation, and successfully compete for spawning reds, they tend to genetically swamp mixed species populations over time.

Until 1972, the New Mexico Department of Game and Fish raised “native” cutthroat at the Seven Springs Hatchery and stocked them throughout the state, often in high-elevation lakes draining into watersheds containing *virginalis*. The stock was derived from fish collected from the Costilla River. They were most likely a hybrid form containing some non-

native cutthroat and rainbow ancestry (Behnke 1979; Behnke 1981). Both these hybrid cutthroats and the rainbow trout stocks introduced into virtually every major coldwater stream system in the state have accounted to a great degree for the replacement of *virginalis* in hundreds of trout waters in New Mexico by hybridization alone. Although no *virginalis* stocks remain in the Pecos River basin of the Sacramento Mountains, for example, many of the naturalized rainbow trout populations contain specimens with tell-tail cutthroat markings indicating some remaining cutthroat influence, the vast majority of which has been lost by repeated rainbow stockings and hybridization (Smorynski, personal communication).

Competition. Brown trout do not hybridize with *virginalis* because they spawn earlier in the year. This gives them a competitive advantage over Rio Grande cutthroats, however, because the latter lose a much higher percentage of their eggs to seasonal flooding. Brown trout often replace Rio Grande trout at middle and lower streams, but are not as successful in higher elevation streams.

Like the all cutthroat subspecies, *virginalis* does not compete well with non-cutthroat trout species. It readily yields feeding spots to rainbow and brown trout, even those of smaller size.

Brook trout also appear to displace cutthroats from higher elevation streams and lakes. Wherever brook or brown trout are introduced into cutthroat waters, the cutthroat trout populations have almost always been displaced (Young 1996).

Habitat Degradation. Habitat degradation facilitates competition pressure by providing the conditions in which brook and brown trout can dominate the Rio Grande cutthroat. Griffith (1988) states that in optimal habitat, native cutthroat may be able to withstand competition from exotic trout, leading Stefferud (1988) to conclude that "habitat protection and enhancement may be extremely powerful tools in the future maintenance of Rio Grande cutthroat trout stocks." Rio Grande cutthroats have dominated brown trout in remote, coldwater streams such as the Rio Chiquito and Upper Trinchera Creek (USFWS 1973). Logging, road building and livestock grazing, by increasing siltation and raising water temperature, will favor brown trout over *virginalis* (USFWS 1973).

Fish Barriers. Eighty to ninety percent of all *virginalis* habitats in New Mexico are upstream from brown trout populations. Many of the remaining populations of *virginalis* are protected from rainbow trout introgression and brown trout displacement because of natural downstream barriers in the streams, such as falls or downstream desiccation. When such natural barriers are not available, artificial barriers are regularly placed in *virginalis* streams (20 of the streams have had such barriers erected in them).

While barriers are an important short-term strategy to protect existing populations while habitat is restored and exotics are removed, it is counterproductive as a long term strategy or substitute for habitat restoration. Barriers exacerbate genetic isolation and fragmentation of the stream populations into dangerously small interbreeding groups. Failure to restore trout streams and connect *virginalis* populations will result in a permanently endangered species at best, stochasticly driven extinction at worst, and a very expensive, high maintenance conservation strategy.

To extend *virginalis* populations downstream and to allow genetic exchange among these trout in a number of tributary streams, the triple habit of blocking, poisoning, and stocking, either with wild fish or the offspring of certified broodstock, is employed. This practice is expensive, time-consuming, often unsuccessful, and generally unpopular with the public. Attempts are currently under way to reclaim Jack's Creek and the head of the Pecos River in this way. If this is successful, it will provide the only complex drainage holding *virginalis* and the most stable habitat for the subspecies.

Roughly a dozen *virginalis* habitats in New Mexico are not protected by downstream barriers of any sort (Stumpff, personal communication 1997).

XV. POOR WATERSHED CONDITION

According to Stumpff and Cooper (1996), 38% of occupied *virginalis* watersheds are in stable condition while 55% are in an unknown condition. Current habitat conditions are insufficient to expand *virginalis* populations:

> "Habitat restoration is essential to re-establishing cutthroat trout to their former range...overhanging banks, riparian vegetation, instream boulders, log jams, pools, water volume, and water depth need to be restored. Watershed conditions need to be restored." (Stumpff and Cooper 1996)

A 1991 report by the Forest Service's air and watershed department (USFS 1991), indicates that degradation is likely worse outside currently occupied sub-basins.

> "...there are still millions of acres of land and thousands of miles of stream that remain in an unsatisfactory condition. Riparian areas, instead of being lush green oases in the hot, dry climate, are void of vegetation, eroding, and, frequently, as dry as the uplands."

Many of the 50% of Forest Service watersheds identified by the report as being in degraded condition, will have to be restored if the Rio Grande cutthroat is to ever to adequately expand its current range.

XVI. INADEQUACY OF EXISTING REGULATORY MECHANISMS

Livestock Grazing. There are five New Mexico National Forests within the current and historic range of the Rio Grande cutthroat trout (Gila, Lincoln, Cibola, Santa Fe and Carson). Despite the fact that scientists have expressed concern over the impacts of grazing on *virginalis*, none of the New Mexico National Forest have adopted a specific conservation plan for the Rio Grande cutthroat trout.

In May, 1996, the Regional Forester signed a Record of Decision amending the Forest Plans for the five forests. The amendment included new grazing direction apparently intended to reverse an admitted trend toward federal listing for aquatic and riparian species under the unamended Forest Plans. The Rio Grande cutthroat was not analyzed in the accompanying Environmental Impact Statement. The Record of Decision contained no *virginalis* specific policy changes. The new grazing direction consists of a utilization table which is supposed to be used in the absence of site specific information. Since some site specific information exists for almost all grazing allotments, it is likely that the utilization table will not be implemented. Even if implemented, there is no evidence to indicate whether or how, the table would improve grazing in Rio Grande cutthroat trout habitat. The table does not require the removal of cattle from riparian areas, trout habitat, cold water fisheries, or any other aquatic designation.

In 1997, the Southwest Region of the Forest Service, to ward off a threatened jeopardy decision on seven species endangered by livestock grazing, developed a Seven Species Plan. The Rio Grande cutthroat trout was not included, nor is there any substantial overlap between the seven species and the trout.

On April 1, 1997, four fisheries biologists presented a briefing on the impacts of grazing on imperiled fish on Southwestern National Forests to the Regional Forester. Their conclusion were remarkably candid and damning:

> "The cumulative and synergistic effects of Forest Service management is causing long-term degradation of the habitats of these species, and contributing to their endangerment and downward trend in range and abundance. Many of these effects are due to irreversible activities that occurred in the distant past. But some are due to current and deliberate action. During our interviews we heard time and again that the needs of the species were not fully considered during NEPA analysis. We heard that terms and conditions of the programmatic BAE for grazing weren't being followed. We heard that biologists were pressured into changing effects determinations so that targets could be met without having to undergo consultation. We heard that mitigation measures weren't applied. But we were always assured that there actually was no problem."
>
> "There are several hundred other riparian dependent species in the region, wildlife that will become the subject of listings and lawsuits if we don't effect a change. We need incentives for line officers to commit to riparian area and endangered species management. We need to commit to management for forest health. Above all, we need a change in management attitude."
>
> "For example, we found that range management is a chronic abuser of riparian habitats. Now range managers truly believe in their hearts that degraded riparian areas can be restored with cattle. And they have come up with an amazing variety of grazing systems to accomplish that...But evaluations of riparian area condition 5 or 10 years later seldom show an upward trend. Why is that? It's because cattle grazing is a core value of the agency, and riparian area health and endangered species management is not. Prescriptions are developed and applied to meet the needs of the rancher, the cattle, or the agency. Soil, vegetation, water, and wildlife resources are secondary considerations."
>
> "Recovery of riparian areas with cattle hasn't worked in the past, is not working now, and won't work in the future. And this is where a change in management attitude is necessary. The only practical way to restore riparian areas supporting endangered species is through removal of cattle impact. And based on experience, we advocate that prescriptions that call for complete rest or nonuse be the first step. A change in attitude to recognize that other multiple uses in riparian areas are more beneficial to the greatest number than a few AUM's is necessary."
>
> "But, management in this region has traded off its love and passion for the land in order to indulge in economically questionable targets. Gifford Pinchot's philosophy of "...providing the greatest good for the greatest number..." has been distorted to a doctrine of providing the most economic use for the few. And this has resulted in the current situation: the FWS threatening a jeopardy call on our management, outside groups taking us to court (and winning) on the same issue, and we being the subject of widespread ridicule and derision."

Overgrazing and habitat destruction continues. Streams flowing through high-elevation meadows are often impacted by cattle or sheep grazing, even within officially designated wilderness areas. In particular, the nine *virginalis* streams arising within the San Pedro Parks Wilderness of the Santa Fe National Forest- nearly ten percent of the remaining *virginalis* habitat- are largely of the open *vega*, or meadow type, and cattle utilize the riparian zones of a number of these streams. Most are heavily degraded. Riparian areas within the Pecos Wilderness are also degraded.

Logging and Road Building. None of the New Mexico National Forest contain specific management direction to prohibit or limit the impact of logging or road building on the Rio Grande cutthroat trout. Though the newly amended Forest Plans contain logging

restrictions to benefit the Mexican spotted owl and Northern goshawk, these restrictions provide little benefit for *virginalis* because they do not include aquatic reserves or riparian buffers.

If carried out, it is likely that road construction for the proposed Angostura Timber Sale along Angostura Creek in Carson National Forest will cause a noticeable decline or even disappearance in the creek's surviving population of *virginalis*. It is also clear that nearly half of New Mexico's remaining *virginalis* populations exist in *de facto* wilderness areas open to road-building and thus are unprotected from the potential disappearance or severe impact represented by road building alone.

In Colorado, only three populations are in protected wilderness areas, 15 in unprotected *de facto* wilderness, and 20 in lands under private corporate ownership subject to possible future road or subdivision development.

Logging on private lands in New Mexico and southern Colorado has the potential to harm or even extirpate *virginalis* populations. Neither the State of Colorado nor New Mexico possess adequate environmental regulations to significantly control private lands logging. The owners of the Taylor Creek Ranch, for example, have destroyed Rio Grande cutthroat trout habitat and harmed existing populations with very little regulatory resistance from the state of Colorado.

U.S. Fish & Wildlife Service. The Rio Grande cutthroat trout should have been listed and protected as an Endangered Species decades ago. Had this been done, it may already be well on its way to complete recovery today.

The Rio Grande cutthroat trout was listed as *endangered* in the 1967 *Red Data Book* of the U.S. Bureau of Sports Fisheries and Wildlife (the precursor to the U.S. Fish & Wildlife Service). *Virginalis* did not appear in the 1968 edition, however, probably because of a report by Behnke suggesting that *unknown* would be a better description given the lack of conclusive data about the subspecies taxonomy, historical distribution, and status (Behnke 1967). Strangely, Behnke's study did establish with fair accuracy the historic and current distribution. Perhaps this why the Bureau's Division of Fisheries, based on a new recommendation by Behnke, suggested that *virginalis* be listed in the 1969 edition as *rare* (King 1968).

The 1972, 1973, and 1974 *Red Data Books* list *virginalis* as *rare* and *endangered* because of range declines associated with "drastic environmental changes wrought by use and misuse of water; the introduction of exotic fish species, particularly rainbow trout and other subspecies of cutthroat trout..." (USBSF&W 1972). Indeed, the 1972 book states that *virginalis* is not viable, establishing two sets of short term goals to maintain the species and to restore it as a "viable component of the ecosystem." Intensive management of livestock (including fencing of streams), protection from logging and road building, and cessation of exotic trout introductions were recommended.

The Rio Grande cutthroat is listed as a *threatened* species on the March 1973 list of "Threatened Wildlife of the United States" (USBSF&W 1973). It was apparently listed as *endangered* on the 1971 list (USFS 1971). Strangely, the U.S. Fish and Wildlife Service failed to place the Rio Grande cutthroat on the endangered species list of 1974 following the passage of the Endangered Species Act in December, 1973. That Act mandates that all

species previously listed as threatened be transferred to the new list.

The Rio Grande cutthroat trout was made a candidate for listing under the Endangered Species Act in 1985 (USFWS 1985).

U.S. Forest Service Conservation Plans. The Forest Service manages the vast majority of Rio Grande cutthroat trout populations and therefore has an extraordinary responsibility to recover the species. Sixty seven of the currently existing Ninety two populations are on public land, most Forest Service (Stumpff and Cooper 1996). Though the Forest Service has a legal mandate under the National Forest Management Act to maintain viable, well-distributed populations of vertebrate species, and though the Rio Grande cutthroat was declared to be no longer viable as far back as 1972 (USBSF&W 1972), none of the National Forests in Colorado or New Mexico have developed a conservation plan to preserve the species.

In 1971, the Santa Fe National Forest developed a draft Rio Grande cutthroat trout conservation plan (USFS 1971). Though the plan states:

> "It is essential that the existing fishery habitat be maintained, improved, and protected to insure future survival of this species for the benefit of mankind,"

The plan was never finalized. In 1993, the Forest stated that it was developing a Rio Grande Cutthroat Restoration Plan with the Carson National Forest and the New Mexico Department of Game and Fish (Tunberg 1993). The plan was never completed.

In 1993, the Lincoln National Forest stated that the Sacramento division had begun "feasibility surveys" as a first step toward re-introducing the subspecies to the Forest (Delorenzo 1993). No populations were ever introduced. Virginalis remains extirpated from the Lincoln National Forest which believes that the absence of the species means its actions can not harm it (Martinez 1997). No management plan for *virginalis* has been created.

In 1994, the Carson National Forest announced that a draft multi-agency *virginalis* plan would be completed in early 1994 (Lucero 1994). The plan was to be produced by the Forest Service, Bureau of Land Management, and the New Mexico Department of Game and Fish. In 1997, the Forest promised that the plan would be completed in 1997. Thus far, no plan has been released (Lucero 1997).

In 1992, the Rio Grande National Forest produced a draft *virginalis* conservation plan. It was never finalized.

The Gila National Forest, though it supports a *virginalis* population in Animas Creek, has no Rio Grande cutthroat trout conservation plan.

In 1988, the Rio Grande cutthroat trout was listed as a Forest Service sensitive species in New Mexico. It is also a Forest Service sensitive species in Colorado.

In 1992, the Chief of the U.S. Forest Service asked Regional Foresters in the Intermountain West to develop inter-regional Habitat Conservation Assessments (HCAs) for all inland cutthroat trout species. In 1994, the Chief reiterated the need for HCAs. The Forest Service has published two volumes of conservation assessments for the Rio Grande and other inland cutthroat trout, but has thus far not developed a regional or inter-regional conservation plan.

State of New Mexico- Habitat Protection. Since the majority of *virginalis* sites and habitats in New Mexico are on National Forest, National Park, Indian Nation, and private lands,

the New Mexico Department of Game and Fish is limited in its capacity to regulate land management to protect and restore the Rio Grande cutthroat trout.

The Department's repeated warnings about the impact of habitat degradation have not resulted in significant changes in land management agencies. In 1976, the Department issued a report entitled "Status and Future of the Rio Grande cutthroat trout" (Hubbard 1976). The report outlined the serious condition of the Rio Grande cutthroat, and the steps necessary to restore it:

> "Since Spanish days, the range and numbers of this trout have probably been declining in New Mexico, as degradation of habitat (e.g. through overgrazing) and use and misuse of water and later the introduction of exotics...by 1972 the subspecies had declined to the point of being listed as a threatened species by the U.S. Fish and Wildlife Service...the decline is unlikely to reverse itself without human help..."
>
> "...streams with limited riparian growth and erosional problems (e.g. degraded banks, rapid run-off form watershed or streambed) tend to lack proper shade (and thereby have higher temperatures), sufficient feeding and shelter areas, and a suitable diversity of invertebrate life. Such streams harbor few or no native trout, whereas streams without these did sustain fish...it appears certain that sufficient information is now known, to correct— or at least attend to— deficiencies in streams to insure better trout survival in them."
>
> "To date, on a limited amount of management has been carried out on behalf of the native cutthroat. With proper attention, this situation can be reversed, and the process should begin soon. For too long, this subspecies has survived in spite of, instead of at the behest of man, and without concerted efforts, we get farther behind."

The Department recommended reduction or elimination of livestock from the five known northern New Mexico metapopulations, establishment of fishery and a supporting hatchery program, a management plan for each metapopulation, restoration of streams occupied by each metapopulation, and the cessation of stocking exotic trout in streams connecting populations.

In 1989, the Department published the results of a statewide fisheries investigation (Sublette *et al.* 1990) It identified the same ongoing problems 13 years after its previous report:

> "Most streams occupied by Rio Grande cutthroat trout have been impacted by overgrazing and livestock. Limited vegetation in the watershed, especially in riparian areas, has led to altered stream nutrient and sediment loads, and has modified flow regimes along with the morphology of the stream course. Trampling of streambanks by livestock has further accelerated habitat destruction. Trout survival in many of these streams is impaired because of the lack of productive riffle areas, suitable spawning sites, undercut banks (to escape predation), pools (for resting, feeding and overwintering), and shade (in proper proportions which reserves cold water temperatures yet allows adequate solar gain essential for primary production). "
>
> "Other factors such as lumbering, mining, and fires also has had adverse effects on Rio Grande cutthroat similar to what grazing has done as far as destroying habitat."
>
> "To insure its survival, it is imperative that exotic salmonids be excluded from the streams where *O. c. virginalis* persists."
>
> "Considering the restricted areas, habitat destruction, competition with exotics, and hybridization there is a definite need to stabilize the present populations of Rio Grande cutthroat and to try to renovate lost areas to avoid losing the species altogether."

State of New Mexico- Reintroduction Programs. All re-introductions of *virginalis* in New Mexico to date have been accomplished by relocation of captured wild fish. Efforts by New Mexico Game and Fish to secure a hatchery or naturalized broodstock of *virginalis* for possible re-introduction efforts have thus far been unsuccessful.

Plans to develop a breeding population of *virginalis* in a small reservoir on McCrystal

Creek were abandoned in 1994 when the dam forming the reservoir developed a number of leaks and had to be destroyed. The New Mexico Department of Game and Fish is currently negotiating with the U. S. Fish and Wildlife Service to make some use of the new federal facility in Mora, New Mexico for the rearing of *virginalis* (Stumpff, personal communication 1997).

State of New Mexico Fishing Regulations. The Rio Grande cutthroat trout is regulated as a game fish in New Mexico and Arizona. Permitted fishing is allowed. There are no non-fishing refugia. New Mexico has not listed virginalis under its state protected species list.

Federal Reintroduction Programs. No numbers of pure-strain *virginalis* had been reared at a hatchery within New Mexico until 1987, when fish of the large-spotted, Pecos strain of *virginalis* from Indian Creek on the Mescalero Apache Reservation were placed in the Mescalero National Fish Hatchery facility with the intent to stock reservation waters. These fish failed to thrive, and by 1993 all stock had died, without any re-introductions having occurred.

Since then, efforts have been made to develop a broodstock at the New Mexico Seven Springs facility and in the Rio Cebolla upstream from the facility, with fish of the smaller-spotted Rio Grande form taken from Cañones Creek, upper Rio Las Vacas, and Rio Puerco in the Jemez Mountains. These efforts are continuing.

XVII. CRITICAL HABITAT DESIGNATION RECOMMENDED

Petitioners strongly recommend the designation of critical for the Rio Grande cutthroat trout coincident with its listing. Critical habitat should be designated in all areas where it is currently located and in key unoccupied areas where restoration is necessary for the conservation of the species.

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Signed this 5th day of February, 1998

REFERENCES CITED

Allendorf, F.W. and R.E. Leary. 1988. Conservation and distribution of genetic variation in a polytypic species, the cutthroat trout. Conservation Biology 2:170-184.

Anderson, J. R. 1993. Letter to Peter Galvin, Greater Gila Biodiversity Project dated 15 December, 1993 From Creede Ranger District, Rio Grande National Forest.

Armour, C.L., D.A. Duff, and W. Elmore. 1991. The effects of livestock grazing on riparian and stream ecosystems. Fisheries 16: 7-11.

Baxter, G. T. and J. R. Simon 1970. Wyoming fishes, Wyoming Game Fish Comm. Bull. No. 4, 168.

Behnke, R. J. 1968. Progress Report: Cutthroat Trout of the Rio Grande and Colorado River Basins. Cooperative Fishery Unit, Colorado State University, Fort Collins, CO.

Behnke, R. J. 1988. About Trout, Rio Grande Cutthroat. Trout, Summer 1988, 29(3): 43-7

Behnke, R. J. 1992. Native Trout of Western North America. American Fisheries Society, Monograph No. 6.

Behnke, R. J. 1967. Rare and Endangered Species: The Rio Grande Cutthroat Trout. Colorado Co-operative Fishery Unit, Colorado State University, Fort Collins, CO. pp. 6-11.

Behnke, R. J. 1979. Monograph of the Native Trouts. BLM, Denver.

Behnke, R. J. 1981 The Cutthroat Trout of Indian Creek, Mescalero Apache Indian Reservation, Tularosa Basin, Otero county, New Mexico.

Behnke, R. J. and M. Zarn. 1976. Biology and management of threatened and endangered western trouts. Gen. Tech. Rep. USDA Forest Service, RM-28: 1-45. Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

Bock, C.E., V.A. Saab, T.D. Rich, and D.S. Dobkin. 1992. Effects of livestock grazing on neotropical migratory landbirds in western North America. USDA Forest Service Gen. Tech. Rep. RM-229. Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

Campbell, D. 1994. Letter to Wilderness Ranger District, Gila National Forest. Published IN: Addendum to the March 24, 1980 Environmental Analysis, Gila Trout Recovery Projects on the Gila National forest, 1994 Restoration of Gila Trout. USDA Forest Service, Gila National Forest, Wilderness Ranger District.

Chaney, E., W. Elmore, and W. S. Platts 1990. Livestock Grazing on Western Riparian Areas. EPA report. 14-7, 26-7.

Chaney, E., W. Elmore, and W.S. Platts.. 1993. Managing change; livestock grazing on western riparian areas. US Environmental Protection Agency. Denver, CO. 31 pp.

Cutler, Alan. 1991. Nested faunas and extinction in fragmented habitats. Conservation Biology Vol. 5, No. 5: 496-505.

Dasmann, Raymond F. 1972. Environmental Conservation. John Wiley and Sons, New York, NY. 473 pp.

DeLorenzo, D. 1993. Letter from Don DeLorenzo, Lincoln National Forest, to Peter Galvin, Greater Gila Biodiversity Project, dated December 23, 1993.

Duff, D. 1996. Bonneville cutthroat trout (*Oncorhynchus clarki utah*) IN Duff, D.A., technical editor. 1996. Conservation Assessment for Inland Cutthroat Trout: Distribution, Status and Habitat Management Implications. USDA Forest Service, Intermountain Region, Ogden Utah.

Duff, D.A. 1995. Fish stocking in U.S. Federal Wilderness Areas: Challenges and opportunities. International Journal of Wildlife 1:17-19

Duff, D.A., technical editor. 1996. Conservation Assessment for Inland Cutthroat Trout: Distribution, Status and Habitat Management Implications. USDA Forest Service, Intermountain Region, Ogden Utah.

Griffith, J. S. 1988. Review of competition between cutthroat trout and other salmonids IN Robert E. Gresswell ed., Status and Management of Interior Stocks of Cutthroat Trout, American Fisheries Society Symposium 4:134-140.

Hall, J. D. and C. O. Baker. 1982. Rehabilitating and enhancing stream habitat: 1. Review and evaluation. U.S. Forest Service General Technical Report PNW-138.

Hanske I. and Gilpin, M. 1991. Metapopulation dynamics: Brief history and conceptual domain. Biological Journal of the Linnean Society 42:3-16.

Harig, Amy L. and Kurt D. Fausch. 1996. Compilation of data on Colorado waters containing Rio Grande cutthroat trout: Final Report to Colorado Division of Wildlife (MOU Project No. 904-96). Colorado Division of Wildlife, Montrose, Co.

Holechek, J.L., R.D. Piper, and C.H. Herbel. 1989. Range management: principles and practices. Prentice Hall, Englewood Cliffs, New Jersey.

Hubbard, J. P. 1976. Status and Future of the Rio Grande Cutthroat Trout. New Mexico Department of Game and Fish, Endangered Species Program Report.

Hunter, C. J. 1991. Better Trout Habitat. Island Press, Washington, D. C.

King, W. 1968. Memo from Willis King, Chief, Division of Fishery Services, to Office of Endangered Species, U.S. Bureau of Sport Fisheries and Wildlife, dated August 16, 1968.

Krueper, D.J. 1992. Effects of land use practices on western riparian ecosystems. USDA Forest Service Gen. Tech. Rep. RM-229. Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

Lamberson, R.H., R. McKelvey, B.R. Noon, and C.Voss. 1992. A dynamic analysis of northern spotted owl viability in a fragmented forest landscape. Conservation Biology 6/4: 505-512

Lande, R. 1987. Extinction thresholds in demographic models of territorial populations. American Naturalist 130: 624-635.

Levins, R. 1969. Some demographic and genetic consequences of environmental heterogeneity for biological control. Bulletin

of the Entomological Society of America 15: 237-240.

Little, R. G. and H. J. McKirdy. Statewide fisheries Investigations, Rancho del Rio Grant, Carson N. F., Project Nos. F-22-R-7 & 8, Job No. A-1. 14 pp.

Lucero, L. 1994. Letter from Leonard Lucero, Carson National Forest Supervisor, to Peter Galvin, Greater Gila Biodiversity Project, dated January 6, 1994.

Lucero, L. 1994. Letter from Leonard Lucero, Carson National Forest Supervisor, to

Luecke, C. 1986. Ontogenetic changes in feeding habits of cutthroat trout. Trans. Am. Fish. Soc. 115:703-10.

MacPhee, C. 1966. Influence of differential angling mortality and stream gradient on fish abundance in a trout-sculpin biotype. Trans. Amer. Fish. Soc. , 95(4):381-387

Marcus, M.D., M.K. Young, L.E. Noel, B.A Mullen. 1990. Salmonid-habitat relationships in the western United States: A review and indexed bibliography. USDA Forest Service, Rocky Mountain Forest and Range Experiment station Gen. Tech. Rep. RM-188. 84 pp.

Martinez, J. M. 1997. Letter from Jose M. Martinez, Lincoln National Forest Supervisor, to Landi Fernley, Southwest Center for Biological Diversity, dated March 17, 1994.

May, B.E. 1996. Yellowstone cutthroat trout (*Oncorhynchus clarki bouvieri*) IN Duff, D.A., technical editor. 1996. Conservation Assessment for Inland Cutthroat Trout: Distribution, Status and Habitat Management Implications. USDA Forest Service, Intermountain Region, Ogden Utah.

McCaffe 1966. Lahontan cutthroat trout, pp.225-31. In: Calhoun, A (ed.), Inland Fisheries Management, California Dept. of Fish and Game.

McClane, A. J. 1965. McClane's Standard Fishing Encyclopedia. Holt, Rinehart and Winston. 210-212.

McGurrin, J.C., C. Ubert, and D. Duff. 1995. Use of cultured salmonids in the federal aid in sport fishing restoration program. American Fisheries Society Symposium 15:12-15.

Murry, M.I. 1996. Natural processes: Wilderness management unrealized. Natural Areas Journal 16(1):55-61.

New Mexico Department of Game and Fish. 1973. Rio Grande Cutthroat Trout. Status Report. 10 pp.

New Mexico Department of Game and Fish. 1968. D. J. project (F-22-R-788, February, 1968)

Pimm, Stuart L., Jared Diamond, Timothy M. Reed, Gareth J. Russel, and Jared Verner. 1993. Times to extinction for small populations of large birds. Proc. Natl. Acad. Sci., Vol 90: 10871-10875.

Platts, W.S. 1991. Livestock grazing. Pp. 389-423 *In*: W.R. Meehan, editor. Influences of Forest and Rangeland Management on Salmonids Fishes and their Habitats. Amer. Fish. Soc. Spec. Pub. 19: 389-423. Bethesda, MD. 751 pp.

Platts, Bill, and R.F. Raleigh. 1984. Impacts of grazing on wetlands and riparian habitat. Pp. 1105-1117 *In*: Developing Strategies for Rangeland Management. Committee on Developing Strategies for Rangeland Management, National Research Council/National Academy of Sciences. Westview Press, Boulder, CO.

Propst, D. L. and M. A. McInnis 1975. An analysis of streams containing native Rio Grande cutthroat in the Santa Fe National Forest. WICHE Report for the Santa Fe National Forest, Region 3, Albuquerque, NM.

Propst, D. L. 1977. Taxonomic Analysis of Cutthroat Trout, Salmo Clarki Ssp., Collected in Northern New Mexico, 1976. Final Report, Contract No. 516-64-22, New Mexico Game and Fish.

Propst, D. L., J. A. Stefferud and P.R. Turner 1992. Conservation and Status of Gila Trout, Oncorhynchus Gilae. The Southwestern Naturalist 37(2)117-125.

Pulliam, H.R. 1988. Sources, sinks and population regulation. American Naturalist 132(5):652-661.

Reiman, B.E., D.C. Lee, J. McIntyre, C.K. Overton, and R. Thurow. 1993. Consideration of extinction risks for salmonids. USDA Forest Service, Fish Habitat Relationships Technical Bulletin No 4.

Reiman, B.E. and K.A. Apperson. 1989. Status and analysis of salmonid fisheries: Westside cutthroat trout synopsis and analysis of fishery information. Idaho Department of Fish and Game, Boise. Job performance report, project F-73-R-11, subproject No. 11, Job No. 1.

Rieman, B.E. and J.D. McIntyre. 1993. Demographic and habitat requirements for conservation of Bull trout. USDA Forest Service General Technical Report INT-302.

Rinne, J. N. and R. A. Lafayette 1991. Southwestern Riparian-Stream Ecosystems: Research Design, Complexity, and Opportunity. USDA Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 9pp.

Schaffer, M.L. 1987. Minimum viable populations; coping with uncertainty IN Viable Populations for Conservation, M.E. Soule, editor, 69-86.

Shiazoa, D. K. and R. N. Williams 1992. Geographic variation, isolation and evolution of cutthroat trout (Salmo clarki). National Geographic Society Final Report, Grant # 3653-87. 28 pp.

Smith, R. H. 1984. Native Trout of North America. Frank Amato Publications, Portland, OR.

Stacey, P.B. and M. Taper. 1992. Environmental variation and persistence of small populations. Ecological Applications 2(1):18-29.

Steffurd, J. 1988. Rio Grande cutthroat trout management in New Mexico IN Robert E. Gresswell ed., Status and Management of Interior Stocks of Cutthroat Trout, American Fisheries Society Symposium 4:90-92.

Stumpff, B. and J. Cooper. 1996. Rio Grande Cutthroat Trout, *Oncorhynchus clarki virginalis* IN Duff, D.A., technical editor. 1996. Conservation Assessment for Inland Cutthroat Trout: Distribution, Status and Habitat Management Implications. USDA

Forest Service, Intermountain Region, Ogden Utah.

Sublette, J. E., M. D. Hatch and M. Sublette 1990. The Fishes of New Mexico. University of New Mexico Press, Albuquerque, NM.

Szaro, R. C. 1989. Riparian forest and scrubland community types of Arizona and New Mexico. Desert Plants 9: 69-138.

Thompson, P.D. 1995. Evaluating the effectiveness of electro-fishing and man-made barriers for controlling Brook trout populations in streams containing cutthroat trout. MS Thesis, University of Wyoming, Laramie. 272 pp.

Tripp, L. and D. B. Rockland 1988. Fishery Resources of the National Forests: Extent, Uses, and Economic Benefits. USDA Forest Service Wildlife and Fisheries, Washington, D.C.

Trotter, P. C. 1987. Cutthroat, Native Trout of the West. Colorado Associated university Press, Boulder, CO. pp.1-19.

Trotter, P.C. and P.A. Bisson. 1988. History and discovery of the cutthroat trout. American Fisheries Society Symposium 4:8-12.

Tunberg, G. 1993. Letter from Gail Tunberg, Wildlife Biologist, Santa Fe National Forest, to Peter Galvin, Greater Gila Biodiversity Project, dated December 20, 1993.

U.S.B.S.F. & W. 1972. Rio Grande cutthroat (*Salmo clarki virginalis*). Red Data Book, U.S. Bureau of Sports Fisheries and Wildlife, Washington, D.C.

U.S.B.S.F. & W. 1973. Threatened Wildlife of the United States. Office of Endangered Species and International Activities, Bureau of Sport Fisheries and Wildlife, Resource Publication 114, March 1973 (Revised Resource Publication 34).

U.S.F.S. 1971. Draft Rio Grande cutthroat habitat management plan. Santa Fe National Forest, Santa Fe, NM.

U.S.F.S. 1994. Letter from Chief to Regional Directors reiterating importance of developing Habitat Conservation Assessments for inland cutthroat trout.

U.S.F.S. 1992. Letter from Chief to Regional Directors requesting preparation of Habitat Conservation Assessment for inland cutthroat trout.

U.S.F.S. 1993. Diamond Bar grazing allotment draft environmental impact statement; Gila National Forest. USDA Forest Service. Southwestern Region, Albuquerque, New Mexico. pp.

U.S.F.W.S. 1973. Rio Grande cutthroat (*Salmo clarki virginalis*). Red Data Book, U.S. Bureau of Sports Fisheries and Wildlife, Washington, D.C.

Utah Division of Wildlife Resources. 1991. Dewatered stream miles. Instream flow task force, Utah Division of Wildlife Resources, Salt Lake City, UT.

Van Eimeren, P. 1996. Westside cutthroat trout (*Oncorhynchus clarki lewisi*) IN Duff, D.A., technical editor. 1996. Conservation Assessment for Inland Cutthroat Trout: Distribution, Status and Habitat Management Implications. USDA Forest Service, Intermountain Region, Ogden Utah.

Warren & Burr. 1994. Status of fresh water fishes. Fisheries 19(1):6-18.

Williams et al. 1989. Fishes of North America: Endangered.. Fisheries 14(6):2-20.

Wilson, Edward O. 1992. The diversity of life. The Belnap Press of Harvard University Press, Cambridge, MA. 424 pp.

Young, M. K., R.N. Schmal, T. W. Kohley and Y. G. Leonard. 1996. Colorado River cutthroat trout (*Oncorhynchus clarki pleuriticus*) IN Duff, D.A., technical editor. 1996. Conservation Assessment for Inland Cutthroat Trout: Distribution, Status and Habitat Management Implications. USDA Forest Service, Intermountain Region, Ogden Utah.

Young, M. K. 1996. Summer movements and habitat use by Colorado River cutthroat trout (*Oncorhynchus clarki pleuriticus*) in small, montane streams. Canadian Journal of Fisheries and Aquatic Sciences 53:1403-1408.