United States Department of the Interior

NATIONAL PARK SERVICE

ROCKY MOUNTAIN REGIONAL OFFICE
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TAKE PRIDE IN AMERICA

IN REPLY REFER TO:
N16 (RMR-RN)

DEC 16 1993

Reference: Gunnison River Reserach Bibliography: Draft Review,
Current Research Project List Review

Dr. Robert Behnke
Fisheries and Wildlife
Colorado State University
Fort Collins, Colorado 80523

Dear Dr. Behnke:

Enclosed, for your review, please find a draft bibliography, draft research project list, and a questionnaire/order form. Your timely review of the bibliography will help speed the production of a final draft.

The completion of a comprehensive literature search has been identified as an essential step in determining the research needs associated with water delivery contract negotiations between the National Park Service (NPS) and the Bureau of Reclamation (BOR) on the Gunnison River. During 1993 a literature search was coordinated and conducted by BOR and NPS. A large bibliographic database has been generated from the library research which currently includes 568 entries. The resulting bibliographies are working drafts. It is hoped that an interagency, interdisciplinary review will result in additional information and a fine-tuning of these documents.

Production of a final draft is considered a high priority project by the entities involved with and interested in the water contract negotiations and related research. However, limited response was received from circulating a preliminary draft of the bibliography for review (with no deadline imposed). We plan to finalize this draft by February 1994. If you would like to provide input, we would appreciate receiving your comments by January 12.

The enclosed packet includes copies of draft bibliographies, a working list of current research projects and a questionnaire. When responding, please include additions, corrections and comments for the bibliographies and the research projects list. If you are interested in receiving a final draft, please complete the questionnaire/order form. If you do not respond, we will assume that you do not wish to receive the final product.

The time, energy and expertise contributed by all who have been involved in this research effort is appreciated.

If you have questions, please contact Regional Water Resources Program Manager Janet Wise. Please mail, fax [(303) 969-2644)], or call responses to Janet Wise or Lynn Riedel at (303) 969-2655. Please use the following address for correspondence: National Park Service, Rocky Mountain Regional Office, Natural Resources Division (RMR-RN), 12795 W. Alameda Parkway, Lakewood, Colorado 80225-0287.

Sincerely,

for

J.T. Reynolds
Acting Associate Regional Director
Operations and Resource Management

Enclosures

Identical correspondence sent to the following:
Ned Andrews, USGS, Boulder, CO
Allan Belt, Area Manager, Uncompahgre Resource Area, BLM, Montrose, CO
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Douglas A. Young, Bureau of Reclamation, Fish and Wildlife Biologist, Upper Colorado Region, Salt Lake City, UT
Gary Smillie, Water Resources Division, Fort Collins

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Gunnison River Contract EIS Studies and Other Current Research in the Gunnison River System

This list is designed to provide information on current and ongoing research in the Gunnison River System. A comprehensive list of current projects in conjunction with the research bibliography should assist in identifying research needs pertaining to water delivery contract negotiations. Research in natural, cultural and historical resources, and socio-economic topics are targeted for the list. Descriptions and results of most of these in-progress projects have not been published and/or project plans and progress reports have not been widely circulated. We hope to gather the following information for each project: 1) name of sponsoring agency, 2) project title and abstract, 3)name of contact person(s) and telephone no./address. **Please add to or edit information for projects that you are familiar with, and include research projects that are not listed.**

WATER: Limnology, Water Quality, River Regulation, Etc.

* **Project title**: Limnology of Blue Mesa Reservoir
Sponsoring agency: U. S. Bureau of Reclamation (BOR)
Contact, telephone no.: Rick Harris, Curecanti National Recreation Area (CURE), (303) 641-2337
Abstract: A 4 year study headed by Dr. Brett Johnson of Colorado State University. This project was initiated in 1993, and presently includes Blue Mesa Reservoir. An expansion of the study to include Crystal and Morrow Reservoirs is desired, however, funding has not been secured for work beyond Blue Mesa Reservoir. One focus of the project is on trophic dynamics (food web dynamics / fish and bio-energetics). The sampling regime involves dissolved oxygen, temperature measurements, and zooplankton collection. Dr. Johnson's work also looks at entrainment associated with dam (turbine) operation.

* **Project title**: CURE water quality monitoring
Sponsoring agency: National Park Service (NPS)
Contact, telephone no.: Rick Harris, CURE (303) 641-2337
Abstract: Water quality monitoring of Blue Mesa, Crystal and Morrow Reservoirs, and tributary streams has been ongoing for 10 years. Between 7 and 21 stream sites, and between 7 and 48 lake sites have been involved in the long-term monitoring effort. From 1987 to 1992 the study focused on Blue Mesa Reservoir and tributaries. In 1993 the monitoring project was revamped to reflect potential threats to water quality. Tributary sampling sites were added to the Crystal and Morrow Reservoir monitoring, Blue Mesa Reservoir sites were added, and a Gunnison River sampling site was added upstream from Blue Mesa Reservoir. Biological monitoring, involving macro-invertebrate sampling, was added to all tributary sampling sites in 1993.

* **Project title:** Planning model (water right allocation) / spreadsheet (water right administration accounting)
Sponsoring agency: BOR
Contact, telephone no.:
Abstract:

* **Project title:** High water 1993 report
Sponsoring agency: BOR
Contact, telephone no.:
Abstract:

* **Project title:** High water photography: video, stills, aerials
Sponsoring agency: BOR
Contact, telephone no.:
Abstract:

* **Project title:** Flushing flows study on Lower Gunnison River
Sponsoring agency: BOR
Contact, telephone no.:
Abstract:

* **Project title:** Survey of water surface elevations associated with 1993 high spring runoff
Sponsoring agency: NPS, WRD (Water Resources Division)
Contact, telephone no.: Mark Wondzell, (303) 225-3537
Abstract: (Late September, 1993). WRD staff surveyed water surface elevations associated with 1993 high spring runoff. In addition, U. S. Fish and Wildlife Service vegetation experts accompanied WRD staff to previous study sites (from 1990) within Black Canyon to assess changes in the riparian community.

* **Project title**: Investigation of a recent major change in the channel of the Gunnison River just upstream from Blue Mesa Reservoir within CURE
Sponsoring agency: NPS, WRD
Contact, telephone no.: Gary Smillie (WRD), (303) 225-3522
Abstract: During high water in the spring of 1993 the Gunnison River broke out of the channel that had been used for many years near the Neversink and Cooper Ranches. Preliminary observations and planning for further investigation (to assess the geomorphic setting) of this channel shift just upstream from Blue Mesa Reservoir were conducted.

FISHERIES BIOLOGY / RECREATION (SPORT FISHING)

* **Project title**: Investigations on the operation of the Aspinall Unit (listed in the bibliography, also)
Sponsoring agency: USFWS, Recovery Implementation Program for Endangered Fish Species in the Upper Colorado River Basin (multi-agency effort)
Contact, telephone no.: Daryl Jennings (NPS), (303) 969-6705; Ed Wick (NPS), (303) 225-3540
Abstract: A 5-year, coordinated program to provide data for a biological opinion on operating the Aspinall Units on the Gunnison River for the benefit of the endangered fishes. The program enters its second year in FY 93. Test flows will be released from the Aspinall Units during the study to more closely mimic a natural hydrograph, allowing investigators to monitor fish and habitat response. A biological opinion will be issued in 1998 following completion of the studies.

* **Project title**: Native fishes of the Gunnison River Basin (assessment and recovery plan by Dr. Behnke)
Sponsoring agency: NPS (CURE)
Contact, telephone no.: Rick Harris, (303) 641-2337
Abstract:

* **Project title**: Gunnison Gorge fish survey, trout population and reproduction
Sponsoring agency: Colorado State Division of Wildlife (CDOW) / U.S. Fish and Wildlife Service (USFWS)
Contact, telephone no.: David Langlois (CDOW),
(303) 249-3431
Abstract:

* **Project title:** Downstream (from BLCA ?) native fish studies
Sponsoring agency: USFWS, CDOW, BOR
Contact, telephone no.:
Abstract:

* **Project title:** Gunnison Gorge trout fry survey
Sponsoring agency: CDOW, USFWS
Contact, telephone no.: David Langlois (CDOW)
Abstract: (303) 249-3431

* **Project title:** Creel Survey
Sponsoring agency: NPS, CDOW
Contact, telephone no.: Rick Harris (CURE), (303) 641-2337
Abstract: The creel survey is a cooperative project investigating the effects of fluctuating water levels and other aspects of Blue Mesa Reservoir operation on sport fish populations. The survey is conducted from May through October. Rainbow trout and Kokonee salmon populations are of particular interest in this survey.

GEOMORPHOLOGY

* **Project title:** Sediment transport in Gunnison Gorge
Sponsoring agency: Bureau of Land Management (BLM), U. S. Geological Survey (USGS)
Contact, telephone no.: John Elliot (USGS Water Resources Division), (303) 236-4882
Abstract:

* **Project title:** (Proposed project) Stream morphology in Black Canyon of the Gunnison
Sponsoring agency: USGS researchers with assistance from NPS personnel
Contact, telephone no.: Myron Chase, Black Canyon of the Gunnison National Monument (BLCA)
Abstract: The primary focus of this proposed project is to assess geomorphic and sediment load changes in the Gunnison River resulting from decreases in water volume and changes in flow distribution over the last few decades. The study will: 1) provide an inventory of existing fluvial conditions in selected reaches of the monument (Black Canyon of the Gunnison National Monument (BLCA)), 2) provide a preliminary assessment of real and potential geomorphic and sediment transport changes resulting from streamflow alterations in the most sensitive reaches (sensitive reaches to be defined using characteristics identified by Elliot and Parker study, 1992), 3) identify additional information needs for addressing the potential impacts of future mainstem streamflow alterations, and 4) provide basic information for any future Black Canyon studies. The proposed work in BLCA would be integrated with an ongoing USGS /BLM study in the Gunnison Gorge downstream of the monument.

VEGETATION:

USFWS (BLCA, 1990 and 1993), BLM (Gunnison Gorge), USGS (Gunnison Gorge), NPS/WRD (BLCA)

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THE GUNNISON RIVER DRAINAGE AND ITS CHANGING FISH FAUNA

PART I: HISTORICAL PERSPECTIVE

Robert J. Behnke

June, 1993

INTRODUCTION

The Colorado River basin is divided at Lee's Ferry about 10 miles below Glen Canyon dam, into the lower and upper basins. Although this division is based on water allocation between upper basin and lower basin states, it also serves as a natural division between upper and lower basin fish faunas. This division of fish species had its origin in Miocene times when the upper and lower basins were two separate entities. By late Miocene, the upper Colorado River had changed course in a southwestward direction to eventually cut the Grand Canyon and join with the lower basin into one continuous river system.

Except for a few "big river" fishes such as squawfish, razorback and flannelmouth suckers and the three chub species of the genus Gila, the fish species of the lower basin are distinctly different from upper basin species (the lower basin contains several endemic genera not found in the upper basin). This differentiation between upper and lower basin fishes denotes their different ancestral origins from different geographical areas. For example both the upper and lower basins have native trout of the genus Oncorhynchus, but the Gila and Apache trout of the lower basin were derived from an ancestral species invading from the Gulf of California at a more ancient time, whereas the native trout of the upper basin is a cutthroat trout derived from the Columbia River (Snake River) basin in more recent times.

Only 13 species of fish are native to the upper basin, all of them are derived from ancestors invading from the Columbia River basin. Seven of the 13 species are endemic to the Colorado River basin (distribution restricted to the basin) which, along with the low number of native species (highly unsaturated fauna) denotes long and relatively complete isolation from surrounding river basins. The nonendemic species such as cutthroat trout, mountain whitefish, speckled dace, sculpins, and mountain suckers typically inhabit smaller streams near headwaters and their ancestors gained entrance into the upper Colorado basin via

stream captures probably during late Pleistocene times and have not had time to differentiate into distinct species. Like the Colorado River cutthroat trout, these nonendemic species may have sufficiently differentiated to be recognized as subspecies (endemic subspecies).

A depauparate, highly unsaturated, native fish fauna exposed to a changing environment and nonnative fish species is highly vulnerable to replacement and extinction, which is well exemplified by the fate of native fishes in both the upper and lower Colorado basins.

Beginning in 1930 with the start of construction of Hoover Dam and extending into 1970's (Crystal regulating reservoir of Gunnison River Aspinall Unit completed 1977), the Colorado River basin was dramatically transformed into a series of large reservoirs with highly regulated river flows dominated by nonnative fishes. The Gunnison River exemplified this environmental transformation.

THE GUNNISON RIVER

Physical, Hydrological Characteristics. The Gunnison drainage from its junction with the Colorado River to the uppermost headwaters of the East and Taylor rivers is about 200 miles in stream length (Gunnison River proper begins at confluence of East and Taylor rivers at Almont). The watershed drains above about 8000 mi^2. Perennial stream flow starts above about 12,000 ft. in upper most tributaries and drops more than 7,500 ft. in elevation to the junction with the Colorado River. Annual flow regimes under virgin conditions reflected snow melt conditions. A rapid rise in Gunnison River flows would occur in May and June (peak flow typically in June) and lowest flows from October through March. The mean monthly June flow would typically average 10 to 20 times that of the average low monthly flow (measured at Grand Junction). Wiltzius (1978) provides data on historical and modified Gunnison flows at various sties.

For the purpose of discussion of fishes, the Gunnison River can be separated into three zones: the headwater (trout zone), the downstream limit of which can arbitrarily be designated at the Gunnison tunnel (Wiltzius noted many days of June, July, and August exceed 70°F with 80°F recorded at the tunnel area on July 16 during the record drought of 1934); a transition zone between cold water and warm water environments would, historically, have extended from the tunnel area to the junction with the Uncompaghre River at Delta (big river fishes -- squawfish, razorback sucker, and bonytail were never recorded in Gunnison above Delta); and a typical, warm water, big river environment occurs from Delta to the junction with the Colorado River. Thus, the National Park Recreation area occupies an area in the headwater zone and the National Monument is in the upper transition zone (in relation to virgin flow-temperature conditions).

Man-Induced Changes. In the late nineteenth century, European man began impacting the Gunnison basin, first by mining (and mine waste pollution, which compared to other drainages of Colorado, except for Uncompaghre drainage above Ouray, was not of catastrophic proportions), and ranching (extensive irrigation diversions with conversions to hay meadows and subsequent degradation of several upper Gunnison tributaries began in early twentieth century). The Redlands diversion dam in the lower Gunnison was constructed in 1907 and became a barrier, at least, during the irrigation season, to migratory species such as squawfish, razorback sucker and bonytail, attempting to move from the Colorado River up the Gunnison. The Gunnison tunnel, completed in 1910, could divert up to 1000 cfs for irrigation in the Uncompaghre Valley. During very low flows the entire Gunnison River flow could be diverted leaving only intermittent pools in the canyon. This uncertainty for sufficient flows for tunnel diversion led to construction of Taylor Park Reservoir, completed in 1937. This reservoir changed annual flow and

temperature regimes in the Taylor River, and to a lesser extent in the upper Gunnison. The greatest environmental change was effected by the construction of the Curecanti Unit (now Aspinall) of the Bureau of Reclamation's Colorado River Storage Project. Blue Mesa dam completed in 1965 forms a reservoir, at full pool, of approximately 9,000 surface acres (largest lake or reservoir in Colorado); Morrow Point dam was completed in 1968 and the Crystal regulating reservoir was completed in 1977. The once world famous Gunnison River trout fishery was inundated by Blue Mesa Reservoir but the changes in flow and temperature regimes below Crystal reservoir transformed the historical upper transitional zone in the Black Canyon and Gunnison Gorge into a premier trout zone by greatly extending the coldwater environment downstream.

Fishes

As mentioned, only 13 fish species are native to the upper Colorado basin, but probably only nine of these occurred in the Gunnison drainage. The native upper Colorado basin fish fauna consisted of: Salmonidae, Colorado River cutthroat trout, Oncorhynchus clarki pleuriticus, mountain whitefish, Prosopium williamsoni; Cyprinidae, roundtail chub, Gila robusta, humpback chub, G. cypha, bonytail, G. elegans, Colorado squawfish, Ptychocheilus lucius, speckled dace, Rhinichthys osculus (subspecies yarrowi may be used for Colorado River basin form); Catostomidae, razorback sucker, Xyrauchen texanus, flannelmouth sucker, Catostomus latipinnis, bluehead sucker, C. discobolus, mountain sucker, C. platyrhynchus; Cottidae, mottled sculpin, Cottus bairdi, Paiute sculpin, C. beldingi.

Of these native species, the humpback chub probably was absent as a regularly occurring species, from the Gunnison River because of lack of deep water, warm habitat. No records of humpback chub are known from the Gunnison but occasional specimens may have moved into the lower Gunnison from the Colorado River for brief periods. The original distribution of

mountain whitefish, mountain sucker, and the two sculpin species is peculiar and not readily explained. The whitefish and mountain sucker were restricted only to the Green River drainage of the upper basin (both are native to the White and Yampa drainages in Colorado). Whitefish from the White River were introduced into the Roaring Fork River in 1955 and have flourished and spread in the upper Colorado. Although a native upper basin species, whitefish presently found in the upper Colorado River and its tributaries are introduced, not native. Why the ancestors of whitefish and mountain sucker did not descend the Green and move up the colorado River is a mystery. The native distribution of the two sculpin species is more difficult to explain. The mottled sculpin is native to the Green River division of the upper basin and in the upper Colorado River it occurs up to and including the Gunnison. From the Eagle River to the headwaters of the Colorado, the Paiute sculpin is the only known native sculpin. Since both species gained access to the upper basin from the Snake River drainage (Columbia basin), such a distribution might result from the Paiute sculpin being the first invader, then a subsequent invasion by mottled sculpin replaced the Paiute sculpin except for the Eagle River upstream. Wiltzius (1978) mentions a sculpin specimen from the Warner Point area of the Monument taken July 20, 1975, which he identified as a Paiute sculpin based on the number of preopercular spines (but he recorded no data on number of pectoral fin rays, palatine teeth, or lateral line). All sculpin specimens I have examined from the Gunnison drainage have been mottled sculpin. If Paiute sculpin are native to the drainage I would expect them to be in headwaters of the North Fork or Uncompaghre. "Sculpins" are known from upper Cow Creek, a headwater tributary to the Uncompaghre (HDR 1988).

Even more perplexing than the distribution pattern of the two species of sculpins, is the historic distribution of the mottled sculpin in the Gunnison River. Both mottled sculpin and Paiute sculpin are typical inhabitants of high gradient trout

streams. In the uppermost, coldest headwaters of the upper basin, under virgin conditions, the cutthroat trout would be the only fish species found. Moving downstream, a sculpin, either mottled or Paiute typically would be the second species encountered, then mountain sucker (not in Gunnison), speckled dace, etc. in progression from small coldwater to larger warmer water habitats. All historic records of mottled sculpin are in the lower and lower transitional zone (upstream, to vicinity of North Fork Confluence). Why the mottled sculpin, contrary to all expectations, did not occur in the upper Gunnison above the Black Canyon is a question for which no logical answer is apparent.

Thus, the historic distribution of native fishes according to zonation would be squawfish, bonytail, roundtail chub, razorback sucker, flannelmouth sucker, bluehead sucker plus speckled dace and mottled sculpin in the lower zone. Razorback sucker, squawfish, and bonytail were not known to occur above Delta, but all of the other above mentioned species occurred in the lower transition zone with mottled sculpin and roundtail chub fading out above the North Fork confluence. Based on collections made in 1965-66 in the Black Canyon of the National Monument only four specimens of roundtail chub were recorded, all taken at the Red Rock Canyon site (Kinnear and Vincent 1967). Speckled dace were recorded at three sites but almost all specimens came from the East Portal area. Flannelmouth sucker was the only native species to be collected at all seven sites; bluehead suckers were found at five sites and nonnative white sucker, rainbow trout, and brown trout were commonly found at all sites. Except for the absence of the native cutthroat trout (replaced by brown trout and rainbow trout) all of the native fish species historically inhabiting the area still occurred in the Black Canyon of the Gunnison in 1966. In addition to the three nonnative fishes, hybrids between white sucker and the two native species were common (found at six of the seven sites).

In the upper (trout) zone of the Gunnison above the tunnel, besides the native cutthroat trout, both of the native suckers --

bluehead and flannelmouth -- along with speckled dace were known to occur historically. This section of the Gunnison contained only four fish species before introductions began and massive environmental changes occurred. Brook trout were first introduced into the Gunnison drainage in 1883, rainbow trout in 1888, and brown trout in 1893. Inadvertent introductions of other nonnative species was common in fish stocking operations. Hatcheries on the eastslope taking water from local streams might have such species as white and longnose suckers, fathead minnow, red shiner, etc. mixed in with a load of the species to be stocked in the Colorado basin. Many of these nonnative species either deliberately or accidentally introduced found the changing environment of the Gunnison basin to their liking.

In less than 10 years after Taylor Park Reservoir was completed in 1937, a deteriorating trout fishery was noted due to sucker infestation. The suckers in question were the nonnative white and longnose sucker. Soon after, northern pike were stocked in Taylor Reservoir in hopes of controlling the suckers. The pike have been successfully reproducing ever since -- at 9,600 ft. elevation, Taylor Park Reservoir is one of the highest bodies of water in the world with a self-sustaining Esox lucius population.

After the establishment of Blue Mesa Reservoir, the two native sucker species disappeared to be replaced by white and longnose suckers in the reservoir and in the Gunnison River above the reservoir. Wiltzius (1978) reported longnose dace, Rhinichthys cataractae, in the Gunnison River (North Beaver and Tomichi creeks) above Blue Mesa (I verified this identification). This is the only known instance, of which I am aware, of the establishment of longnose dace in the Colorado basin.

After the new flow and temperature regime governed by the Curecanti reservoirs was initiated, the colder temperatures characteristic of the original upper trout zone, were extended for downstream through the transitional zone. This greatly increased the abundance and growth of brown and rainbow trout,

made the two native sucker species rare, and established a thriving population of longnose suckers, a species not found here before Curecanti (in 1966, I assisted Kinnear and Vincent with fish collections and sucker identification and I did not see a longnose sucker in the collections).

(A) The past Curecanti flow regime also significantly changed the annual hydrograph by greatly reducing the May-June peaks by reservoir storage while increasing the late summer flow by reservoir release of the spring storage.

Except for sporadic occurrence of speckled dace, all fishes now inhabiting the reservoirs and the Gunnison-Taylor-East rivers and their tributaries are nonnative species -- rainbow trout, brown trout, brook trout, lake trout, kokanee, longnose sucker, white sucker, fathead minnow and longnose dace (plus northern pike). If Mysis shrimp, long established in Taylor Reservoir, become established in Blue Mesa Reservoir, the present kokanee-rainbow trout fishery (hatchery based fishery) is expected to be profoundly affected.

In the lower transition zone and in the lower zone, nonnative species, in addition to those discussed above, include channel catfish, black bullhead, carp, red shiner, sand shiner, fathead minnow, green sunfish, largemouth bass, and plains killifish (Fundulus zebrinus). The latter three species mainly occur in the off-channel lentic or ponded habitats (carp and catfish may also be common here). This off-channel ponded-backwater habitat is precisely the habitat required for razorback sucker reproduction. The decline of razorback suckers began long before the era of dams and river regulation. Their decline was due to predation on eggs and larvae by nonnative species, especially carp, catfish, bass, and sunfishes in these off-channel lentic environments (adult razorback suckers appear to have no trouble surviving, but recruitment is lacking).

(B) 5

The details of the history of the native cutthroat trout and their potential for restoration is treated in part II of this report.

LITERATURE CITED

HDR Engineering Inc. 1988. Feasibility study for upper Gunnison-Uncompaghre basin: Recreation, and environmental enhancement opportunities. Submitted to: Colo. Water Resources and Power Develop. Auth.

Kinnear, B. S. and R. E. Vincent. 1967. Fishes and fish habitats in the Black Canyon of the Gunnison National Monument. Colo. St. Univ. for N.P.S.

Wiltzius, W. J. 1978. Some factors historically affecting the distribution and abundance of fishes of the Gunnison River. Final Rep. to Bur. Rec. Fishery Investigations of the lower Gunnison River Drainage. Colo. Div. Wildlife.

PART II: THE NATIVE CUTTHROAT TROUT OF THE GUNNISON DRAINAGE AND POTENTIAL FOR RESTORATION

INTRODUCTION

The cutthroat trout species, Oncorhynchus clarki, is a widely distributed, polytypic species occurring from northern California to Prince William Sound, Alaska (coastal subspecies) and inland subspecies range from the headwaters of the Columbia River and South Saskatchewan River of British Columbia and Alberta to the Rio Grande basin of southern New Mexico. In their evolution and distribution the species fractioned into four major groups (the "major" subspecies of Behnke 1992). The original splitting of these four major evolutionary lines occurred long ago, perhaps a million years or more (mid Pleistocene), and considerable genetic divergence occurs among the four major subspecies (for example, allozyme differentiation as detected by electrophoresis). The Colorado River cutthroat trout, O. c. pleuriticus, was derived from an ancestral transfer from the Upper Snake River drainage (and/or indirectly from the Snake River system via the Bonneville basin) and is one of the "minor" subspecies associated with the "Yellowstone" cutthroat evolutionary line (Behnke 1992). From the Colorado basin, cutthroat trout radiated into the South Platte (stomias, the greenback cutthroat) and Rio Grande (virginalis, Rio Grande cutthroat) to form a group of three very closely related subspecies. The cutthroat trout is the only species native to the upper Colorado basin which crossed the Continental Divide to become established in Atlantic Ocean watersheds.

Although I consider pleuriticus as a minor subspecies in the Yellowstone evolutionary line, its degree of morphological divergence (supported by limited evidence on allozyme divergence) from Yellowstone cutthroat (subspecies bouvieri) suggests the ancestral separation from its parental source in the upper Snake River probably occurred prior to the last glacier epoch (perhaps 100,000 years or more). This assumption is also supported by the degree of differentiation in spotting pattern apparent among

pleuriticus populations in different geographic areas of the upper Colorado basin. For example, pleuriticus in the headwaters of the Green River drainage typically have the smallest spots while those native to the Little Snake of the Yampa River drainage have very large spots more evenly distributed over the body, more typical of stomias than of other pleuriticus. Because of this intrasubspecific differentiation, for a biodiversity preservation program, I would recommend that the highest priority for restoration of native cutthroat to the Gunnison drainage should be given to transplants from pure populations still persisting in the drainage (although very rare).

The historical distribution of Colorado River cutthroat trout was in all suitable tributaries of the Green and Colorado rivers southward to the San Juan drainage. Although spotting pattern varies, all pleuriticus have the potential to develop strikingly beautiful coloration of rich crimson and golden yellow or orange (in 1875 when D. S. Jordan first saw specimens of California golden trout, O. aguabonita, he misidentified them as pleuriticus). Full expression of coloration depends on carotenoid pigments in the diet, thus pleuriticus feeding on crustaceans, especially mature males, exhibit the most intense colors.

Similar to the razorback sucker, the decline to near demise of Colorado River cutthroat began well before the era of dams and river regulation and was caused by the introductions of nonnative trout species--brook trout replaced cutthroat in small headwater streams and rainbow and brown trout replaced them in larger rivers. Hybridization with rainbow trout was the most pervasive cause of the disappearance of pure populations of native cutthroat trout. This replacement of cutthroat trout and their replacement by nonnative trout occurred rapidly after introductions began. A note in a 1903 issue of Outdoor Life lamented the plans of the Colorado Fish Commission to construct a hatchery on the Bear (Yampa) River. The author claimed this was the last relatively large river he could still catch the

beautiful, and preferred native cutthroat. In a 1904 issue a story recounting a fishing trip to the upper Poudre River mentioned that only about 20% of the trout caught were native greenback cutthroat. The replacement of cutthroat by rainbow trout in the upper Gunnison occurred in an incredibly short time.

GUNNISON DRAINAGE

We know little about the native cutthroat trout fishery in the upper Gunnison because the early fame of the upper Gunnison River as a world class trout fishery was based on the nonnative rainbow trout (Wiltzius 1978, 1985).

The Denver and Rio Grande narrow gauge railroad reached the Gunnison Valley (via Denver, Pueblo, westward over Marshall Pass) in 1881. This greatly facilitated the transport of fish for stocking (and the transport of anglers). Brook trout were stocked in the upper Gunnison drainage in 1883. By 1889, brook trout were already common in Tomichi Creek (Jordan 1891) and by 1898, brook trout were so abundant in Tomichi Creek, the Colorado Fish Commission set up an egg-taking station (Wiltzius 1985). The first recorded stocking of rainbow trout in the upper Gunnison occurred in 1888. This stocking probably consisted of only a few thousand newly hatched fry because only 22,000 rainbow trout were stocked in all of Colorado in 1888 (Wiltzius 1985 table 11). During the next several years similar limitations on the number of rainbow trout for stocking in Colorado were in force. It wasn't until 1903 and thereafter that millions of rainbow trout eggs were available for hatchery propagation and stocking in Colorado when an egg-taking station was established on Beaver Creek to spawn thousands of rainbow trout on their spawning run from the Gunnison River (Beaver was only one of many tributaries - such as South Beaver, Ohio, East and West Elk, Cebolla, Steuben, and Soap creeks - known to have spawning runs of Gunnison River rainbows at the turn of the century).

Wiltzius (1985 Fig. B-22) reproduced a photo of nine rainbow trout caught by three anglers during three hours of fishing in

the Gunnison River below the confluence with Tomichi Creek in August, 1895. The trout ranged from 5 1/2 to 9 pounds -- the total weight of the nine fish was slightly more than 80 pounds! This amazing catch was made only seven years after the first few thousand rainbow fry were stocked in the Gunnison. I estimate that these large rainbow trout would have been about 5 to 7 years of age; that is, from fry stocking during 1888-90.

Such phenomenal survival and growth could only be expected if the baby rainbow trout were stocked into an ideal environment with an absence of predators and competitors. Although bluehead and flannelmouth suckers and speckled dace were native to the upper Gunnison, I suspect the virgin environment of the upper Gunnison would have overwhelmingly favored the trout niche over nonsalmonid niches and the rainbow trout stocked in the 1888-90 period would have faced little or no competition from the native nonsalmonid fishes. What about the native cutthroat trout who had inhabited the upper Gunnison for thousands of years? Wouldn't an abundant, established cutthroat population limit the success of the early rainbow introductions by competition and predation? I believe they would have (until hybridization would have gradually eliminated them) but I suspect that by 1888, the native cutthroat trout in the upper Gunnison was severely overexploited with their abundance reduced to a very low level, essentially leaving an open niche to be filled by rainbow trout.

Wiltzius (1985) cites rampant poaching of trout by market fishermen, the use of trout to feed mining camps and as an important food source of early settlers during the nineteenth century. There was little enforcement of fish protection laws.

The cutthroat trout is the most vulnerable species of trout to angling -- it is the easiest caught, or "dumbest" of all trouts. From 1881, anglers from the Denver and Pueblo area had easy access to the upper Gunnison. The railroad paralleled the upper Gunnison into the upper Black Canyon, emerging at Cimmaron, to Montrose and Delta and again paralleling the Gunnison to Grand Junction (by 1883 to Salt Lake City). The Denver and Rio

Grande widely advertised this beautiful route to the Black Canyon. Many hotels catering to sportsmen sprang up along the [redacted]ius cites an 1885 specialty at the railroad dining stop at Cimarron -- fresh caught trout from the Gunnison (native cutthroat trout).

Thus, by 1888, I suspect that cutthroat trout were quite rare in the upper Gunnison and the stage was set for their largely vacant niche to be filled by rainbow trout. Wiltzius (1985) cites a record of a 12 lb. 3 oz. "blackspotted" (common name used for cutthroat) trout caught in the Gunnison near the mouth of Cebolla Creek in 1894 (which is larger than the largest recorded angler caught rainbow of 12 lbs. caught in 1897). This was probably one of the last native trout of the upper Gunnison, born before rainbow introductions and which had, up to that time, avoided anglers and poachers.

By the early 1930's, virtually all of the spawning tributaries, mentioned above, were so badly degraded from irrigation practices and livestock grazing that trout from the Gunnison River (rainbow and brown trout) could no longer use them. In 1934, all spawning of rainbow trout was observed only in the main Gunnison River. Evidently, this loss of much of the reproductive environment limited the abundance of wild trout in the upper Gunnison. Despite the upper Gunnison's reputation as the "world's best trout stream", it is clear from the data presented by Wiltzius (1978) that during the 1950's and 60's, the total angler catch and catch per hour of trout were directly correlated with the number of catchable-size hatchery rainbow trout stocked in the upper Gunnison. The recruitment of wild trout had been greatly impaired due to loss of tributary stream spawning. Eventually, brown trout became the dominant wild trout of Taylor, East, and upper Gunnison (rainbow trout increase toward Blue Mesa Reservoir) rivers. The East, Taylor, and Gunnison river fisheries are supplemented by the stocking of hatchery rainbow trout.

NATIVE TROUT RESTORATION

The time seems appropriate for a determined, cooperative effort for native trout restoration by state (DOW) and federal (NPS, USFS, BLM) agencies responsible for land management in the upper Gunnison drainage. Ongoing state-federal cooperative restoration projects for Colorado River cutthroat trout provide an infrastructure to expand the program (communication and information from Sherman Hebein, DOW, to Ed Wick [NPS], March 30, 1993 and personal communication with Hebein, June 22 as elaborated below). I would recommend, from a conservation of biodiversity point of view, that for future restoration of pleuriticus in the Gunnison drainage, pure populations of cutthroat trout, native to the Gunnison drainage be used for the introductions. As previously mentioned, spotting patterns and other taxonomic characters of pleuriticus vary among different areas of the upper Colorado basin. Recent introductions for pleuriticus restoration, such as West Beaver Creek in 1992 (drains via Beaver Creek through NPS recreation area to Gunnison R. east of Blue Mesa Reservoir), came from eggs taken at Bench Lake, RMNP. Bench Lake contains a pure population of Trappers Lake pleuriticus which, originally were stocked in Williamson Lakes, California in 1931 from Trappers Lake. In 1987, 194 trout from Williamson Lakes were brought to Colorado and stocked in Bench Lake to maintain a pure population of Trappers Lake pleuriticus after hybridization with rainbow trout impaired the purity of Trappers Lake cutthroat. Trappers Lake is at the head of the White River, tributary to the Green River division of the upper Colorado basin. If pure populations of pleuriticus native to the Gunnison drainage can be documented, they should receive the highest priority for transplants into restoration streams in the drainage. A site on Beaver Creek had been scheduled for barrier construction and chemical treatment in July, 1993 (delay expected according the Mr. Hebein) in preparation for native trout introduction. Recently, Mr. Hebein and Daryl Jennings (NPS) examined potential barrier site on East Elk Creek for

consideration of pleuriticus introduction. A problem with East Elk Creek concerns a massive network of beaver ponds (filled with brook trout) which would make it very difficult to obtain a complete fish kill from chemical treatment. Mr. Hebein supplied copies of DOW surveys of many tributary streams in the upper Gunnison drainage and the HDR (1978) report contains data on most streams tributary to the upper Gunnison, Blue Mesa, Morrow Point, and Crystal reservoirs. It should be possible to find additional sites for native trout restoration. Of particular interest in this respect, Mr. Hebein mentioned a series of nine small reservoirs on Young's Creek, now containing brook trout, which he would like to use for native trout restoration. Young's Creek is in the Gunnison drainage (Tongue-Surface Creek) on the Grand Mesa.

In regards to the occurrence of pure populations of native trout in the Gunnison drainage, they are very rare, but I (and Mr. Hebein) can offer a few rays of hope. I searched my records of pleuriticus occurrence in the upper Colorado basin and found no sites in the Gunnison drainage. In 1992, however, Mr. Hebein collected 10 specimens of cutthroat trout from Second Creek, a small headwater tributary to the Smith Fork of the Gunnison. These specimens were sent to C.S.U. and examined by grad student Don Proebstel and me. We agree that they probably represent a pure population of pleuriticus. The spotting pattern is highly uniform (hybrid influence results in "unstable", highly variable spotting pattern) and the taxonomic characters are typical of pleuriticus except that basibranchial teeth were not found in two of the 10 specimens. Typically, the absence of basibranchial teeth in cutthroat trout indicates a hybrid influence with rainbow trout but it is not unusual, especially in small, isolated populations, for basibranchial teeth to be lacking in some pure cutthroat trout. Second Creek appears to be a valid source of native Gunnison pleuriticus for restoration.

Mr. Hebein also told me he discovered another population of cutthroat trout in Road Beaver Creek, a tributary to Cebolla

Creek at Rudolph Hill (south of Powderhorn). Road Beaver Creek trout have not been examined. If a collection can be made this summer and sent to C.S.U., we can make a diagnosis of purity.

The above discussion on native trout restoration pertains to restoration in small, isolated sites. Considering the present environmental conditions and the nonnative trout species of the upper Gunnison, its tributaries, and tributaries to Blue Mesa, Morrow Point, and Crystal reservoirs, attempts to restore native trout on a large scale in any of these waters is not feasible.

What is feasible, however, is the stocking of native trout in reservoirs to gain public acceptance and appreciation for preservation (and utilization) of a rare and beautiful part of native biodiversity. Wiltzius (1978) recommended that "cutthroat trout" be stocked in Morrow Point Reservoir because of the cold temperature regime to which cutthroat are well-adapted. Mr. Hebein told me he stocked about 30,000 Trappers Lake finger- (I assume these came directly from Trappers Lake) into Morrow Point Reservoir five years ago. Subsequent responses from anglers indicate the Trappers Lake cutthroat did well in Morrow Point. Enthusiastic tales of large, beautiful cutthroat exhibiting fine fighting ability led to requests for additional stocking of cutthroat in Morrow Point Reservoir. A problem is that Morrow Point Reservoir receives only about 16,000 angler hours per year of angler-use (due to difficulty of access). With such low angler use, it has low priority for the stocking of hatchery fish. If this problem can be resolved, I would recommend that a significant sport fishery for pleuriticus be created in Morrow Point Reservoir. Because no natural reproduction and recruitment from the stocked fish is expected, the only genetic concerns regarding the source of pleuriticus to be stocked is that they be "preadapted" to thrive in Morrow Point Reservoir. Trappers Lake cutthroat (even if slightly hybridized) is the only pleuriticus that evolved in a relatively large, deep, cold lake for thousands of generations -- and this is likely

reflected in the promising results of the recent stocking in Morrow Point.

Several years ago, I identified a pure population of pleuriticus in Nanita Lake, RMNP. This population was introduced at some unknown time from an unknown source population. The Nanita Lake cutthroat are not derived solely from Trappers Lake cutthroat, which can be identified on the number and morphology of their gillrakers and on basibranchial teeth number. I concluded that the Nanita Lake cutthroat most probably came, in part, from the "Grand Mesa Lakes". The Grand Mesa Lakes are tributary to the Tongue-Surface Creek drainage of the Gunnison (northeast of Delta) and (with Trappers Lake) provided the overwhelming majority of Colorado River cutthroat trout propagated in hatcheries in Colorado from 1898 through the 1930's (one of the Grand Mesa Lakes also was reputed to contain the now extinct yellowfin cutthroat, O. c. macdonaldi [Behnke 1992]).

In 1991, the Colorado Division of Wildlife began propagation of the Nanita Lake cutthroat. The Nanita Lake cutthroat, although probably not as "preadapted" to conditions in Morrow Point Reservoir as Trappers Lake fish, should be considered, along with Trappers Lake cutthroat, for stocking in the reservoir.

In view of the high probability that the Nanita Lake cutthroat represents, at least, in part, the cutthroat trout native to the Grand Mesa Lakes of the Gunnison drainage, and if the Young's Creek reservoirs are rehabilitated for native trout restoration, Nanita Lake fish could be stocked. The mature cutthroat trout in Nanita Lake (with an abundant crustacean fauna - particularly a bright red Diaptomus copepod) is a truly magnificent fish. With circulation of this report to parties (NPS, USFS, USFWS, BLM, DOW) interested in the restoration of native cutthroat trout in the Gunnison drainage, agency representatives should be invited to a meeting (NPS headquarters, Gunnison) to bring together all information and ideas to discuss how restoration can be accelerated and expanded. Potential introduction sites, potential source

contains a proportion of the genotype of

populations, and the possibility-probability of creating a significant fishery for pleuriticus in Morrow Point Reservoir.

LITERATURE CITED

Behnke, R. J. 1992. Native trout of western North America. Am. Fish. Soc. Monogr. 6.

HDR Engineering Inc. 1988. Feasibility study for upper Gunnison-Uncompaghre basin: Recreation and environmental enhancement opportunities. Submitted to: Colo. Water Resources and Power Develop. Auth.

Jordan, D. S. 1891. Report of explorations in Colorado and Utah during the summer of 1889, with an account of the fishes found in each of the river basins examined. Bull. U.S. Fish Comm. 9:1-40.

Wiltzius, W. J. 1978. Some factors historically affecting the distribution and abundance of fishes of the Gunnison River. Final Rep. to Bur. Rec., Fishery Investigations of the lower Gunnison River drainage. Colo. Div. Wildlife.

Wiltzius, W. J. 1985. Fish culture and stocking in Colorado, 1872-1978. Colo. Div. Wildlife Div. Rep. 12.

ADDENDA

Some items peripheral to the report, but of interest and importance for future discussion and planning are included in this addenda and attachments.

Don Proebstel, with communications from Mary McAfee (DOW, Grand Junction) told me it was doubtful that any eggs have yet been taken from Bench Lake, RMNP, of Trappers Lake cutthroat trout, as reported to me by Sherman Hebein. ~~This~~ The fish stocked in West Beaver Creek in 1992 for native cutthroat restoration most likely were from Nanita Lake (evidently, DOW considers both Bench Lake and Nanita Lake to hold pure Trappers Lake cutthroat). Attachments one and two are copies of reports concerning identification of cutthroat trout from RMNP describing the original discovery and analysis of Nanita Lake trout. I concluded that Nanita Lake ~~had~~ has pure pleuriticus but not pure Trappers Lake pleuriticus (based mainly on degree of basibranchial teeth development). Most probably, all or most of the non-Trappers Lake pleuriticus ancestry in Nanita Lake came from the Grand Mesa Lakes (Gunnison drainage) because this was the major source of pleuriticus propagated in Colorado at various periods from 1899 to about 1940 (up to about one million -- some years more -- eggs were taken at Trappers Lake annually, but two to three million, or more, eggs were taken from Grand Mesa Lakes (other lakes such as Grand, Sweetwater, Freeman, and Black were also used for Colorado cutthroat propagation in some years). By 1914 some lakes "high on the Grand Mesa" were stocked with Yellowstone cutthroat probably mixed with Rio Grande cutthroat from Bert Hosselkus' hatchery at Creede. Brook trout and rainbow trout were also stocked in some of the Grand Mesa Lakes. It is also possible, but never verified, that yellowfin cutthroat from Twin Lakes were stocked (about 1885 if true). By the 1920's, into 1930's, records of trout propagation on the Grand Mesa Lakes (ca. 1890's-1910-1915) were of pure, Gunnison River drainage pleuriticus. Much of the early stocking of trout by individuals and by sportsmen clubs was unrecorded, such as described for RMNP.

omission

In any event, the Nanita Lake fish probably contain some of the original Gunnison drainage pleuriticus genotype, mixed with Trappers Lake pleuriticus genes, and they have been completely under natural selection in their native and introduced environments. They would be well-suited for a Grand Mesa restoration project such as the Young's Creek reservoirs (and/or Morrow Point Reservoir).

In regards to any native trout restoration program where hatchery propagation is used, there will be a temptation to "improve on nature" and expedite the program by developing a hatchery brood stock. Conscious or inadvertent selection for artificial environments, food, behavior, etc. will certainly occur. Hereditary changes from natural selection (where survival under natural conditions is the bottom line) toward selection for domestication is unavoidable. Such genetic alteration is contrary to the goals of restoration and should be taken in to account in regards to the role of hatchery propagation.

Attachments three and four concern some interesting history on the Grand Mesa lakes and trout propagation. Attachment five includes photos of yellowfin trout and a great catch of Gunnison River rainbow trout. Attachment six is illustration of pleuriticus (based on upper Green River form and distribution map). Attachment seven provides details of native and nonnative fishes of upper Colorado basin.

RESTORATION POTENTIAL FOR NATIVE CUTTHROAT TROUT IN THE GUNNISON DRAINAGE: SUMMARY OF OCTOBER 22 MEETING

ABSTRACT

Two types of restoration are discussed: a high profile reservoir fishery and self-sustaining refuge populations best representing the genome of the Gunnison form of pleuriticus. Organization that coordinates efforts of agencies and private groups will be necessary for success.

Reservoir Fishery

Morrow Point Reservoir holds promise to produce trophy cutthroat trout from fingerling stocking; a fishery that could gain considerable renown well beyond the local area. Because a self-sustaining population is not a feasible goal in Morrow Point, the parental source of pleuriticus for stocking is not a major consideration. Colorado DOW uses both Trappers Lake and Nanita Lake stocks in their hatchery program. Rainbow x cutthroat hybrids have been documented in Trappers Lake for many years and although sight-selection of spawners is made during egg-taking operations, it is assumed that present Trappers Lake cutthroat are not pure. Nanita Lake, in Rocky Mountain National Park, holds a population of pure Colorado River cutthroat trout, probably derived from a mixture of parents from Tappers Lake and lakes on the Grand Mesa stocked many years ago. Since the trout stocked into Morrow Point will not perpetuate themselves through natural reproduction, Trappers Lake and/or Nanita Lake trout could be stocked. If both forms were stocked and marked, valuable fisheries management performance data could be obtained. There may be a problem concerning hatchery production of large numbers of cutthroat and their availability for stocking in Morrow Point. About 25,000 to 30,000 fingerlings (2-3 inches) should be stocked annually or, perhaps, on alternate years, to sustain a sport fishery in a reservoir the size of Morrow Point (817 surface acres, 117,000 acre

feet volume at normal pool). If DOW hatcheries might have difficulties in supplying fingerling cutthroat on a reliable basis, the possibility of maintaining a local brood stock can be considered. Almost 50,000 eggs can be obtained from about 100 pounds of spawners (50 lb. females, 50 lb. males). If no other fish are present, biomass of cutthroat trout can be expected to range from about 10 lbs. per surface acre in ponds of low productivity to about 100 lbs./acre in highly productive ponds. That is, a relatively small brood stock pond could serve the purpose of providing eggs for reservoir stocking (and, perhaps, eventually provide surpluses to evaluate native cutthroat performance in Blue Mesa Reservoir).

Possible brood stock sites might be one of the renovated Young's Creek ponds (discussed in previous report) or a private pond with a cooperative landowner in the area. Bruce Rosenlund (USFWS, Greenback Recovery Team) has established broodstocks of greenback cutthroat trout in a small private pond and a small pond on the Fort Carson army base. Bryce Nielsen (Utah Dept. Wildlife Resources) has established the original Pyramid Lake strain of Lahontan cutthroat trout in a small private pond and has created additional ponds.

If space or disease problems arise in DOW hatcheries, the feasibility and economics of contracting with a private hatchery to hatch the eggs and raise fingerlings can be looked into.

It was emphasized that Morrow Point is a limited entry fishery, a unique type of fishing experience. Although limited to an annual maximum of a few thousand angler days, these angler days have a much greater economic value than a standard trout angler day. The beautiful Colorado River cutthroat trout is ideally suited to make these very special angler days a memorable experience.

If a Morrow Point native cutthroat trout fishery is a success, the program should expand to stock these cutthroat in Blue Mesa Reservoir to supplement the fishery for nonnative rainbow trout and kokanee. This would be an example of an ancient fish culture

method to increase total fish production, called polyculture, or in modern ecological terms, niche packing. This would also be in conformance with DOW's new long range plans to emphasize native species and could be a win-win situation demonstrating that DOW is greatly expanding the use of native fish in its sport fisheries programs.

Refuge Populations

In my previous report I pointed out that the cutthroat trout native to the Colorado River basin are all classified in the same subspecies, pleuriticus, but there is considerable geographic variability. The distribution of fishes in the basin with differential distribution of species of suckers, sculpins, and mountain whitefish between the Green River and Colorado River sections of the basin suggests that, although there is no doubt that the cutthroat trout native to the Gunnison drainage is the subspecies pleuriticus, it should not be considered identical to the pleuriticus of other sections of the basin. A more refined restoration program for the subspecies pleuriticus would emphasize maintenance of representative populations of different drainages especially where no mixing or gene flow has occurred among the drainages for probably several thousand years. With this is mind, the highest priority should be given to establish pure, native Gunnison drainage cutthroat in refugia.

An obvious problem for implementation of Gunnison pleuriticus restoration is that no pure population has been verified, but two probable candidate populations are known, Second Creek, tributary to the Smith Fork, and Road Beaver Creek, tributary to Cebolla Creek.

In my experience with restoration, the problem of "uncertainty" can greatly delay implementation of a program. Pending verification of purity, there might be possibilities to transplant some fish from Second Creek and/or Road Beaver Creek into ponds (if, for example, private ponds are offered as brood stock ponds) which could serve as temporary refugia and a source of

brood stock if these populations might be pure and propagated in the future.

A general appeal could be made among anglers who hike the backcountry to be on the lookout for cutthroat trout populations in remote, headwater areas. If found they could be analyzed for purity. Also, alert people to be on the lookout for small headwater streams with natural barriers which would be ideal sites to serve as refugia for introduced populations. Artificial barriers can be expensive to construct and, if substantial construction is required, artificial barrier sites would be close to access road (for heavy equipment). A problem with a restoration site near ready angler access is that after all fish are eliminated above a barrier, it takes some years for the introduced cutthroat trout to increase in abundance near the carrying capacity of the stream. In the meantime, an angler fishing and catching trout in a stream below a barrier and finding no fish above the barrier, might consider it a good deed to transplant some below barrier fish above the barrier.

Needle Creek Reservoir was mentioned as an example of an ideal restoration site. A small reservoir with natural reproduction which currently supports a "grade B" cutthroat population. I have not seen these cutthroat trout nor the data on which their classification as "slightly hybridized" is based, but any self-sustaining population which resembles native cutthroat trout, should not be destroyed. Are there waters similar to Needle Creek Reservoir with nonnative trout? If such a pond or reservoir now contains a population of stunted brook trout, their elimination and replacement by native cutthroat trout would create a superior fishery with larger trout and also conform to contemporary DOW policy.

Organizational-Administrative Aspects

At the meeting I discussed an article from the April 2, issue of Science magazine concerning uncertainty in conservation issues. Although the subject matter of the article does not concern restoration programs, the list of "principles of effective

management" have a basic commonality applicable to all conservation programs. These principles are especially meaningful in regards to keeping a program on track and continually making progress towards fulfillment of a goal. My modification and interpretation of the five principles are as follows.

1. Understand human motivation--self interest, group interest, special interest points of view. The top federal agency people have enunciated new goals, missions, visions, and mandates for natural resource management, protection and stewardship (ecosystem management, ecosystem integrity, enhancement of biodiversity, etc.). The Colorado Division of Wildlife recently released a draft of its new long range plan which appears to agree with the new direction of the federal agencies. These new directions, however, emanate from the "top down". At the local and regional level, personnel, especially the more senior employees, whose careers have been associated with commodity or user goals, may be reluctant to embrace new goals. This point leads to the second principle (2) of consensus. We should not expect complete consensus on all matters where different viewpoints may conflict. For example, there will likely be some opposition to the eradication of nonnative trout to restore native trout. A person with "Solomon-like" wisdom and leadership would be a most useful member of a recovery organization to resolve potential conflicts before an issue becomes polarized.

3. Rely on scientists to recognize or identify problems but not to solve them. 4. Distrust claims ... That research (in some unspecified way) will solve all problems, and 5. Confront uncertainty.

I group the last three principles together to illustrate common problems I have noticed in programs to recover endangered species or to restore native species, which can be expressed as: "When in doubt, research". This mindset can result in wheel-spinning delays and failure. Most people commonly use what I call the appeal to authority (a "scientist") to answer a question or settle a matter of proof or certainty. It can be a delusion to

believe that doing something ("research") is better than doing nothing when faced with uncertainty. It is common for native trout restoration programs to fund "research" on habitat and water quality analysis, invertebrate surveys, etc. as prerequisites for restorations. Such studies can provide useful, but not essential information. Anyone with perfunctory understanding of native trout biology can make a professional judgement that if all nonnative trout can be removed from a stream, their niche can be readily filled by native trout because the basic components of the niche as they relate to habitat, reproduction, feeding, etc. are sufficiently similar.

The question of certainty of purity is common to most restoration projects. Modern genetic techniques can provide powerful evidence on "genetic purity" and a decision on pure pleuriticus might be made with reasonable certainty, but do not expect "scientific proof" of certainty to identify pure Gunnison pleuriticus. Such an identification would rely more on circumstantial evidence. If a population in the Gunnison drainage appears to be pure pleuriticus and its degree of isolation would indicate that the population has never been contaminated by stocked trout, move ahead with the program.

Other Fishes

The peculiar distribution of sculpins in the Gunnison drainage was discussed in the previous report. Only the mottled sculpin, Cottus bairdi, is known from the Gunnison, whereas only the Pauite sculpin, C. beldingi is known from the Eagle River and upstream in the Colorado River system. It would be useful, while conducting stream surveys, etc. in the future to obtain a better understanding of sculpin distribution in the drainage and investigate the possible occurrence of Paiute sculpin.

The Colorado Division of Wildlife recently published (Sept. 1993) "Historical accounts of upper Colorado River basin endangered fishes" authored by Fred Quartarone. Accounts of the present endangered fishes were recalled by "old timers". Among the

accounts are stories about squawfish and razorback suckers and in the Gunnison River around Delta.

Enclosures

The enclosures accompanying their report are not intended to be duplicated and circulated with the report but they can be filed for review by those interested. The enclosures relate to the following matters.

1. Clippings from outdoor columns in Denver Post and Rocky Mountain News. It is obvious that the writers have a highly negative perception of DOW's new long range plan. The fear is that funds from hunting and fishing licenses will be lavishly used to benefit people who don't buy licenses and that somehow the new emphasis on nongame species and ecosystems will negatively impact hunters and anglers. There is a problem when translating highly generalized and vague goals or missions into implementation of specific actions and anyone can make their own interpretation reflecting personal bias. Restoration of native cutthroat trout, while conforming to the new mission, also can provide unique opportunities, enriching and diversifying the angling experience not available with nonnative trout. As such it can be sold as a win-win program.

2. Announcement of Modoc, California, chapter of Trout Unlimited with mention of the TU-USFWS-BLM agreement in regards to "Bring back the natives" program funded by the National Fish and Wildlife Foundation. In regards to funding of restoration efforts, the Lake City T.U. chapter, perhaps in cooperation with Gunnison chapter, can apply for funds. Enclosure 3 is an example.

3. Copy of T.U. chapter application (to National T.U.) to help fund barrier construction for native Colorado River cutthroat trout in a tributary to the Green River, Wyoming. Note that a T.U. chapter in Illinois is the applicant (there aren't many T.U. members in Pinedale area). Don Duff has been the liaison between the USFWS and T.U. Don has been very active in native trout restoration programs and I believe this and several other applications relating to native trout restoration, protection, and

enhancement were put together by him. As a scientific advisor to T.U., I review and rate funding applications each year. I give highest ratings to native trout projects.

4. Copy of letter to Bryce Nielsen regarding preservation of Pyramid Lake form of Lahontan cutthroat trout and reference to the article in Science magazine using the "certainty principle" to explain delays and inactions of native trout restoration.

5. Reprint from 1974 Trans. Am. Fish. Soc. Twenty years ago, with a graduate research project, I attempted to demonstrate the practical values of cutthroat trout for fisheries management, explained in terms of polyculture or niche packing. If it was read it wasn't understood, if it was understood, the concept was never implemented. The new goals and missions of DOW should be more conducive to applications of the ideas brought out in this paper. It's underlying intent is to promote appreciation of native trout.

Gunnison River Research Bibliography (Draft)
Subject Bibliography, Not Restricted to Gunnison River System

Table of Contents

Water: Supply, Quality, Law, Hydrology (1)

Ecology/Biology/Environmental Studies (13)

Resources Management/Environmental Impact Statement/Environmental Assessment (23)

Fisheries Biology (26)

Geology/Geomorphology/Soils (33)

Mapping/Photo Documentation (40)

Recreation/Economics (41)

Cultural Resources/History (44)

Organization of the Bibliography

Reviewers of this draft are encouraged to comment on its organization. The Gunnison River Research Bibliography has been constructed using Pro-cite software for IBM computer systems. Bibliographic entries in this Pro-cite database include key descriptive words which can be used to organize the entries (records) in different ways. A bibliography focusing only on the Gunnison River region can be generated from the database with ease. Bibliographies on specific subject areas, authors and time periods can be created using the search features of Pro-Cite. This draft version includes research from the Upper Colorado River Basin and related research from other regions.

Gunnison River Research Bibliography (Draft)

Water: Supply, Quality, Law, Hydrology

Ackerman, D. J.; and T. Brooks. Reconnaissance of ground-water resources in the North Fork Gunnison River Basin, southwestern Colorado. Denver, Colorado: U. S. Dept. of the Interior, U. S. Geological Survey; 1986; 85-4230. 21 pp. U. S. Geological Survey, Books and Open-File Reports, distributor.

Administration of water quality and water quantity in Colorado. Colorado Water. 1992 Apr; 12.

Anderson, T., ed. Water rights: scarce resource allocation, bureaucracy, and the environment. ; 1983. 348 pp.

Andrews, E. D. (United States Geological Survey, Boulder Laboratory, MS 458, Box 25046, Federal Center, Denver CO 80225; 303-541-3002). Design of maintenance flows for regulated streams. American Geophysical Union; 1992 Dec.

--------. Effective and bankfull discharge of streams in the Yampa River basin, Colorado and Wyoming. Hydrology. 1980; 46: 311-330.

Archuleta, A. S.; R. Krueger; L. DeWeese; and B. Osmundson. Occurrence of inorganic elements in the Upper Colorado River Basin and implications for threatened and endangered fish. Colorado Field Office: U. S. Fish and Wildlife, Environmental Contaminants Final Report (in preparation); 1993.

Ashton, G. D. Analysis of potential icing problems in the Gunnison River -- based on a series of analyses. Houston, Texas: EMANCO, Inc., unpublished report; 1988. 11 pp.

--------. Effect of diversions of flows of Gunnison River on ice extent downstream. Houston, Texas: EMANCO, Inc., unpublished report; 1987. 6 pp.

August, M. H.; et al. Hydrologic and climatic data bases used to assess potential effects of climate change on water resources of American River, Carson River, and Truckee River Basins, California-Nevada, and of Gunnison River Basin, Colorado. U. S. Geological Survey Open File Report 92-627: U.S.G.S.; 1992. 72 pp.

Baker, W. L. Climatic and hydrology effects on the regeneration of Populus angustifolia James along the Animas River, Colorado. Journal of Biogeography. 1990 Jan 1; 17(1): 59.

Beaumont, P.; and T. M. Oberlander. Observations on stream discharge and competence at Mosaic Canyon, Death Valley, California. Geological Society of America Bulletin. 1971; 82(6).

Behnke, R. J. Potential impacts of reduced winter flows in Gunnison River on trout reproduction and growth in relation to lower temperatures and ice formation. Fort Collins, Colorado: Colorado State University, Department of Fishery and Wildlife Biology; 1986.

Beidleman, R. G. Administrative history of the Black Canyon of the Gunnison National Monument. Rocky Mountain Regional Office: National Park Service; ? 234 pp.

--------. The Gunnison River diversion project. Colorado Magazine: The State Historical Society of Colorado. 1959; 36(3): 187-201 and 266-285.

Bell, D. C.; and N. K. Johnson. State water laws and federal water uses: the history of conflict, the prospects for accommodation. Environmental Law. 1990 Sep;

Black Canyon of the Gunnison, description of hypothetical flow regimes of the Gunnison River below Gunnison Tunnel for departure analysis. 3 pp.

Black Canyon summary of Judge Brown ruling (Colorado water court) on the Arapahoe water case from the finds of fact, conclusions of law, and judgement and decree dated October 21, 1991.

Booker, J. F.; and R. A. Young. Economic impacts of alternative water allocation institutions in the Colorado River Basin. Completion report. 1991 Aug 1; (161).

Bradley, W. C.; and A. I. Mears. Calculations of flows needed to transport coarse fraction of Boulder Creek alluvium at Boulder, Colorado. Geological Soceity of America Bulletin. 1980 Mar; 91(Part 2): 1057-1090.

Bridge, J. S.; and J. Jarvis. Velocity profiles and bed shear stress over various bed configurations in a river bend. Earth Surface Processes. 1977; 2: 281-294.

Brooks, T.; and D. J. Ackerman. Reconnaissance of ground water resources in the lower Gunnison River basin, southwestern Colorado. U.S. Geological Survey, Water Resources Investigation Report: prepared in cooperation with the Colorado Department of Natural Resources, Division of Water Resources; 1985; 84-4185. 30 pp.

Brown, T. C.; B. L. Harding; and E. A. Payton. Marginal economic value of streamflow: a case study for the Colorado River Basin. Water Resources Research. 1990 Dec 1; 26(12): 2845.

Bruce, C. A. History of federal reclamation and its accomplishments on the Uncompahgre Project, Colorado. Gunnison, Colorado: Western State College (thesis); 1933.

Bureau of Land Management, U.S.D.I. Project plan: Gunnison Gorge instream flow assessment, Uncompahgre Basin Resource Area, Colorado. Montrose, Colorado: B.L.M., U.S.D.I.; 1992 Aug. 17 pp.

Bureau of Reclamation, U.S.D.I. Blue Mesa Dam and Powerplant. Denver, Colorado: U. S. Bureau of Reclamation; 1975. 426 pp.

--------. Bostwick Park project: Colorado, Montrose and Gunnison counties. Washington, D. C. (?): Bureau of Reclamation; 1982.

--------. Colorado River Storage Project and participating Projects, Upper Colorado River Basin. Upper Colorado Region: Bureau of Reclamation; 1950.

--------. Crystal dam, reservoir, and power plant, Curecanti unit, Colorado River storage project (draft environmental impact statement). Upper Colorado Region: Bureau of Reclamation; 1971. 32 pp.

--------. Draft environmental assessment Uncompahgre Valley hydropower project. Upper Colorado Region: Bureau of Reclamation; 1988.

--------. Draft environmental impact statement, AB Lateral Hydropower Facility, Uncompahgre Valley Hydropower Project. Upper Colorado Region, Bureau of Rec.: In cooperation with the National Park Service and Bureau of Land Management; 1989. 232 pp.

--------. Lower Gunnison Basin Unit feasibility report/final environmental statement/Colorado River Water Quality Improvement Program. Salt Lake City, Utah (?): Upper Colorado Region, Bureau of Rec., prepared in cooperation with U. S. Fish and Wildlife Service; 1984.

--------. Lower Gunnison Basin unit (winter water): preconstruction report. Upper Colorado Region: Bureau of Rec.; 1987.

--------. Paonia project: Colorado, Delta and Gunnison counties. Washington, D. C. (?): Bureau of Rec., Upper Colorado region; 1983. 8 pp.

--------. Proposed contract to deliver water from the Wayne N. Aspinall Unit of the Black Canyon of the Gunnison National Monument. Grand Junction, Colorado: Bureau of Reclamation, National Park Service, Bureau of Land Management and Colorado Water Conservation Board; 1992. 21 pp.

--------. Wayne N. Aspinall storage unit. Washington, D. C. (?): Bureau of Reclamation; 1989. 10 pp.

Burgi, P. H. Winter ice jams on the Gunnison River. Denver, Colorado: U.S. Bureau of Reclmation, Engineering and Research Center, Division of Research, Hydraulics Branch; 1979; REC-ERC- 79-4. 30 pp.

Burkhard, W. T. Taylor River flows, Upper Gunnison River investigations. ; Federal Aid Project F-51-R.

Burkhard, W. T.; and R. D. Sherman. Upper Gunnison River investigations. ; Federal Aid Project F-51-R.

Butler, D. L.; et al. Reconnaissance investigation of water quality, bottom sediment, and biota associated with irrigation drainage in the Gunnison and Uncompahgre River basins and at Sweitzer Lake, west-central Colorado, 1988-89. Denver, Colorado: U.S.D.I., U. S. Geological Survey, Books and Open File Reports Section; prepared in cooperation with the U. S. Fish and Wildlife Service and the U. S. Bureau of Reclamation; 1991; 91-4103. 99 pp.

Butler, M. Minimum streamflow hydropgraphs and sediment transport in the Yampa River canyon reaches. Region 6 draft report: U.S. Fish and Wildlife Service; 1988.

Carrier, J. Water and the West: the Colorado River. National Geographic. 1991 Jun 1; 179(6): 2.
Increasing demand and persistent drought have drawn down the reservoirs of the Colorado River system, a critical water source for seven states and part of Mexico.

Chang, A. T. C.; J. L. Foster; and A. Rango. The role of passive microwaves in characterizing snow cover in the Colorado River Basin. GeoJournal. 1992 Mar 1; 26(3): 381.

Colborn, T. Measurement of low levels of molybdenum in the environment by using aquatic insects - Gunnison River, Gunnison County, Colorado. ; 1982.

Colby, B. R.; and C. H. Hembre. Computations of total sediment discharge, Niobrara River near Cody, Nebraska. Water Supply Paper 1357: U. S. Geological Survey; 1955.

Colorado Department of Health, Water Quality Control Commission. Classifications and numeric standards for Gunnison and Lower Dolores River Basins. Denver, Colorado: Colorado Department of Health; 1988.

Colorado Department of Natural Resources, Office of the Executive Director. The Colorado water study: directions for the future: legal studies. Denver, Colorado: Colo. Dept. of Natural Resources; 1978. 900 pp.

Colorado Public Health Service. Salinity investigation of Grand Valley and Gunnison River, 1962 report on Colorado River Basin Water Quality Control Project. Denver, Colorado: Division of Water Supply and Pollution Control; 1962. 41 pp.

Colorado State Department of Health. Classifications and numeric standards for Gunnison and Lower Dolores River Basins. Denver, Colorado: Colo. Dept of Health, Water Quality Control Commission; 1988.

Colorado Water Conservation Board. Report of Policy and Review Committee, Gunnison River Storage, to the Colorado Water Conservation Board. Denver, Colorado: Policy and Review Committee, Gunnison River Storage; 1952.

Colorado West Group. Environmental assessment for water and sewer systems, Black Canyon of the Gunnison National Monument. prepared for NPS Rocky Mountain Region; 1975.

Costa, J. E. Paleohydraulic reconstruction of flash flood peaks from boulder deposits in the Colorado Front Range. Geological Society of America Bulletin. 1983; 94: 986-1004.

Costa, J. E.; and Jarrett, R. D. Debris flows in small mountain stream channels of Colorado and their hydrologic implications. Bulletin of the Association of Engineering Geologists. 1981; 18: 309-322.

Davis, A.; and R. L. Olsen. Distribution of metals between water and entrained sediment in streams impacted by acid mine discharge, Clear Creek, Colorado U. S. A. Applied Geochemistry: Journal of the International ... 1991; 6(3): 333.

Dawdy, D. O. The Colorado doctrine and in-stream flows. Environment. 1992 Jul; 5 pp.

Dawdy, D. R. Hydrology of Glen Canyon and the Grand Canyon. In: Colorado river ecology and dam management. : National Academy Press; 1991: 40-53.

Dean, A. M. Lake water intakes under icing conditions. ; 1983.

Debano, L. F.; and L. J. Schmidt. Potential for enhancing riparian habitats in southwestern United States with watershed practices. Forest Ecology and Management. 1990 Jun 1; 33/34(1/4): 385.

Denisov, P. P. An investigation of water-power regimes in stream- flow regulation. Water resources. 1991 Nov 1; 18(6): 599.

Dolan, R.; A. Howard; and D. Trimble. Structural control of the rapids and pools of the Colorado River in the Grand Canyon. Science. 1978; 202(4363): 629-631.

Dowdy, D. R.; and V. A. Vanoni. Modeling alluvial channels. Water Resources Research. 1986; 22(9): 71S-81S.

Eckert, J. B.; and E. Wang. Effects of irrigation water supply variations on limited resource farming in Conejos County, Colorado. Water Resources Research. 1993 Feb 1; 29(2): 229.

Eckhardt, D. W.; and D. W. Litke. Estimation of reservoir surface areas using satellite imagery, Upper Gunnison River Basin, Colorado. ; 1988.

Economic Research Service, U.S.D.A. Water and related land resources, Gunnison River Basin, Colorado: a report based on a cooperative study by Colorado Water Conservation Board and United States Department of Agriculture. Salt Lake City, Utah: U.S.D.A., prepared by Economic Research Service, U. S. Forest Service, Soil Conservation Service; 1962. 103 pp.

Engineering Consultants. Floodplain information report: Gunnison River, Tomichi Creek, Gunnison, Colorado. Denver, Colorado: prepared by Engineering Consultants, Inc. for the City of Gunnison, Gunnison County, and the Colorado Water Conservation Board. 32 leaves.

Estes, M. K. The effect of the Federal Endangered Species Act on state water rights. Environmental Law. Spring 1992.

Fahnestock, R. K. Morphology and hydrology of a glacial stream - White River, Mount Rainier, Washington. Geological Survey Professional Paper 422-A; 1963. 70 pp.

Federal Emergency Management Agency. Flood insurance study: Gunnison County, Colorado, unincorporated areas, Community number 080078. Washington, D. C. (?): Federal Emergency Management Agency; 1989. 13 pp.

Federal Water Pollution Control Administration. A report on pollution of the Upper Colorado River basin. Cincinnati, Ohio: Federal Water Pollution Control Administration, Technical Advisory and Investigations Branch; 1969; PR-16. 82 pp.

Florsheim, J. L.; P. Goodwin; and Y. Rubin (Philip Williams & Associates, Ltd., Pier 35 The Embarcadero, S.F., CA 94133, and Dept. of Civil Eng., U. C., Berkley CA 94720). Historic changes in geomorphic and hydrologic processes in the Russian River, California. In managing regulated streams poster session. American Geophysical Union; 1992 Dec.

Flug, M.; W. R. Walker; and G. V. Skogerboe. Energy-water- salinity: Upper Colorado River Basin. Journal of Water Resources Planning and Management Division, ASCE, Proc. Paper 14844. 1979; 105(WR2): 305-315.

--------. Optimal water use and salinity control for energy - Upper Colorado River Basin. Water Resources Bulletin. 1979; 15(4): 964-973.

Foote, W. E., ed. A technical presentation of Morrow Point Dam and powerplant foundation investigation: Colorado River Storage Project, Colorado. Denver, Colorado: Dept. of the Interior; 1965. 190 pp.

Gellis, A.; R. Hereford; and S. A. Schumm. Channel evolution and hydrologic variations in the Colorado River basin: factors influencing sediment and salt loads. Journal of hydrology. 1991 May 1; 124(3): 317.

General Accounting Office. Improvements needed in the Corps of Engineers' regulatory program for protecting the nation's waters. Wash., D.C.: G.A.O.; 1977; CED-78-17. 16 pp.

Gomez, B.; and M. Church. An assessment of bed load sediment transport formulae for gravel bed rivers. Water Resources Research. 1989; 25(6): 1161-1186.

Graf, W. L. The effect of dam closure on downstream rapids. Water Resources Research. 1980; 16(1): 129-136.

--------. Fluvial adjustments to the spread of tamarisk in the Colorado Plateau region. Geological Society of America Bulletin. 1978; 89: 1491-1501.

--------. Rapids in canyon rivers. Journal of Geology. 1979; 87: 533-551.

Grand Valley on-farm programs protect Colorado River from salt. Irrigation Journal. 1991 Sep 1; 41(6): 8.
Over-irrigation and seepage from canals in the Grand Valley contribute more than 600,000 tons of salt annually to the Colorado River. On-farm programs developed by the SCA and the ARS are reducing the salt load.

Gray, J. R.; and G. G. Fisk. Monitoring radionuclide and suspended-sediment trasport in the Little Colorado River basin, Arizona and New Mexico, USA. IAHS publication. 1992; (210): 505.

Gunnison County Board of County Commissioners. Gunnison County land use resolution. Gunnison, Colorado: Gunnison County Board of County Commissioners; 1983.

Gunnison River Storage Policy and Review Committee. Report of Policy and Review Committee, Gunnison River Storage to the Colorado Water Conservation Board. 1952.

Guy, D. J. When the law dulls the edge of chance: transferring Upper Basin water to the Lower Colorado River Basin. Utah Law Review. 1991; 1991(1): 25.

Hardinger, H. W. Report on the Crystal River District of Gunnison County, Colorado. Denver, Colorado; 1900. 17 leaves.

HDR Engineering, Inc. AB Lateral Unit water supply study. Omaha, Nebraska: HDR Engineering, Inc., unpublished report; 1988.

--------. Phase I feasibility study for Upper Gunnison- Uncompahgre Basin, task memorandum no. 5, development and calibration of basin model comparison of existing supplies with future in-basin demands. HDR Engineering, Inc.; 1988.

--------. Upper Gunnison-Uncompahgre Basin: phase I feasibility study: final report. Denver, Colorado: prepared by HDR Engineering in association with WBLA, Inc. et al; 1989.

--------. Upper Gunnison-Uncompahgre Basin: phase I feasibility study: final report-appendicies. Denver, Colorado: prepared by HDR, Inc.; 1989.

Herron, W. H. Profile surveys in the Colorado River basin in Wyoming, Utah, Colorado, and New Mexico. U.S. Geological Survey Water-Supply Paper 396: U.S.G.S.; 1917. 6 pp. plus 43 plates.

Hobbs Jr., G.; and B. W. Raley. Water rights protection in water quality law. Univeristy of Colorado Law Review. 1989; 60(4): 841.

Holden, P. B. The relationship between flows in the Yampa River and success of rare fish populations in the Green River system. Logan, Utah: Bio/West, Inc.; 1980; Report PR-31-1. 39 pp.

Holden, P. B.; and L. W. Crist. Documentation of changes in the macroinvertebrate and fish populations in the Green River system. Logan, Utah: Bio/West Inc.; 1980; Report PR-16-5. 92 pp.

--------. Documentation of changes in the macroinvertebrate and fish populations in the Green River due to inlet modification of Flaming Gorge Dam. Logan, Utah: Bio/West Inc.; 1981; Report PR- 16-5. 92 pp.

Howe, C. W.; J. K. Lazo; and K. R. Weber. The economic impacts of agriculture-to-urban water transfers on the area of origin: a casy study of the Arkansas River Valley in Colorado. American Journal of Agricultural Economics. 1990 Dec 1; 72(5): 1200.

Hubbell, D. W.; and D. Q. Matejka. Investigations of sediment transportation, Middle Loup River at Dunning, Nebraska. Geological Water-Supply Paper 1476; 1959.

Hupp, C. R. Plant ecological aspects of flood geomorphology and paleoflood history. In: Baker, V. R.; R. K. Kochel; and P. C. Patton, eds. Flood Geomorphology. Published by Wiley; 1988.

Iorns, W. V.; C. H. Henbree; and G. L. Oakland. Water resources of the Upper Colorado River Basin - technical report - introduction and summary. U. S. Geological Survey: U.S.D.I.; 1965; Professional Paper 441-A. 370 pp.

Josberger, E. G.; and E. Beauvillain. Snow cover of the Upper Colorado River Basin from satellite passive Microwave and visual imagery. Nordic hydrology. 1989; 20(2): 73.

Kaeding, L. R.; and D. B. Osmundson. Biologically defensible flow recommendations for the maintenance and enhancement of Colorado squawfish habitat in the '15-mile' reach of the Upper Colorado River during July, August and September. Grand Junction, Colorado: U. S. Fish and Wildlife Service, U.S.D.I.; 1989. 169 pp.

Karr, J. R.; and I. J. Schlosser. Water resources and the land- water interface. Science. 1978; 201: 229-234.

Kaweeka, B. The effect of flood-control regulation of a montane stream on the communities of sessile algae. Acta hydrobiologica. 1990; 32(3 / 4): 345.

Kircher, J. E.; R. S. Dinicola; and R. M. Middleburg. Trend analysis of salt load and evaluation of the frequency of water quality measurements for the Gunnison, the Colorado, and Dolores rivers in Colorado and Utah. Water-Resources Investigations: U.S. Geological Survey; 1984; 84-4048.

Komar, P. D. Applications of grain-pivoting and sliding analyses to selective particle entrainment of gravel and to flow- competence evaluations. Sedimentology.

--------. Flow-competence evaluations of the hydraulic parameters of floods: an assessment of the technique. British Geomorphology Research. Flood Volume.

--------. Sediment transport by floods. In: Baker, V. R.; R. C. Kochel; and P. C. Patton, eds. Flood Geomorphology. Wiley; 1988.

--------. Selective gravel entrainment and the empirical evaluation of flow competence. Sedimentology. 1987; 34: 1165- 1176.

Kondolf, G. M.; and P. Wilcock (Department of Landscape Architecture, University of California, Berkeley CA 94702; 510- 642-2904, and Department of Geography and Environmental Engineering, Johns Hopkins Univeristy, Baltimore, MD 21218; 410-526-5421). The flushing flow problem. American Geophysical Union; 1992 Dec.

Kondolf, G. M.; G. F. Cada; and M. J. Sale. Assessing flushing- flow requirements for brown trout spawning gravels in steep streams. Water Resources Bulletin. 1987; 23: 127-135.

Kostaschuk, R. A.; G. M. McDonald; and P. E. Putnam. Depositional processes and alluvial fan-drainage basin morphometric relationships near Banff, Alberta, Canada. Earth Surface Processes and Landforms. 1986; 11: 471-484.

Krishna, J. H.; J. G. Arnold; and C.W. Richardson. Predicting water and sediment yields from agricultural and grassland watersheds. Modeling Agricultural, Forest, and Rangeland Hydrology, Proceedings of the 1988 International Symposium; 1988 Dec 12; Chicago, Illinois. American Society of Agricultural Engineers.

Kunkle, S.; R. Nickerson; G. Smillie; and R. Andrascik. Metal concentrations in fish at Curecanti National Recreation Area, Gunnison, Colorado. Curecanti NRA: U.S. National Park Service; 1983.

Laitos, J. G. Water quality antidegradation: the Colorado experience. Natural Resources and Environment. 1989 Mar; 4(1): 19.

Lane, L. J.; M. H. Diskin; and K. G. Renard. Input-output relationships for an ephemeral stream channel system. Journal of Hydrology. 1971; 13(1): 22-40.

Larkin, R. G.; and J. M. Sharp Jr. On the relationship between river-basin geomorphology, aquifer hydraulics, and ground-water flow direction in alluvial aquifers. The Geographical Society of America Bulletin. 1992 Dec;

Laronne, J. B.; and M. A. Carson. Interrelationships between bed morphology and bed-material transport for a small gravel-bed channel. Sedimentology. 1976; 23: 67-85.

Laursen, E. M.; and E. Silverston. Hydrology and sedimentology of the Colorado River in Grand Canyon. Grand Canyon National Park Report Series: Colorado River Research Program Technical Report No. 13; 1976.

Laursen, E. M.; S. Ince; and J. Pollack. On sediment transport through the Grand Canyon. Proceedings of the Third Federal Inter-Agency Sedimentation Conference. ; 1976: 4-76-4-87.

Lehre, A. K. Sediment budget of a small California Coast Range drainage basin near San Francisco. In: Davies, T. R. H.; and A. J. Pearce. Erosion and Sediment Transport in Pacific Rim Steeplands, proceedings of the Christchurch Symposium; 1981 Jan. : IAHS-AISH Publication No. 132.

Leopold, L. B. The rapids and the pools - Grand Canyon. Geological Survey Professional Paper 669; 1969.

Leshy, J. D. The prior appropriation doctrine of water law in the West: an emperor with few clothes. Journal of the West. 1990 Jul; 9 pp.

Libecap, G. D. Markets for federal water: subsidies, property rights, and the Bureau of Reclamation. Journal of Economic Literature. 1991 Mar;

Lindgren, D. E. The Colorado River: are new approaches possible now that the reality of overallocation is here. In: Rocky Mountain Mineral Law Institute: [proceed ... ; 1992: 25.

Lisle, T. E. Overview: channel morphology and sediment transport in steepland streams. In: Beschta, R. L. et al, eds. Erosion and Sedimentation in the Pacific Rim, Proceedings of an International Symposium at Oregon State University, Corvallis, OR; 1987 Aug 3. IAHS Publication No. 165; 1987.

Lohman, S. W. Abandonment of the Unaweep Canyon, Mesa County, Colorado, by capture of the Colorado and Gunnison Rivers. U.S.Geological Survey Research. 1961: B144-B146.

Maddux, H. R.; D. M. Kubly; J. C. deVos, Jr.; W. R. Persons; R. Staedicke; and R. L. Wright. Effects of varied flow regimes on aquatic resources of Glen and Grand Canyons; final report. Salt Lake City, Utah: U. S. Bureau of Reclamation, U.S.D.I.; 1987; Contract 4-AG40-01810. 291 pp.

Markoff, D. R. History of the Gunnison Waterworks since 1906. Gunnison, Colorado: Western State College (thesis); 1966. 98 leaves.

Martinez, P. J. White River Taylor Draw Project: pre- and post- impoundment fish community investigations; final report. Grand Junction, Colorado: Colorado Division of Wildlife; 1986A; Contract 5281-x. 121 pp.

McAda, C. W.; and L. R. Kaeding. Physical changes in the Gunnison and Colorado Rivers resulting from construction of the Aspinall Unit and related projects, with hypotheses to assess the effects on the endangered fishes; final report. Grand Junction, Colorado: U. S. Fish and Wildlife Service, U.S.D.I.; 1991. 60 pp.

McConnell, I. W. Topographic work in the grand canyon of the Gunnison. Water Supply Paper: U.S. Geological Survey; 1904; 95. 162-167.

Mears, A. I. Flooding and sediment transport in a small alpine drainage basin in Colorado. Geology. 1978; 7(1): 53-57.

Median, A. L. Possible effects of residential development on streamflow, riparian plant communities, and fisheries on small mountain streams on central Arizona. Forest Ecology and Management. 1990 Jun 1; 33/34(1/4): 335.

Michaels, G. B.; T. Flynn; J. J. Hill; and D. J. Schneck. Use of bacterial populations in assessing the effects of thermal effluents on water quality of streams. Gunnison, Colorado: Western State College; 1982. 26 leaves.

Miller, T. A history of the Gunnison Water Works: 1880-1906. Gunnison, Colorado: Western State College (thesis); 1966. 68 leaves.

Minckley, W. L.; and G. K. Meffe. Differential selection by flooding in stream fish communities in the arid American Southwest. Pages 93-105 In: W. J. Matthews and D. C. Heins. Community and evolutionary ecology of North American stream fishes. Norman: University of Oklahoma Press; 0310; cpp.

Moulder, E. A. Memorandum on the ground water investigation of the north rim of the Black Canyon of the Gunnison National Monument, Colorado. Fort Collins, CO: National Park Service, (on file) Water Resources Division; 1960.

Murphy, E. C. Discussion of flood conditions on Purgatory, Grand, and Gunnison rivers. In: Destructive floods in the United States in 1905. Water-Supply paper 162: U.S. Geological survey; 1906. 105 pp.

Nash, L. L.; and P. H. Gleick. Sensitivity of streamflow in the Colorado Basin to climatic changes. Journal of Hydrology. 1991 Jul 1; 125(3): 221.

Nation: Endangered River. Time. 1991 Jul 22; 138(3): 20.
The very prosperity it made possible now threatens the mighty Colorado.

National Park Service, U.S.D.I. [Letter to Office of Legislation, NPS Washington Office, from Rocky Mountain Regional Office]. Wash., D.C.; 1982.
Legislative support data package for proposed boundary adjustment at Black Canyon of the Gunnison National Monument, letter and attachments.

--------. Action plan to quantify decreed reserved water rights of the United States at Black Canyon of the Gunnison National Monument. NPS; 1989. 6 pp.

--------. Colorado Water Division 4 general adjudication action plan, preparation of evidence to support quantification of reserved water rights of the United States at Black Canyon of the Gunison National Monument. 10 pp.

--------. Hydraulic features of the Gunnison River, Black Canyon of the Gunnison National Monument, Colorado. 6 pp.

--------. Hydraulic characterization of the Gunnison River, Black Canyon of the Gunnison National Monument, Colorado. Gunnison, Colorado: N.P.S.; 1990.

--------. Instream flows for recreation: A handbook on concepts and research methods. Oregon State University: Cooperative Park Studies Unit, National Park Service Water Resources Division; 1993. 103 pp.

--------. Preliminary water-related resource attributes, Black Canyon of the Gunnison National Monument. BLCA: NPS; 1989.

--------. Proposed wilderness area, Black Canyon of the Gunnison National Monument, Colorado. NPS Midwest Region: Curecanti Group; 1973. 56 leaves.

Natural resource notes: the burden of maintaining Colorado's water quality. Colorado Lawyer. 1989 Jan 1; 18(1): 23.

Nehring, R. B. Evaluation of instream flow methods and determination of water quantity needs for streams in the state of Colorado. Fort Collins, Colorado: Colorado Division of Wildlife; 1979. 144 pp.

--------. Fish flow investigations: F-51-R, Job no. 1, progress report. Fort Collins, Colorado: Colorado Division of Wildlife, Federal Aid in Fish and Wildlife Restoration; 1988.

Nelson, Haley, Patterson and Quirk, Inc. Engineering study for water supply and sewage collection and treatment for Black Canyon of the Gunnison National Monument. N, H, P and Q, Inc.: prepared for the National Park Service under contract no. 4970B20019; 1972. 70 pp.

Nelson, S. M.; and S. A. Flickinger. Salinity tolerance of Colorado squawfish, *Ptychocheilus lucius* (*Pisces: Cyprinidae*). Hydrobiologia. 1992 Oct 23; 246(2): 165.

Nesler, T. P.; R. T. Muth; and A. F. Wasowicz. Evidence for baseline flow spikes as spawning cues for Colorado squawfish in the Yampa River. Colorado American Fisheries Society Symposium; 1988. 5: 68-79.

Norris, J. M. Surface water-quality characteristics in the upper North Fork Gunnison River Basin, Colorado. Lakewood, Colorado: U. S. Geological Survey, water-resources investigations report; 1987; 86-4152. 42 pp. Books and Open-File Reports Section.

Norris, J. M.; and Maura, W. S. [Microfiche]. Water-quality data for streams in the Upper North Fork of the Gunnison River, Colorado. Lakewood, Colorado: U. S. Dept. of the Interior, Geological Survey; 1985. For sale by Open-File Services Section, Branch of Distribution.

O'Brien, J. S. Analysis of minimum streamflow and sediment transport in the Yampa River, Dinosaur National Monument. Fort Collins, Colo.: Colorado State University Engineering Research Center report; 1987. 21 pp.

O'Keefe, J.; and B. Davies. Conservation and management of the rivers of the Kruger National Park: suggested methods for calculating instream flow needs. Aquatic Conservation: Marine and Freshwater Ecosystems. 1991; 1: 55-71.

Osborn, H. B.; and J. R. Simanton. Gullies and sediment yield. Rangelands. 1989; 11(2).

Osmundson, D. B.; and L. R. Kaeding. Recommendations for flows in the '15-mile reach' during October-June for maintenance and enhancement of endangered fish populations in the Upper Colorado River; final report. Grand Junction, Colorado: Region 6, U. S. Fish and Wildlife Service, U.S.D.I.; 1991. 81 pp.

--------. Studies of Colorado squawfish and razorback sucker use of the '15-mile reach' of the Upper Colorado River as part of conservation measures for the Green Mountain and Ruedi Reservoir water sales; final report. Grand Junction, Colorado: U. S. Fish and Wildlife Service, U.S.D.I.; 1989.

Parker, R. S.; J. M. Nelson; J. G. Elliot; and W. P. Carey (United States Geological Survey, WRD, MS-415, Box 25046, DFC, Lakewood, CO 80225; 303-236-4882). Changes in bed mobility due to altered streamflows in cobble-bedded mountain streams in the Gunnison River Basin, Colorado. American Geophysical Union; 1992 Dec.

Paulin, K.; H. Tyus; and C. Williams. Responce of young Colorado squawfish and razorback suckers to water flow and light intensity; unpublished report. Vernal, Utah: U. S. Fish and Wildlife Service; 1990.

Petit, F. Evaluation of grain shear stresses required to initiate movement of particles in natural rivers. Earth Surface Processes and Landforms. 1990; 15: 135-148.

Petsch, H. E. Streamflow statistical summaries for Colorado streams through September 30, 1975. Lakewood, Colorado: U. S. Geological Survey Open-file Report No. 83-693, vol. 3; 1983.

Pugh, C. A. Hydraulic model studies of landslide-generated water waver-Morrow Point Reservoir. ; 1982. 60 pp.

Randall, G. Dammed Colorado. Buzzworm. 1992 May 1; 4(3): 26.
The Colorado became a river without its own destiny when the last big dam, in Glen Canyon, was completed, turning the lifeblood of the west into an artery for development. Now the Bureau of Reclamation is trying to work with the environmentalists to breathe some life in the river's flow. But will that really fix things?

Reid, I.; and L.E. Frostick. Dynamics of bedload transport in Turkey Brook, a coarse-grained alluvial channel. Earth Surface Processes and Landforms. 1986; 11: 143-155.

Rumburg, C. B.; B. H. Gery; and K. Butcher. Gunnison County stream water quality study. Denver, Colorado: Water Division, U. S. Environmental Protection Agency; 1978. 85 leaves.

S. E. L. & Associates. Rivers: studies in the science, environmental policy, and the law of instream flow. ? ?;

Schmidt, J. C. Recirculating flow and sedimentation in the Colorado River in Grand Canyon, Arizona. The Journal of Geology. 1990; 98(5): 709-724.

Schmidt, J. C.; and D. T. Patten (Department of Geography and Earth Resources, Utah State University, Logan UT 84322-5240; 801-750-1791, and Center for Environmental Studies, Arizona State Univeristy, Tempe, AZ 85287; 602-925-2975). Development of interim and permanent reservoir-release rules for Glen Canyon Dam. American Geophysical Union; 1992 Dec.

Schwartz, S. S. (Interstate Commission on the Potomac River Basin, Rockville, MD; 301-984-1908). Functional analysis of transport criteria for river regulating reservoirs. American Geophysical Union; 1992 Dec.

Sievers, G. D. The bacteriology and relative hardness of certain waters of the Gunnison watershed. Gunnison, Colorado: Western State College (thesis); 1949. 45 leaves.

Stanford, J. A.; and J. V. Ward. The effects of mainstream dams on physiochemistry of the Gunnison River, Colorado [Chapter 4]. In: Adams, V. D.; and V. A. Lamarra, eds. Aquatic resources management of the Colorado River ecosystem. Ann Arbor, Michigan: Ann Arbor Science; 1983: 43-56.

Status of reservoirs, Colorado River Storage Project, reservoir behind Crystal Dam. ; 1990.

Stevens, B. K.; and H. J. Vaux. Assessing strategies for control of irrigation-induced salinity in the Upper Colorado River Basin: comment. American Journal of Agricultural Economics. 1990 May 1; 72(2): 493.

Stevens, M. A. AB Lateral hydropower project, changes in river morphology. Grand Junction, Colorado: HDR Engineering, Inc., and Bureau of Reclamation; 1988. 16 pp.

Stromberg, J. Instream flow models for mixed deciduous riparian vegetation within a semiarid region. Regulated Rivers (in press). 1992;

Stromberg, J. C.; and D. T. Patten. Instream flow requirements for cottonwoods at Bishop Creek, Inyo County, California. Rivers. 1991; 2: 1-11.

Stromberg, J. C.; and D. C. Patten. Riparian vegetation instream flow requirements: a case study from a diverted stream in the Eastern Sierra Nevada, California, USA. Environmental Management. 1990 Mar 1; 13(2): 185.

Tyus, H. M. An instream flow philosophy for recovering endangered Colorado River fishes. Rivers: studies in the science, environmental... 1992 Jan 1; 3(1): 27.

--------. Loss of stream passage as a factor in the decline of the endangered Colorado squawfish. Pages 138-144 In: Issues and Technology in the Management of Impacted Western Wildlife; Proceedings of a national symposium. Boulder, Colorado: Thorne Ecological Institute Technical Publication 14; 1984.

Tyus, H. M.; and C. A. Karp. Habitat use and streamflow needs of rare and endangered fishes, Yampa River, Colorado. Vernal, Utah: U. S. Fish and Wildlife Service, U.S.D.I.; 1989; FWS Biological Report 89 (14). 27 pp.

--------. Habitat use and streamflow needs of rare and endangered fishes, Green River, Utah. Vernal, Utah: U. S. Fish and Wildlife Service, U.S.D.I.; 1991. 54 pp.

U. S. Army Corps of Engineers, Sacramento District. Flood hazard information, North Fork Gunnison River, Hotchkiss to Somerset, Delta and Gunnison Counties, Colorado (Gunnison and Uncompahgre Rivers). Sacramento, California: U. S. Army Corps of Engineers, Sacramento District; 1980. 11 pp.

U. S. Congress. An act to establish a boundary for the Black Canyon of the Gunnison National Monument, and for other purposes. Washington, D. C.: U.S.G.P.O., Supt. of Docs.; 1984; Public Law 98-357. 2 pp.

--------. A bill to amend the Wild and Scenic Rivers Act by designating segments of certain rivers in the State of Colorado for study as potential components of the National Wild and Scenic Rivers System. Wash., D.C.: U. S. Congress; 1973. 3 pp.

U. S. Department of Interior, Assistant Secretary. Published by U. S. Government Printing Office, House Document No. 77, 88th Congress, 1st Session; 1963.
Letter transmitting a supplemental report and certification of economic justification on the Crystal Dam, reservoir, and power plant, which comprises a segment of the Curecanti unit, Colorado river storage project, in Colorado.

U. S. Department of Interior; and State of Colorado. Preliminary working draft: Colorado River storage project Wayne N. Aspinall storage unit water service contract between The Bureau of Reclamation, The National Park Service, The Bureau of Land Management and The Colorado Water Conservation Board. 12 pp.

--------. Public information packet: proposed contract to deliver water from the Wayne N. Aspinall Unit to the Black Canyon of the Gunnison National Monument. Unpublished report by Bureau of Reclamation, National Park Service, Bureau of Land Management and Colorado Water Conservation Board; 1992 Apr. 21 pp.

U. S. Department of Interior. Quality of water Colorado River basin, progress report (12). ; 1985. 200 pp.

U. S. Fish and Wildlife Service, U. S. D. I. Final Biological Opinion for the operation of Flaming Gorge Dam. Denver, Colorado: Region 6, U. S. Fish and Wildlife Service; 1992B. 44 pp plus appendices.

U. S. Forest Service, U.S.D.A. Instream flow needs assessment and recommendations for the proposed Piedra Wilderness (San Juan National Forest). Rocky Mountain Regional Office: U. S. Forest Service; 1992. 25 pp.

U. S. Forest Service; Soil Conservation Service; and Economic Research Services, U. S. D. A. Water and related land resources, Gunnison River Basin, Colorado. Salt Lake City, Utah: Economic Research Services, U.S.F.S., S.C.S.; 1962. 103 pp.

U. S. Geological Survey, U.S.D.I. Botanical evidence of floods and flood-plain deposition. ; 1964. 35 pp.

--------. Water resources of the State of Colorado. ; 1902.

U. S. House of Representatives, Committee on Interior and Insular Affairs, Subcommittee on National Parks and Public Lands. Black Canyon National Conservation Act of 1991: hearing before the Subcommittee on National Park and Public Lands of the committee on Interior and Insular Affairs, House of Representatives, One Hundred Second Congress, second session on H.R. 1321... ; 1993.

U. S. House of Representatives, Committee on Interior and Insular Affairs. Establishing a boundary for the Black Canyon of the Gunnison National Monument, and for other purposes. Washington, D. C. (?): U. S. G.P.O.; 1984; 98-608. 5 pp.

U. S. Senate, Committee on Energy and Natural Resources. Establishing a boundary for the Black Canyon of the Gunnison National Monument, Colorado. Washington, D. C.: U.S.G.P.O.; 1984; 98-549. 7 pp.

U. S. Senate, Committee on Interior and Insular Affairs, Environment and Land Resources Subcommittee. The preparation of the East River unit plan, Gunnison National Forest, Colorado: report together with additional and minority views of the Subcommittee on the Environment and Land Resources of the Committee on Interior and Insular Affairs, September 1976. Washington, D. C.: U.S.G.P.O.; 1976. 196 pp.

Vanicek, C. D.; R. H. Kramer; and D. R. Franklin. Distribution of Green River fishes in Utah and Colorado following closure of Flaming Gorge Dam. The Southwestern Naturalist. 1970; 14: 297- 315.

Verdin, J. P.; L. Hall; J. Halls; and P. Davidson. Application of remote sensing and GIS to estimate irrigation water use in the Upper Gunnison River Basin in Colorado. 10 pp.

Viscoli, S. J. The Resource Conservation Group proposal to lease Colorado river water. Natural Resources Journal. 1991 Sep; 31(4): 887.

Volkman, J. M. Within the Hundredth Meridian: western states and their river basins in a time of transition. University of Colorado Law Review. 1988 Jun; 59(3): 551.

Wang, D. C.; and J. D. Salas. Forecasting streamflow for Colorado River systems. Completion report. 1991 Dec 1; (164).

Ward, J. V.; and J. A. Stanford. Draft-occurrence and significance of hyporheic zones in the Black Canyon of the Gunnison River, Colorado. 33 pp.

--------. Serial discontinuity in the Gunnison River, Colorado: relation to stream flows and decreed federal water rights in the Gunnison Gorge National Monument. 6 pp.

Water project above Black Canyon approved. National Parks. 1992 May; 2 pp.

Water Science and Technology Board. Colorado River ecology and dam management. Washington, D. C.: National Academy Press; 1991. 276 pp.

--------. River and dam management. Washington, D. C.: National Academy Press; 1987. 152 pp.

WBLA, Inc. Curecanti minimum stream flow water rights study- draft. Boulder, CO: manuscript prepared for The Nature Conservancy, Colorado field office; 1986. 39 pp.

Webb, R. H.; P. T. Pringle; and G. R. Rink. Debris flows from the tributaries of the Colorado River, Grand Canyon National Park, Arizona. U. S. Geological Survey Open File Report 87-118: U. S. Geological Survey; 1987.

Webb, R. H.; P. T. Pringle; S. L. Reneau; and G. R. Rink. Monument Creek debris flow, 1984: implications for formations of rapids on the Colorado River in Grand Canyon National Park. Geology. 1988; 16(1): 50-54.

White, W. R.; and T. J. Day. Transport of graded gravel bed material. Hey, R. D.; J. C. Bathurst; and C. R. Thorn, eds. Gravel-bed Rivers, Fluvial Processes, Engineering and Management (published by John Wiley and Sons Ltd.). 1982;

Whittig, L. D.; et al. Delineation and correlation of salinity to landforms and geologic formations, Upper Colorado River Basin. Davis, California: University of California, Davis; 1985.

Wiele, S. M.; and J. D. Smith (USGS PO Box 25046 MS 458, Denver, CO 80225, 303-541-3001). Modeling of flow in the Colorado River through the Grand Canyon. American Geophysical Union; 1992 Dec.

Wilkinson, C. F. To settle a new land: an historical essay on water law and policy in the American West and Colorado. In: Getches, D. H. Water and the American West. University of Colorado, Boulder, Co., USA: University of Colorado School of Law, Natural Resources Law Center; 1988: 1-17.

Williams, G. P.; and M. G. Wolman. Downstream effects of dams on alluvial rivers. U.S. Geological Survey professional paper 1286: U.S.G.S.; 1984.

Williams, O. R.; S. L. Ponce; and A. E. Johns. The use of departure analysis in decision making. In: Water use data for water resources management. : American Water Resources Association; 1988: 447-453.

Young, R. A.; R. L. Gardner; and E. W. Sparling. Assessing strategies for control of irrigation-induced salinity in the Upper Colorado River Basin: reply. American Journal of Agricultural Economics. 1990 May 1; 72(2): 497.

Ecology / Biology / Environmental Studies

Ackerman, D. J.; and T. Brooks. Reconnaissance of ground-water resources in the North Fork Gunnison River Basin, southwestern Colorado. Denver, Colorado: U. S. Dept. of the Interior, U. S. Geological Survey; 1986; 85-4230. 21 pp. U. S. Geological Survey, Books and Open-File Reports, distributor.

Andersen D. C.; and D. J. Cooper (Bureau of Reclamation Environmental Sciences Section, Denver Office, and Colorado State University Dept. of Fishery and Wildlife Biology). Comparative ecosystem dynamics in riparian zones along regulated and unregulated rivers, the Green and Yampa - preliminary proposal. Submitted to: Bureau of Reclamation: Upper Colorado Regional Office; 1993.

Andrews, E. D. Downstream effects of Flaming Gorge Reservoir on the Green River, Colorado and Utah. Geological Society of America Bulletin. 1986; 97: 1012-1023.

Aspi, J.; J. Lumme; and A. Hoikkala. Reproductive ecology of the boreal riparian guild of Drosophila. Ecography. 1993 Jan 1; 16(1): 65.

Asplund, K. K.; and M. T. Gooch. Geomorphology and the distributional ecology of Fremont Cottonwood (Populus fremontii) in a desert riparian canyon. Desert Plants. 1988; 9(1): 17.

Atwood, W. W.; and K. F. Mather. The grand canyon of the Gunnison River (abstract). Association of American Geographers. 1915; 5: 138-139.

Auble, G. T.; J. Friedman; and M. L. Scott (U. S. Fish and Wildlife Service: National Ecology Research Center and E. P. O. Biology Dept., University of Colorado, Boulder, Co.) Relating riparian vegetation to present and future streamflows. In review: Ecological Applications (Dec. 1992).

--------. Riparian vegetation of the Black Canyon of the Gunnison River, Colorado: composition and response to selected hydrologic regimes based on a direct gradient assessment model. Unpublished reort by U. S. Fish and Wildlife Service, National Ecology Research Center: for National Park Service, Water Resources Division, Water Rights Branch; 1991. 79 pp.

Baker, W. L. Classification of the riparian vegetation of the montane and subalpine zones in western Colorado. The Great Basin Naturalist. 1989 Apr 31; 49(2): 214.

--------. Climatic and hydrology effects on the regeneration of Populus angustifolia James along the Animas River, Colorado. Journal of Biogeography. 1990 Jan 1; 17(1): 59.

--------. Macro- and micro-scale influences on riparian vegetation in western Colorado. The Annals of the Association of American Geographers. 1989; 14 pp.

Barclay, J. S. Impact of stream alterations on riparian communities in southcentral Oklahoma. U. S. Dept of Interior: U. S. Fish and Wildlife Service (FWS/OBS-80/17); 1980.

Bare, L. T. Distribution of larval trematodes and their mulloscan hosts in the Gunnison area. Gunnison, Colorado: Western State College (thesis); 1927. 15 leaves.

Barrell, J. Flora of the Gunnison Basin: Gunnison, Saguache, and Hinsdale Counties, Colorado; a study in the distribution of plants. Rockford, Illinois: Natural Land Institute; 1969. 494 pp.

Beidleman, R. G. The Black Canyon of the Gunnison National Monument. Colorado Magazine: The State Historical Society of Colorado. 1963; 40(3): 161-178.

--------. Checklist of Black Canyon National Monument plants. Colorado Springs, Colorado: Colorado College; 1969. 6 pp.

--------, compiler. Natural resources basic data for Curecanti and Black Canyon. Scientific Field Team Report for NPS Midwest Region: U.S. National Park Service; 1968. 100 pp.

Bifoss, C. G. A survey of the fresh-water molluscs and their trematode parasites in the lower Gunnison area. Gunnison, Colorado: Western State College (thesis); 1927. 47 leaves.

Bowden, C. In search of a lost river: The Imperial National Wildlife Refuge preserves a flavor of the old, untamed Colorado. Arizona Highways. 1990 Apr 1; 66(4): 34.

Bowen, J. R. Mosquitoes of the Gunnison River Drainage, Colorado. Gunnison, Colorado: Western State College of Colorado; 1971. 246 leaves.

Brown, S.; M. S. Brinson; and A. E. Lugo. Structure and function of riparian wetlands [Pages 17-31]. In: R. R. Johnson and J. F. McCormick, technical coordinators. Strategies for protection and management of floodplain wetlands and other riparian ecosystems. Washington, D.C.: U. S. Forest Service, U.S.D.A.; 1979; Publ. GTR-WO-12. 410 pp.

Bruce, C. A. History of federal reclamation and its accomplishments on the Uncompahgre Project, Colorado. Gunnison, Colorado: Western State College (thesis); 1933.

Bureau of Land Management, U.S.D.I. Gunnison resource area resource management plan and environmental impact statement. Montrose, Colorado: B.L.M., U.S.D.I.; 1991.

--------. Resources management plan for the Gunnison Gorge Recreation Lands, Colorado. Montrose, Colorado: B.L.M., U.S.D.I.; 1985.

Bureau of Reclamation, U.S.D.I. Uncompahgre project: Colorado, Delta, Gunnison, and Montrose counties. Washington, D. C. (?): Bureau of Reclamation, Upper Colorado Region; 1983. 8 pp.

Burkhard, W. T.; N. F. Smith; T. A. Lytle; and H. E. Burdick Sr. Final report for fish and wildlife resource analysis of the Grand Mesa project. Contract 7-07-40-S0425: Colorado Division of Wildlife; 1979.

Butler, D. L.; et al. Reconnaissance investigation of water quality, bottom sediment, and biota associated with irrigation drainage in the Gunnison and Uncompahgre River basins and at Sweitzer Lake, west-central Colorado, 1988-89. Denver, Colorado: U.S.D.I., U. S. Geological Survey, Books and Open File Reports Section; prepared in cooperation with the U. S. Fish and Wildlife Service and the U. S. Bureau of Reclamation; 1991; 91-4103. 99 pp.

Colborn, T. Aquatic insects as measures of trace element presence: cadmium and molybdenum. Gunnison, Colorado: Western State College of Colorado (thesis); 1981. 157 leaves.

--------. Measurement of low levels of molybdenum in the environment by using aquatic insects - Gunnison River, Gunnison County, Colorado. ; 1982.

Cole, K. L. Reconstruction of past desert vegetation along the Colorado river using packrat middens. Palaeogeography, palaeoclimatology, palaeoecology. 1990 Jan 1; 76(3/4): 349.

Colorado Agricultural Experiment Station. List and location of snow courses and soil moisture stations. Fort Collins, Colorado; 1971. 16 pp.

Cook, K. J. Field observations of two heron species in Gunnison County, Colorado: great blue heron (*Ardea herdias treganzai*) and black-crowned night heron (*Nycticorax nycticorax hoactli*). ; 1979. 70 pp.

Copeland, H. L. Seasonal and diel invertebrate drift patterns in regulated streams. ; 1989.

Debano, L. F.; and L. J. Schmidt. Potential for enhancing riparian habitats in southwestern United States with watershed practices. Forest Ecology and Management. 1990 Jun 1; 33/34(1/4): 385.

Dekamps, H.; M. Fortune; F. Gazelle; and G. Pautou. Historical influence of man on the riparian dynamics of a fluvial landscape. Landscape Ecology. 1988; 1: 163-174.

Dolson, J. The Black Canyon of the Gunnison, a story in stone: the natural and human history of Black Canyon of the Gunnison National Monument. Boulder, Colorado: Pruett Publishing Co.; 1982. 53 pp.

Duncan, W. F. A.; M. A. Brusven; and T. C. Bjornn. Energy-flow response models for evaluation of altered riparian vegetation in three southeast Alaskan streams. Water Research. 1989 Aug 1; 23(8): 965.

Economic Research Service, U.S.D.A. Water and related land resources, Gunnison River Basin, Colorado: a report based on a cooperative study by Colorado Water Conservation Board and United States Department of Agriculture. Salt Lake City, Utah: U.S.D.A., prepared by Economic Research Service, U. S. Forest Service, Soil Conservation Service; 1962. 103 pp.

Engineering Consultants. Floodplain information report: Gunnison River, Tomichi Creek, Gunnison, Colorado. Denver, Colorado: prepared by Engineering Consultants, Inc. for the City of Gunnison, Gunnison County, and the Colorado Water Conservation Board. 32 leaves.

Estes, M. K. The effect of the Federal Endangered Species Act on state water rights. Environmental Law. Spring 1992.

Fenner, P.; W. W. Brady; and D. R. Patton. Effects of regulated water flows on regeneration of Fremont cottonwood. Journal of Range Management. 1985; 38: 135-138.

Finch, D. M. Habitat use and habitat overlap of riparian birds in three elevational zones. Ecology. 1989 Aug 1; 70(4): 866.

Fischer, N. T.; M. S. Tolle; A. C. Cully; and L. D. Potter. Vegetation along the Green and Yampa Rivers and response to fluctuating water levels, Dinosaur National Monument. Final Report under Contract # CX 1200-Z-B024: Submitted to the National Park Service; 1983. 179 pp.

Fox, C. J.; and J. Y. Nishimura. Soil management report: Taylor River area, Gunnison National Forest. Denver, Colorado: U. S. Forest Service, Rocky Mountain Region, Division of Multiple Use, Soils and Watershed Management; 1965. 87 leaves.

Fox (F. M.) & Associates. Roaring Fork and Crystal Valleys: an environmental and engineering geology study --Eagle, Garfield, Gunnison and Pitkin counties, Colorado. Denver, Colorado: Colorado Geological Survey, Dept. of Natural Resources. Prepared for the Colorado Geological Survey and the Colorado Division of Planning; 1974.

Franz, E. H.; and F. A. Bazzaz. Simulation of vegetation response to modified hydrologic regimes: a probabilistic model based on niche differentiation in a floodplain forest. Ecology. 1977; 58: 176-183.

Fraser, W. C. A study of lichen ecology in the plant communities of Taylor River Canyon, Colorado. Gunnison, Colorado: Western State College (thesis); 1965. 73 leaves.

Gecy, J. L.; and M. V. Wilson. Initial establishment of riparian vegetation after disturbance by debris flows in Oregon. The American Midland Naturalist. 1990 Apr 1; 123(2): 282.

General Accounting Office. Improvements needed in the Corps of Engineers' regulatory program for protecting the nation's waters. Wash., D.C.: G.A.O.; 1977; CED-78-17. 16 pp.

Goettlicher, W. P.; and M. J. Pucherelli. Mapping instream habitat on the San Juan River as related to the Animas-La Plata Project using airborne videography; draft. Denver, Colorado: Applied Sciences Branch, Research and Laboratory Services Branch, Bureau of Reclamation, U.S.D.I.; 1992. 41 pp.

Graf, W. L. Fluvial adjustments to the spread of tamarisk in the Colorado Plateau region. Geological Society of America Bulletin. 1978; 89: 1491-1501.

Grater, R. K. Preliminary study of the status of bighorn at the Black Canyon of the Gunnison National Monument. National Park Service: U.S.D.I.; 1937. 19 pp.

Gregory, S. V.; F. J. Swanson; W. A. McKee; and K. W. Cummins. An ecosystem perspective of riparian zones. BioScience. 1991; 41: 540-551.

Gunnison Basin and American Flat/Silverton: wilderness study areas. U.S.D.I., Bureau of Land Management. Gunnison, Colorado: Bureau of Reclamation; 1986. ; 122 x 82 cm., on sheet 67 x 108 cm.; 1:50,000.

Hardinger, H. W. Report on the Crystal River District of Gunnison County, Colorado. Denver, Colorado; 1900. 17 leaves.

Hauer, F. R.; J. A. Stanford; and J. V. Ward. Serial discontinuities in a Rocky Mountain river. II. Distribution and abundance of *Trichoptera*. In: Regulated Rivers, Research and Management. John Wiley & Sons, Ltd.; 1989; Vol. 3.: 177-182.

HDR Engineering, Inc. Phase I feasibility study for Upper Gunnison-Uncompahgre Basin, task memorandum no. 5, development and calibration of basin model comparison of existing supplies with future in-basin demands. HDR Engineering, Inc.; 1988.

--------. Phase I feasibility study for Upper Gunnison- Uncompahgre Basin, task memorandum no. 4, recreation and environmental enhancement opportunities. HDR Engineering, Inc.; 1988.

--------. Upper Gunnison-Uncompahgre Basin: phase I feasibility study: final report. Denver, Colorado: prepared by HDR Engineering in association with WBLA, Inc. et al; 1989.

Hewitt III, M. J. Synoptic inventory of riparian ecosystems: the utility of Landsat Thematic Mapper data. Forest Ecology and Management. 1990 Jun 1; 33/34(1/4): 605.

Howe; and F. Knopf. On the imminent decline of Rio Grande cottonwoods in central New Mexico. The Southwestern Naturalist. 1991; 36: 218-224.

Hughes, R. M.; and R. F. Noss. Biological diversity and biological integrity: current concerns for lakes and streams. Fisheries. 1992; 17(3): 11-19.

Hupp, C. R. Plant ecological aspects of flood geomorphology and paleoflood history. In: Baker, V. R.; R. K. Kochel; and P. C. Patton, eds. Flood Geomorphology. Published by Wiley; 1988.

--------. Riparian vegetation recovery patterns following stream channelization: a geomorphic perspective. Ecology. 1992 Aug 1; 73(4): 1209.

Hyde, A. S. Birds of Gunnison Country. Gunnison, Colorado: Western State College Foundation; 1979; No. 1 of 400. 140 pp.

Hydropower project threatens Black Canyon. National Parks. 1992 Jan: 1 p.

Iorns, W. V.; C. H. Henbree; and G. L. Oakland. Water resources of the Upper Colorado River Basin - technical report - introduction and summary. U. S. Geological Survey: U.S.D.I.; 1965; Professional Paper 441-A. 370 pp.

Johnson, R. R. Historic changes in vegetation along the Colorado River in the Grand Canyon. In: Colorado River Ecology and Dam Management. Wash., D. C.: National Academy Press; 1991: 178-206.

Johnson, W. C. Dams and riparian forests; case study from the Upper Missouri River. Regulated Rivers (to be published in early 1993).

Karr, J. R.; and I. J. Schlosser. Water resources and the land- water interface. Science. 1978; 201: 229-234.

Kaweeka, B. The effect of flood-control regulation of a montane stream on the communities of sessile algae. Acta hydrobiologica. 1990; 32(3 / 4): 345.

Knight, A. W. Studies on the stoneflies (*Plecoptera*) of the Gunnison River drainage in Colorado. Ann Arbor, Michigan: University Microfilms International (thesis); 1965. 142 leaves.

Knight, A. W.; and D. W. Argylo. Limited limnological studies of the Gunnison River, Colorado. In: Pendergast, D. M., ed. Ecological studies of the flora and fauna of the Curecanti Reservoir basins, western Colorado. University of Utah Anthropological Papers, No. 59. Upper Colorado Series No. 8. Salt Lake City, Utah: University of Utah Press; 1962: 135-149.

Knopf, F. L.; and M. L. Scott. Altered flows and created landscapes in the Platte River headwaters, 1840-1990. In: Sweeney, J. M., ed. Management of dynamic ecosystems. West Lafayette, Indiana, USA: The Wildlife Society, North Central Section; 1990: 47-70.

Knopf, F. L.; R. R. Johnson; T. Rich; F. B. Samson; and R. C. Szaro. Conservation of riparian ecosystems in the United States. Wilson Bulletin. 1988; 100: 272-284.

Kovalchik, B. L.; and L. A. Chitwood. Use of geomorphology in the classification of riparian plant associations in mountainous landscapes of central Oregon, U. S. A. Forest Ecology and Management. 1990 Jun 1; 33/34(1/4): 605.

Lamb, B. L.; and E. Lord. Legal mechanisms for protecting riparian resource values. Water Resources Research. 1992; 28: 965-977.

Lichvar, R. Riparian vegetation reconnaissance of the Black Canyon of the Gunnison, Spring 1987. Houston, Texas: EMANCO, Inc., unpublished report; 1987 Mar. 14 pp.

Liu, Z. J.; and G. P. Malanson. Long-term cyclic dynamic of simulated riparian forest stands. Forest ecology and managment. 1992 Apr 1; 48(3 / 4): 217.

Maddux, H. R.; D. M. Kubly; J. C. deVos, Jr.; W. R. Persons; R. Staedicke; and R. L. Wright. Effects of varied flow regimes on aquatic resources of Glen and Grand Canyons; final report. Salt Lake City, Utah: U. S. Bureau of Reclamation, U.S.D.I.; 1987; Contract 4-AG40-01810. 291 pp.

Mariah and Associates. Threatened and endangered plant survey and reconnaissance for riparian and wetland habitats on portions of the AB Lateral and Shavano Falls Facilities of the Uncompahgre Valley Hydropower Project, Montrose County, Colorado. Houston, Texas: EMANCO, Inc., unpublished report; 1986.

Marsh, B. W. The Uncompahgre valley and the Gunnison tunnel: a description of scenery, natural resources, products, industries, exploration, adventures, &c. Montrose, Colorado: Marsh and Torrence; 1905: 13-151.

McAda, C. W.; and L. R. Kaeding. Physical changes in the Gunnison and Colorado Rivers resulting from construction of the Aspinall Unit and related projects, with hypotheses to assess the effects on the endangered fishes; final report. Grand Junction, Colorado: U. S. Fish and Wildlife Service, U.S.D.I.; 1991. 60 pp.

Meinig, D. W. Macro- and micro-scale influences on riparian vegetation in western Colorado. Annals of the Association of the American Geographer. 1989 Mar 1; 79(1): 65.

Michaels, G. B.; T. Flynn; J. J. Hill; and D. J. Schneck. Use of bacterial populations in assessing the effects of thermal effluents on water quality of streams. Gunnison, Colorado: Western State College; 1982. 26 leaves.

Morris, D. P.; and Lewis Jr., W. M. Nutrient limitation of bacterioplankton growth in Lake Dillon, Colorado. Limnology and Oceanography. 1992 Sep 1; 37(6): 1179.

Mulholland, P. J. Regulation of nutrient concentrations in a temperate forest stream: Roles of upland, riparian, and instream processes. Limnology and oceanography. 1992 Nov 1; 37(7): 1512.

Nash, L. L.; and P. H. Gleick. Sensitivity of streamflow in the Colorado Basin to climatic changes. Journal of Hydrology. 1991 Jul 1; 125(3): 221.

National Park Service, U.S.D.I. Assessment of potential impacts to water-related resource attributes. BLCA: NPS; 1990.

--------. Final recommendation, wilderness study, Black Canyon of the Gunnison National Monument, Colorado. (on file at BLCA): NPS; 1971. 33 pp.

--------. Gunnison River. Denver, Colorado: Denver Service Center: prepared by NPS in cooperation with the Colorado Dept. of Natural Resources; 1979; NPS 1479. 177 pp.

--------. Instream flows for recreation: A handbook on concepts and research methods. Oregon State University: Cooperative Park Studies Unit, National Park Service Water Resources Division; 1993. 103 pp.

--------. Preliminary water-related resource attributes, Black Canyon of the Gunnison National Monument. BLCA: NPS; 1989.

--------. Project plan, assessment of potential impacts to water- related resource attributes. BLCA/RMRO?: NPS; 1990.

--------. Proposed wilderness area, Black Canyon of the Gunnison National Monument, Colorado. NPS Midwest Region: Curecanti Group; 1973. 56 leaves.

--------. Wild and scenic river study, Gunnison River. NPS, Black Canyon of the Gunnison National Monument: Prepared in cooperation with the Colorado Department of Natural Resources; 1979. 176 pp.

--------. Wilderness recommendation, Black Canyon of the Gunnison National Monument, Colorado. BLCA: NPS; 1979. 33 pp.

National Research Council. River and dam management: A review of the Bureau of Reclamation's Glen Canyon Environmental Studies. Washington, D. C.: National Academy Press; 1987. 203 pp.

Nature Conservancy. Proposal for developing a riparian vegetation classification system for Colorado. Colorado Field Office, Boulder, Colo.: TNC; 1990. 17 pp.

Nehring, R. B. Evaluation of instream flow methods and determination of water quantity needs for streams in the state of Colorado. Fort Collins, Colorado: Colorado Division of Wildlife; 1979. 144 pp.

Office of Surface Mining, U.S.D.I. Technical environmental analysis, mining and reclamation plan, Mt. Gunnison mine, Gunnison County, Colorado, ARCO Coal Company. Prepared for Office of Surface Mining: U. S. Dept. of the Interior.

O'Keefe, J.; and B. Davies. Conservation and management of the rivers of the Kruger National Park: suggested methods for calculating instream flow needs. Aquatic Conservation: Marine and Freshwater Ecosystems. 1991; 1: 55-71.

Olander, H. C.; N. B. Lamm; and B. A. Florquist (Prepared for the Colorado Geological Survey and the Colorado Division of Planning by F. M. Fox & Associates). Roaring Fork and Crystal Valleys: an environmental and engineering geology study: Eagle, Garfield, Gunnison, and Pitkin Counties. Denver, Colorado: Colorado Geological Survey, Dept. of Natural Resources; 1974. 64 pp.

Payne, J. F. Aspects of the life histories of selected species of North American crayfishes. Fisheries. 1978; 3(6): 5-7.

Pearlstine, L.; H. McKellar; and W. Kitchens. Modelling the impacts of a river diversion on bottomland forest communities in the Santee River floodplain, South Carolina. Ecological Modelling. 1985; 29: 283-302.

Pennak, R. W.; and J. V. Ward. Interstitial faunal communities of the hyporheic and adjacent groundwater biotopes of a Colorado mountain stream. Arch. Hydrobiol./Suppl. 1986; 74(3): 356-396.

Rector, C. D.; E. W. Mustard; and J. T. Windell. Lower Gunnison River basin wetland inventory and evaluation. Denver, Colorado: U. S. Dept. of Agriculture, Soil Conservation Service; 1979; contract no. 7-07-40-X0327. 90 pp.

Rector, D. C. Lower Gunnison River Basin wetland inventory and evaluation. Boulder, Colorado: University of Colorado (thesis); 1979. 71 leaves.

Reed; and Norton. Algae of Black Canyon of the Gunnison National Monument. appendix in: ? ; 1963.

Reed, P. B. National list of plant species that occur in wetlands: National summary. Washington, D.C., USA: U. S. Fish and Wildlife Service; 1988; Biological Report 88 (24).

Reid, J. W. *Acanthocyclops pennaki* n. sp. (*Copepoda: Cyclopoida*) from the hyporheic zone of the South Platte River, Colorado, U. S. A. Transactions of the American Microscopical Society. 1992 Oct 1; 111(4): 269.

Rinne, J. N.; and R. A. Lafayette. Southwestern riparian-stream ecosystems: research design, complexity, and opportunity (Research Report RM-299). U.S.D.A. Forest Service: Rocky Mountain Forest and Range Experiment Station; 1991.

Rocky Mountain/Southwestern Perigrine Falcon Recovery Team. American perigrine falcon, Rocky Mountain and Southwestern population, recovery plan. U.S. Fish and Wildlife Service: U.S.D.I.; 1977. 183 pp.

Rominger, J. M. Preliminary studies of the agrostology of Black Canyon of the Gunnison National Monument. prepared for Black Canyon of the Gunnison National Monument: on file at NPS Midwest Regional Office; 1963. 4 pp.

Rood, S. B.; and J. M. Mahoney. Collapse of riparian poplar forests downstream from dams in western prairies: probable causes and prospects for mitigation. Environmental Management. 1990; 14: 451-464.

Sievers, G. D. The bacteriology and relative hardness of certain waters of the Gunnison watershed. Gunnison, Colorado: Western State College (thesis); 1949. 45 leaves.

Smith, S. D.; and A. B. Wellington. Functional responses of riparian vegetation to streamflow diversion in the eastern Sierra Nevada. Ecological Applications. 1991 Feb 1; 1(1): 89.

Snyder, W. D.; and G. C. Miller. Changes in riparian vegetation along the Colorado River and Rio Grande, Colorado. The Great Basin Naturalist. 1992 Dec 1; 52(4): 357.

Stanford, J. A., Director Flathead Lake Biological Station, University of Montana, Polson, Montana. Flow alteration and ecosystem stability in the Gunnison River, Colorado: a perspective. Polson, Montana: U. of Montana; 1989 Mar. 8 pp.

Stanford, J. A.; and J. V. Ward. The effects of mainstream dams on physiochemistry of the Gunnison River, Colorado [Chapter 4]. In: Adams, V. D.; and V. A. Lamarra, eds. Aquatic resources management of the Colorado River ecosystem. Ann Arbor, Michigan: Ann Arbor Science; 1983: 43-56.

--------. The effects of regulation on the limnology of the Gunnison River: a North American case history. A. Lillehammer and S. Saltveit, eds. Regulated Rivers. Oslo, Norway: Universitetsforlaget As.; 1985: 467-480.

--------. The hyporheic habitat of river ecosystems. Nature. 1988; 335(6185): 64-66.

--------. Lotic zoobenthos of the Colorado system. In: Davies B. R.; and K. F. Walker, eds. The ecology of river systems. Dordrecht, The Netherlands: Dr. W. Junk Publishers; 1986.

--------. Management of aquatic resources in large catchments: recognizing interactions between ecosystem connectivity and environmental disturbance. In: Naiman, R. J., ed. Watershed Management: Balancing Sustainability with Environmental Change. New York: Springer-Verlag; 1992: 000-000.

Stanford, J. A.; and Hauer. Mitigating the impacts of stream and lake regulation in the Flathead River catchment, Montana, USA: an ecosystem perspective. Aquatic Conservation: Marine and Freshwater Ecology. 1992 Mar 1; 2(1): 35.

Stanford, J. A.; and J. V. Ward (Flathead Lake Biological Station, University of Montana, Polson, Montana and Dept. of Zoology, Colorado State University, Fort Collins, Colorado). Occurrence and significance of hyporheic zones in the Black Canyon of the Gunnison River, Colorado. Draft report. : Submitted to National Park Service, Water Resources Division, Fort Collins, Co.; 1991 Mar.

--------. Preliminary interpretations of the distribution of *Hydropsychidae* in a regulated river. In: G.P. Moretti, ed. Proceedings of the Third International Symposium on *Trichoptera*, Series *Entomologica*. 1981; 20: 323-328.

--------. Reservoirs of the Colorado system. In: Davies, B. R.; and K. F. Walker, eds. The ecology of river systems. Dordrecht, The Netherlands: Dr. W. Junk Publishers; 1986.

--------. Serial discontinuities in a Rocky Mountain river. I. Distribution and abundance of *Plecoptera*. In: Regulated rivers: research & management. : John Wiley & Sons, Ltd.; 1989; Vol. 3: 169-175.

--------. Serial discontinuities in a rocky mountain river II. distribution and abundance of *Trichoptera*. In: Regulated rivers: research and management. : John Wiley & Sons, Ltd.; 1989. 6 pp.

Stanford, J. A.; F. R. Hauer; and J. V. Ward. Serial discontinuity in a large river system. Verh.Internat.Verein.Limnol. 1988; 23: 1114-1118.

State of Colorado, Department of Natural Resources. River Otter restoration, endangered wildlife investigations performance report (SE 3-3). Southwest Region: Colorado Division of Wildlife; 1980. 66 pp.

--------. Signs of the river otter in the Black Canyon of the Gunnison River (addendum to report SE 3-3). J. Sisk, preparer. Southwest Region: Colorado Division of Wildlife; 1980. 57-66.

Stromberg, J. Instream flow models for mixed deciduous riparian vegetation within a semiarid region. Regulated Rivers (in press). 1992;

Stromberg, J. C.; and D. T. Patten. Instream flow requirements for cottonwoods at Bishop Creek, Inyo County, California. Rivers. 1991; 2: 1-11.

Stromberg, J. C.; and D. C. Patten. Riparian vegetation instream flow requirements: a case study from a diverted stream in the Eastern Sierra Nevada, California, USA. Environmental Management. 1990 Mar 1; 13(2): 185.

Szaro, R. C.; and J. N. Rinne. Ecosystem approach to management of southwestern riparian communities. Transactions 53rd North American Wildlife and Natural Resources Conference. 1988: 502- 511.

Tabacchi, E.; A. Planty-Tabacchi; and O. Decamps. Continuity and discontinuity of the riparian vegetation along a fluvial corridor. Landscape Ecology. 1990; 5: 9-20.

Tesky, R. O.; and T. M. Hinckley. Impact of water level changes on woody riparian and wetland communities. vol. 1: Plant and Soil Responses to Flooding. Office of Biological Sciences: U. S. Dept. of Interior, U.S. Fish and Wildlife Service; 1977; FWS/OBS-77/58.

Tierney, R. W. Transpiration and water use in a montane riparian ecosystem. ; 1992.

U. S. Congress. A bill to amend the Wild and Scenic Rivers Act by designating segments of certain rivers in the State of Colorado for study as potential components of the National Wild and Scenic Rivers System. Wash., D.C.: U. S. Congress; 1973. 3 pp.

U. S. Fish and Wildlife Service, U. S. D. I. Final Biological Opinion for the operation of Flaming Gorge Dam. Denver, Colorado: Region 6, U. S. Fish and Wildlife Service; 1992B. 44 pp plus appendices.

U. S. Forest Service, U.S.D.A. Instream flow needs assessment and recommendations for the proposed Piedra Wilderness (San Juan National Forest). Rocky Mountain Regional Office: U. S. Forest Service; 1992. 25 pp.

U. S. Forest Service; Soil Conservation Service; and Economic Research Services, U. S. D. A. Water and related land resources, Gunnison River Basin, Colorado. Salt Lake City, Utah: Economic Research Services, U.S.F.S., S.C.S.; 1962. 103 pp.

U. S. Geological Survey, U.S.D.I. Botanical evidence of floods and flood-plain deposition. ; 1964. 35 pp.

--------. Water resources of the State of Colorado. ; 1902.

U. S. House of Representatives, Committee on Interior and Insular Affairs, Subcommittee on National Parks and Public Lands. Black Canyon National Conservation Act of 1991: hearing before the Subcommittee on National Park and Public Lands of the committee on Interior and Insular Affairs, House of Representatives, One Hundred Second Congress, second session on H.R. 1321... ; 1993.

U. S. Senate, Committee on Interior and Insular Affairs, Environment and Land Resources Subcommittee. The preparation of the East River unit plan, Gunnison National Forest, Colorado: report together with additional and minority views of the Subcommittee on the Environment and Land Resources of the Committee on Interior and Insular Affairs, September 1976. Washington, D. C.: U.S.G.P.O.; 1976. 196 pp.

United States Congress. Gunnison River, Colorado, wild and scenic river proposals: message from the president of the United States transmitting a report recommending the designation of a segment of the Gunnison River, Colorado as a component of the national wild and scenic rivers system, pursuant to section 4(a) of the wild and scenic rivers act, as amended. Wash., D. C.: U.S.G.P.O.; 1979. 176 pp.

Walsh, R. G.; et al. Wild and scenic river economics: recreation use and preservation values. ; 1985.

Ward, J. V. An illustrated guide to the mountain stream insects of Colorado. : ?; 1992. 191 pp.

Ward, J. V.; and J. A. Stanford. Benthic faunal patterns along the longitudinal gradient of a Rocky Mountain river system. International Association for Theoretical and Applied Limnology; 1989; Munich, Germany. Stuttgart, Germany: E. Schweizerbart'sche Verlagsbuchhandlung; 1991; 24: 3087-3094.

--------. Draft-occurrence and significance of hyporheic zones in the Black Canyon of the Gunnison River, Colorado. 33 pp.

--------. Ecological factors controlling stream zoobenthos with emphasis on thermal modification of regulated streams. In: Ward, J. V.; and J. A. Stanford, eds. The Ecology of Regulated Streams. New York: Plenum Publishing; 1979: 35-55.

--------, eds. The ecology of regulated streams. New York: Plenum Press; 1979. 398 pp.

--------. *Ephemeroptera* of the Gunnison River, Colorado, USA. Campbell, I. and P. Suter. Proceedings of the Fifth International Conference on *Ephemeroptera*; 1989. Leiden: E. J. Brill.

--------. *Ephemeroptera* of the Gunnison River, Colorado, U.S.A. I. C. Campbell, ed. Mayflies and Stoneflies. 1990; : 215-220.

--------. The intermediate disturbance hypothesis. An explanation for biotic diversity patterns in lotic ecosystems. In: Fontaine, T. D.; and S. M. Bartell, eds. Dynamics of Lotic Ecosystems. Ann Arbor, Michigan: Ann Arbor Scientific Publishers, Inc.; 1983A: 347-356. 494 pp.

--------. Serial discontinuity in the Gunnison River, Colorado: relation to stream flows and decreed federal water rights in the Gunnison Gorge National Monument. 6 pp.

--------. The serial discontinuity concept of lotic ecosystems. In: Fontaine, T. D. III; and S. M. Bartell, eds. Dynamics of Lotic Ecosystems. Ann Arbor, Michigan: Ann Arbor Science Publishers; 1983B: 29-42.

Warner, M. T.; and D. B. Walker. Through the Black Canyon. Ann Arbor, Michigan, USA: Braun-Brumfield; 1972.

Water Science and Technology Board. Colorado River ecology and dam management. Washington, D. C.: National Academy Press; 1991. 276 pp.

Williams, G. P.; and M. G. Wolman. Downstream effects of dams on alluvial rivers. U.S. Geological Survey professional paper 1286: U.S.G.S.; 1984.

WRD file (author ?). Draft: woody riparian vegetation along the Gunnison River-Black Canyon of the Gunnison National Monument. 12 pp.

Wullschleger, J. G. Initial impacts of an impoundment on downstream benthic invertebrate fauna. ; 1990.

Resources Management / Environmental Impact Statement / Environmental Assessment

Brown, S.; M. S. Brinson; and A. E. Lugo. Structure and function of riparian wetlands [Pages 17-31]. In: R. R. Johnson and J. F. McCormick, technical coordinators. Strategies for protection and management of floodplain wetlands and other riparian ecosystems. Washington, D.C.: U. S. Forest Service, U.S.D.A.; 1979; Publ. GTR-WO-12. 410 pp.

Bureau of Land Management, Gunnison Basin Resource Area, U.S.D.I. Draft resource management plan and environmental impact statement, March, 1991. Montrose, Colorado: prepared by U. S. Dept. of the Interior, Bureau of Land Management, Colorado State Office, Montrose District, Gunnison Resource Area; 1991.

Bureau of Land Management, Montrose District, U.S.D.I. Final suitability report and environmental impact statment: proposed wilderness designation of the Powderhorn Instant Study Area, Gunnison and Hinsdale Counties, Colorado. Montrose, Colorado: prepared by Bureau of Land Management, Dept. of the Interior, Montrose District, Colorado; 1984. 196 pp.

Bureau of Land Management, U.S.D.I. Gunnison resource area resource management plan and environmental impact statement. Montrose, Colorado: B.L.M., U.S.D.I.; 1991.

--------. Management guidelines for multiple use of public lands microform: Gunnison Basin and American Flats-Silverton Planning Areas. Montrose, Colorado: B.L.M., U.S.D.I.; 1982. 47 pp.

--------. Proposed domestic livestock grazing management program in the Gunnison Basin resource area and Silverton planning unit, Montrose District, Colorado. Montrose, Colorado: B.L.M., U.S.D.I.; 1980. 401 pp.

--------. Proposed wilderness designation of the wilderness study areas within the Gunnison Basin and American Flat/Silverton planning units of the Montrose District, Colorado: draft environmental impact statement. Montrose, Colorado: B.L.M., U.S.D.I.; 1982. 50 pp.

--------. Proposed wilderness designation of the wilderness study areas within the Gunnison Basin and American Flats/Silverton planning units of the Montrose District, Colorado: final environmental impact statement. Gunnison, Colorado: Montrose District, B.L.M., U.S.D.I.; 1987. 263 pp.

--------. Resources management plan for the Gunnison Gorge Recreation Lands, Colorado. Montrose, Colorado: B.L.M., U.S.D.I.; 1985.

--------. Uncompahgre Basin resource management plan and environmental impact statement (on file at BLCA). Montrose District, Colorado: B.L.M., U.S.D.I.; 1987. 3 pp.

Bureau of Reclamation, U.S.D.I. Crystal dam, reservoir, and power plant, Curecanti unit, Colorado River storage project (final environmental impact statement). Upper Colorado Region: Bureau of Reclamation; 1971. 53 pp.

--------. Crystal dam, reservoir, and power plant, Curecanti unit, Colorado River storage project (draft environmental impact statement). Upper Colorado Region: Bureau of Reclamation; 1971. 32 pp.

--------. Crystal Dam, reservoir, and power plant, Curecanti unit, Colorado River storage project, Colorado. Supplement to final environmental impact statement. Upper Colorado Region: Bureau of Reclamation; 1973. 25 pp.

--------. Draft environmental assessment Uncompahgre Valley hydropower project. Upper Colorado Region: Bureau of Reclamation; 1988.

--------. Draft environmental impact statement, AB Lateral Hydropower Facility, Uncompahgre Valley Hydropower Project. Upper Colorado Region, Bureau of Rec.: In cooperation with the National Park Service and Bureau of Land Management; 1989. 232 pp.

--------. Final environmental impact statement: AB Lateral hydropower facility, Uncompahgre Valley Reclamation Project, Montrose and Delta Counties, Colorado, Vols. I and II. Upper Colorado Region: Bureau of Reclamation; 1990. 532 pp.

--------. Lower Gunnison Basin Unit feasibility report/final environmental statement/Colorado River Water Quality Improvement Program. Salt Lake City, Utah (?): Upper Colorado Region, Bureau of Rec., prepared in cooperation with U. S. Fish and Wildlife Service; 1984.

--------. Preliminary draft environmental impact statement, AB Lateral Hydropower Facility environmental report. Upper Colorado Region: Bureau of Rec.; 1989. 166 pp.

--------. Statement of environmental impact - overland ditch and reservoir company, Hotchkiss, Colorado, Reclamation Project. Upper Colorado Region: Bureau of Rec.; 1971.

Colorado State Planning Division. A comprehensive plan for the Gunnison-Uncompahgre region, Colorado. Denver, Colorado: Colo. State Planning Division; 1962.

Colorado West Group. Environmental assessment for water and sewer systems, Black Canyon of the Gunnison National Monument. prepared for NPS Rocky Mountain Region; 1975.

Economic Research Service, U.S.D.A. Water and related land resources, Gunnison River Basin, Colorado: a report based on a cooperative study by Colorado Water Conservation Board and United States Department of Agriculture. Salt Lake City, Utah: U.S.D.A., prepared by Economic Research Service, U. S. Forest Service, Soil Conservation Service; 1962. 103 pp.

Federal Highway Administration, U.S.D.T. Final environmental impact statement: Hotchkiss to Paonia Dam, Delta and Gunnison Counties, Colorado. Denver, Colorado (?): prepared by the Colorado Dept. of Highways in cooperation with the U. S. Dept. of Transportation, Federal Highway Administration; 1979; RS-133(5). 299 pp.

Gunnison Basin livestock grazing environmental assessment. 20 pp.

National Park Service, U.S.D.I. Amended draft environmental statement, land use plan for the East River Unit, Gunnison National Forest. Washington, D. C.: U.S.G.P.O.; 1978. 207 pp.

--------. Assessment of potential impacts to water-related resource attributes. BLCA: NPS; 1990.

--------. Black Canyon of the Gunnison National Monument, Colorado: environmental assessment, development concept plans. Denver, Colorado: prepared by Denver Service Center, National Park Service; 1980. 204 pp.

--------. Black Canyon of the Gunnison natural resource management plan and environmental assessment with finding of no significant impact. BLCA: NPS; 1983. 75 pp.

--------. Curecanti National Recreation Area: statement for management. CURE: NPS; 1984.

--------. Curecanti National Recreation Area: statement for management. CURE: NPS; 1986.

--------. Curecanti National Recreation Area: statement for management. CURE: NPS; 1988.

--------. Draft general management plan and development concept plans, Black Canyon of the Gunnison National Monument, Colorado. BLCA: NPS; 1982. 65 pp.

--------. Environmental assessment development concept plans, Black Canyon of the Gunnison National Monument, Colorado. Denver Service Center (on file at Rocky Mountain Regional Office): NPS; 1980. 204 pp.

--------. General management plan and development concept plans, Black Canyon of the Gunnison National Monument, Colorado. Denver, Colorado: Denver Service Center; 1983. 69 pp.

National Park Service, U.S.D.I.; Colorado Water Conservation Board. Gunnison wild and scenic river study: final environmental statement. Denver, Colorado: NPS Rocky Mountain Regional Office in cooperation with Colorado Dept. of Natural Resources; 1979. 116 pp.

National Park Service, U.S.D.I. Gunnison wild and scenic river study: draft environmental statement. Washington, D. C.: National Park Service: prepared in cooperation with the Colorado Water Conservation Board; 1979. 147 pp.

--------. Land protection plan, Black Canyon of the Gunnison National Monument, Colorado. NPS unpublished rport: prepared by BLCA for NPS Rocky Mountain Regional Office; 1985. 18 pp.

--------. Proposed Wilderness Area, Black Canyon of the Gunnison National Monument, Colorado: final environmental impact statement. Omaha, Nebraska: prepared by NPS Midwest Regional Office; 1972. 64 pp.

--------. Record of decision and finding of no significant impact for the General Management Plan and development concept plans, Black Canyon of the Gunnison National Monument, Colorado. Denver, Colorado: prepared by National Park Service; 1980. 4 leaves.

--------. Resource/boundary evaluation for lands adjacent to Black Canyon of the Gunnison National Monument, Colorado. Denver, Colorado: NPS Rocky Mountain Regional Office, U.S.D.I.; 1990. 76 pp.

--------. Statement for management: Black Canyon of the Gunnison National Monument. BLCA: NPS; 1987. 42 pp.

--------. Statement for management: Black Canyon of the Gunnison National Monument. BLCA: NPS; 1989. 43 pp.

--------. Study plan, canyon floor access, Black Canyon of the Gunnison Monument, Colorado. BLCA: NPS; date?

--------. Supplement to the final environmental impact statement, proposed wilderness area, Black Canyon of the Gunnison National Monument, Colorado. prepared by BLCA staff: NPS; 1976. 14 pp.

U. S. Forest Service, U.S.D.A. Analysis of impacts upon the administration, management and use of the Gunnison National Forest and upon forest resources, Curecanti Unit, Colorado River Storage Project, Colorado. Denver, Colorado: Report prepared by U.S.D.A., U. S. Forest Service, Rocky Mountain Region, in cooperation with U.S.D.I., Bureau of Reclamation; 1958. 11 leaves.

--------. Final environmental impact statement for Grand Mesa, Uncompahgre, and Gunnison National Forests: land and resource management plan. Delta, Colorado: U. S. Department of Agriculture, U. S. Forest Service; 1983.

--------. Final environmental impact statement and the land and resource management plan for the White River National Forest Land and Resource Management Plan, Eagle, Garfield, Gunnison, Mesa, Moffat, Pitkin, Rio Blanco, Routt, and Summit counties, Colorado. Glenwood Springs, Colorado: U. S. Dept. of Agriculture, U. S. Forest Service; 1984.

--------. Grand Mesa, Uncompahgre, and Gunnison National Forests: land and resource management plan (proposed). Delta, Colorado: U. S. Forest Service, Rocky Mountain Region; 1981. 114 pp.

--------. Grand Mesa, Uncompahgre, and Gunnison National Forests land and resource management plan. Delta, Colorado: U. S. Forest Service, Rocky Mountain Region; 1983.

--------. Gunnison National Forest: general statement and working circle plan, July 1, 1962-June 30, 1972. Denver, Colorado: U. S. Forest Service, Region 2; 1960. 25, 46 leaves.

--------. Mount Emmons Mining Project: final environmental impact statement. Washington, D. C.: U. S. Forest Service; 1982. 240 pp.

--------. Proposed amendment of the land and resource management plan for the Grand Mesa, Uncompahgre, and Gunnison National Forests: land and resource management plan. Delta, Colorado: U. S. Forest Service, Rocky Mountain Region; 1989.

--------. Summary of the draft environmental impact statement and proposed forest plan: Grand Mesa, Uncompahgre, and Gunnison National Forest. Delta, Colorado: U. S. Forest Service; 1982. 38 pp.

--------. Summary of the final environmental impact statement and the land and resource management plan for the White River National Forest, Eagle, Garfield, Gunnison, Mesa, Moffat, Pitkin, Rio Blanco, Roult, and Summit counties, Colorado. Glenwood Springs, Colorado: U. S. Department of Agriculture, U. S. Forest Service; 1984.

Fisheries Biology

Archer, D. L.; and H. M. Tyus. Colorado squawfish spawning study, Yampa River. Salt Lake City, Utah: U. S. Fish and Wildlife Service, Colorado River Fishery Project; 1984. 34 pp.

Archer, D. L.; L. R. Kaeding; and H. M. Tyus. Colorado River Fishes Monitoring Project, Final Report. Lakewood, Colorado: U. S. Fish and Wildlife Service, U.S.D.I.; 1986.

Archer, D. L.; L. R. Kaeding; B. D. Burdick; and C. W. McAda. A study of the endangered fishes of the Upper Colorado River. Final Report - Cooperative Agreement 14-16-0006-82-959. Grand Junction, Colorado: U. S. Fish and Wildlife Service, U.S.D.I.; 1985. 134 pp.

Archuleta, A. S.; R. Krueger; L. DeWeese; and B. Osmundson. Occurrence of inorganic elements in the Upper Colorado River Basin and implications for threatened and endangered fish. Colorado Field Office: U. S. Fish and Wildlife, Environmental Contaminants Final Report (in preparation); 1993.

Armour, C. L. (U.S. Fish and Wildlife Service, National Ecology Research Center, Riverine and Wetland Ecosystems Branch, Fort Collins, Co.) Guidance for evaluating and recommending temperature regimes to protect fish. Instream flow information paper 28. U. S. Fish and Wildlife Service: U. S. Dept. of Interior; 1991 Dec; 90(22). 13 pp.

Banks, J. L. Fish species distribution in Dinosaur National Monument during 1961 and 1962 [M. S. Thesis]. Ft. Collins, Colorado: Colorado State University; 1964. 96 pp.

Behnke, R. J. The impacts of habitat alterations on the endangered and threatened fishes of the Upper Colorado River Basin: A discussion. In: W. O. Spofford, A. L. Parker, and A. V. Kneese, Editors. Energy development in the Southwest: Problems of water, fish and wildlife in the Upper Colorado River Basin. Washington, D. C.: Resources for the Future, Research Paper R-18; 1980; 2: 182-192.

--------. Potential impacts of reduced winter flows in Gunnison River on trout reproduction and growth in relation to lower temperatures and ice formation. Fort Collins, Colorado: Colorado State University, Department of Fishery and Wildlife Biology; 1986.

Behnke, R. J.; and D. E. Benson. Endangered and threatened fishes of the Upper Colorado River Basin. Ft. Collins, Colorado: Colorado State University, Cooperative Extention Service; 1980; Bulletin 503A. 34 pp.

Bio/West, Inc. Aquatic biology studies for proposed Colorado-Ute Electric Association powerplant near Grand Junction, Colorado. Logan, Utah: Bio/West, Inc., unpublished report; 1981. 66 pp.

Bosley, C. E. Pre-impoundment study of the Flaming Gorge Reservoir. Wyoming Game and Fish Commission: Technical Report 9; 1960. 1-81.

Bozek, M. A.; and F. J. Rahel. Assessing habitat requirements of young Colorado River cutthroat trout by use of macrohabitat and microhabitat analyses. Transactions of the American Fisheries Society. 1991 Sep 12; 120(5): 571.

--------. Comparison of streamside visual counts to electrofishing estimates of Colorado River cutthroat trout fry and adults. North American Journal of Fisheries Management. 1991 Dec; 11(1): 38.

--------. Generality of microhabitat suitability models for young Colorado River cutthroat trout (Oncorhynchus clarkipleuriticus) across sites and among years in Wyoming streams. Canadian Journal of Fisheries and Aquatic Science. 1992 Mar 1; 49(3): 552.

Bozek, M. A.; L. J. Paulson; and J. E. Deacon. Factors affecting reproductive success of bonytail chubs and razorback suckers in Lake Mohave, Final Report, 14-16-0002-81-251. Boulder City, Nevada: Bureau of Reclamation; 1984.

Bramblett, R. G.; and K. D. Fausch. Fishes, macroinvertebrates and aquatic habitats of the Purgatoire River in Pinon Canyon, Colorado. The Southwestern Naturalist. 1991 Sep 1; 36(3): 281.

Bulkley, R. V.; and R. Pimental. Temperature preference and avoidance by adult razorback suckers. Transactions of the American fisheries Society. 1983; 112: 601-607.

Burdick, B. D. A plan to evaluate stocking to augment or restore razorback sucker in the Upper Colorado River. Grand Junction, Colorado: U. S. Fish and Wildlife Service; 1992. 56 pp.

Burdick, B. D.; and L. R. Kaeding. Biological merits of fish passage as part of recovery of Colorado squawfish in the Upper Colorado River Basin, final report. Grand Junction, Colorado: U. S. Fish and Wildlife Service; 1990. 23 pp.

--------. Reproductive ecology of the humpback chub and the roundtail chub in the Upper Colorado River; 1985. Proceedings of the Annual Conference of Western Association of Game and Fish Agencies: 65:163 (abstract).

Carlson, C. A.; G. G. Prewitt; D. E. Snyder; E. J. Wick; E. L. Ames; and W. D. Frank. Fishes and macroinvertebrates of the White and Yampa Rivers, Colorado. Denver, Colorado: U. S. Bureau of Land Management, U.S.D.I.; 1979; Biological Science Series No. 1. 276 pp.

Carothers, S. W.; and C. O. Minckley. A survey of the fishes, Aquatic invertebrates and aquatec plants of the Colorado River for selected tributaries from Lees ferry to Separation Rapids. Flagstaff, Arizona: Museum of Northern Arizona; 1981; U. S. Bureau of Reclamation contract 7-07030-C0026.

Chamberlain, T. K. Fishes, particularly the suckers, Catostomidae, of the Colorado River Drainage and of the Arkansas River Drainage, in relation to the Gunnison-Arkansas transmountain diversion. College Station, Texas: U. S. Fish and Wildlife Service, U.S.D.I.; 1946.

Chart, T. E. Impact of mainstream impoundment on the distrubution and movements of the resident flannelmouth sucker (*Catostomus latipinnis*) population in the White River, Colorado. The Southwestern Naturalist. 1992 Mar 1; 37(1): 9.

Day, J. S. Fish of the Black Canyon of the Gunnison National Monument. Black Canyon of the Gunnison National Monument, unpublished report: National Park Service; 1975. 21 pp.

Douglas M. E.; and P. C. Marsh. Ecology and conservation biology of the humpback chub (Gila cypha) in the Little Colorado River; progress report to Bureau of Reclamation. Tempe, Arizona: Arizona State University; 1993; Cooperative Agreement No. 1-FC-40-10490. 8 pp.

Douglas, M. E.; W. L. Minckley; and H. M. Tyus. Qualitative characters, identification of Colorado River Chubs (Cyprinidae: genus Gila), and the 'Art of Seeing Well'. Copeia. 1989 Aug 8; (3): 653.

Ecology Consultants, Inc. Capture locations of rare fish in the Upper Colorado River system; final report. Fort Collins, Colorado: U. S. Fish and Wildlife Service, U.S.D.I.; 1978; FWS/ OBS-78/32. 44 pp.

Ellis, M. M. Fishes of Colorado. Boulder, Colorado: University of Colorado Studies; 1914; Vol 11(1). 136 pp.

Espergen, G. G.; D. D. Miller; and R. B. Nehring. Modeling the effects of various angling regulations on trout populations in Colorado streams. Special Report Number 67: Colorado Division of Wildlife; 1990. 24 pp.

Gorman, O. T.; S. C. Leon; O. E. Maughan. Habitat use by humpback chub, *Gila cypha*, in the Little Colorado River and other tributaries of the Colorado River in the Grand Canyon; annual report to Bureau of Reclamation. Pinetop, Arizona: U. S. Fish and Wildlife Service; 1993; Glen Canyon Environmental Studies Phase II. 34 pp.

Gosse, J. C. Microhabitat of trout in tailwaters below western dams. ; 1985.

Haynes, C. M.; and R. T. Muth. Identification of habitat requirements and limiting factors for Colorado squawfish and humpback chubs. Federal Aid Project Progress Report, SE-4: Colorado Division of Wildlife; 1982. 43 pp.

--------. Identification of habitat requirements and limiting factors for Colorado squawfish and humpback chubs. Federal Aid Project Progress Report, SE-3: Colorado Division of Wildlife; 1984. 21 pp.

Holden, P. B. The relationship between flows in the Yampa River and success of rare fish populations in the Green River system. Logan, Utah: Bio/West, Inc.; 1980; Report PR-31-1. 39 pp.

--------. A study of habitat use and movement of the rare fishes in the Green River, Utah. Transactions of the Bonneville Chapter, American Fisheries Society. 1978: 66-89.

Holden, P. B.; and T. M. Twedt. The development of habitat suitability curves and estimation of available habitat for Colorado squawfish in the San Juan River, New Mexico and Utah. Logan, Utah: Bio/West, Inc.; 1980; Report PR-46-1-1.

Holden, P. B.; and L. W. Crist. Documentation of changes in the macroinvertebrate and fish populations in the Green River system. Logan, Utah: Bio/West Inc.; 1980; Report PR-16-5. 92 pp.

--------. Documentation of changes in the macroinvertebrate and fish populations in the Green River due to inlet modification of Flaming Gorge Dam. Logan, Utah: Bio/West Inc.; 1981; Report PR- 16-5. 92 pp.

Holden, P. B.; and E. J. Wick. Life history and prospects for recovery of Colorado squawfish. Pages 98-108 In: W. H. Miller, H. M. Tyus, and C. A. Carlson, editors. Proceedings of a symposium on fishes of the Upper Colorado River system: present and future. Bethesda, Maryland: American Fisheries Society; 1982. 131 pp.

Holden, P. B.; C. Richards; L. W. Crist; and J. R. Campbell. Aquatic biology studies for proposed Colorado-Ute Electric Association power plant near Grand Junction, Colorado. Submitted to Burns and McDonnell Planning and Environmental Analysis Division: Kansas City, MO; 1981; PR 56-1. 66 pp.

Huner, J. V. Exploitation of freshwater crayfishes in North America. Fisheries. 1978; 3(6): 2-19.

Joseph, T. W.; J. A. Sinning; R. J. Behnke; and P. B. Holden. An evaluation of the status, life history and habitat requirements of endangered and threatened fishes of the Upper Colorado River system. Fort Collins, Colorado: U. S. Fish and Wildlife Service, U.S.D.I.; 1977; FWS/OBS-77/2.

Kaeding, L. R.; and D. B. Osmundson. Biologically defensible flow recommendations for the maintenance and enhancement of Colorado squawfish habitat in the '15-mile' reach of the Upper Colorado River during July, August and September. Grand Junction, Colorado: U. S. Fish and Wildlife Service, U.S.D.I.; 1989. 169 pp.

Kidd, G. (Northwest Fisheries Research). An investigation of endangered and threatened fish species in Upper Colorado River as related to Bureau of Reclamation projects; final report. Salt Lake City, Utah: U. S. Bureau of Reclamation, U.S.D.I.; 1977. 36 pp.

Kinnear, B. S.; and R. E. Vincent. Fishes and fish in the Black Canyon of the Gunnison National Monument. Fort Collins, Colorado: Colorado State University; 1967. 45 pp.

Kondolf, G. M.; G. F. Cada; and M. J. Sale. Assessing flushing- flow requirements for brown trout spawning gravels in steep streams. Water Resources Bulletin. 1987; 23: 127-135.

Kunkle, S.; R. Nickerson; G. Smillie; and R. Andrascik. Metal concentrations in fish at Curecanti National Recreation Area, Gunnison, Colorado. Curecanti NRA: U.S. National Park Service; 1983.

Loudermilk, W. E. Aspects of razorback sucker (*Xyrauchen texanus*, Abbott) life history which help explain their decline. Proceedings of the Desert Fishes Council. 1985; 13(1981): 67-72.

Maddux, H. R.; L. A. Fitzpatrick; and W. R. Noonan. Colorado River endangered fishes critical habitat, draft biological support document. Salt Lake City, Utah: U. S. Fish and Wildlife Service, Utah/Colorado Field Office; 1993 Sep 3. 225 pp.

Marsh, P. C.; and W. L. Minckley. Observations on recruitment and ecology of razorback sucker: Lower Colorado River, Arizona-California-Nevada. The Great Basin Naturalist. 1989 Jan 31; 49(1): 71-78.

Martinez, P. J. White River Taylor Draw Project: pre- and post- impoundment fish community investigations; final report. Grand Junction, Colorado: Colorado Division of Wildlife; 1986A; Contract 5281-x. 121 pp.

McAda, C. W.; and L. R. Kaeding. Movements of adult Colorado squawfish during the spawning season in the Upper Colorado River. Transactions of the American Fisheries Society. 1991 May 1; 120(3): 339.

McKean, J. R.; D. M. Johnson; and R. G. Walsh. Gunnison County interindustry spending and employment attributed to fishing at Blue Mesa Reservoir. Fort Collins, Colorado: Colorado Water Resources Research Institute, Colorado State University; 1988; 53. 114 pp.

Median, A. L. Possible effects of residential development on streamflow, riparian plant communities, and fisheries on small mountain streams on central Arizona. Forest Ecology and Management. 1990 Jun 1; 33/34(1/4): 335.

Middleton, W. H. Hybridization and distribution of Catostomid fishes in Blue Mesa Reservoir and the Upper Gunnison River Drainage. Gunnison, Colorado: Western State College of Colorado; 1969. 121 leaves.

Miller, D. D. Application of a population simulation model to the selection of angling regulations for stream fisheries. ; 1992. 39 pp.

Miller, W. H.; H. M. Tyus; and C. W. McAda. Movements, migration and habitat preference of radiotelemetered Colorado squawfish, Green, White, and Yampa Rivers, Colorado and Utah; Colorado River Fishery Project. Salt Lake City, Utah: U. S. Fish and Wildlife Service; 1983. 39 pp.

Minckley, W. L.; and G. K. Meffe. Differential selection by flooding in stream fish communities in the arid American Southwest. Pages 93-105 In: W. J. Matthews and D. C. Heins. Community and evolutionary ecology of North American stream fishes. Norman: University of Oklahoma Press; 0310; cpp.

Molles, M. The impacts of habitat alterations and introduced species on the native fishes of the Upper Colorado River Basin. Pages 163-181 In: W. O. Spofford, A. L. Parker, and A. V. Kneese, editors. Energy development in the Southwest - problems of water, fish and wildlife in the Upper Colorado River Basin; Vol. 2 Resources for the Future. Washington, D.C.; 1980.

Nehring, R. B. Fish flow investigations: F-51-R, Job no. 1, progress report. Fort Collins, Colorado: Colorado Division of Wildlife, Federal Aid in Fish and Wildlife Restoration; 1988.

--------. Fisherman use and catch evaluation of the Gunnison River and sport fish population analysis for 1988 from the east portal access area below Crystal Dam to the North Fork confluence. Fort Collins, Colorado: Colorado Division of Wildlife; 1988.

--------. Gunnison River sport fish population evaluation and fisherman use and catch study for the East Portal access area below Crystal Dam to the North Fork confluence. Fort Collins, Colo.: Colorado Division of Wildlife; 1983.

--------. Job 1. Fish flow investigations; Job 2. Wild trout introductions. Fort Collins, Colorado: Colorado Division of Wildlife; 1988; F-51.

--------. Stream fisheries investigations: Colorado Division of Wildlife, Federal Aid in Fish and Wildlife Restoration, F-51, final report. Fort Collins, Colorado: Colorado Division of Wildlife; 1988. 34 pp.

Nehring, R. B.; and D. D. Miller. The influence of spring discharge levels on rainbow and brown trout recruitment and survival, Black Canyon of the Gunnison River, Colorado, as determined by IFIM/PHABSIM models. Proceedings of the Western Association of Fish and Wildlife Agencies and the Western Division of the American Fisheries Society; 1987. ; 67: 388-397.

Nehring, R. B.; and R. Anderson. Stream fisheries investigations, Colorado Division of Wildlife, Federal Aid in Fish and Wildlife Restoration, F-51, job progress report. Fort Collins, Colorado: Colo. Div. of Wildlife; 1985.

Nelson, S. M.; and S. A. Flickinger. Salinity tolerance of Colorado squawfish, *Ptychocheilus lucius* (*Pisces: Cyprinidae*). Hydrobiologia. 1992 Oct 23; 246(2): 165.

Nesler, T. P.; and L. Lentsch. Aspinall Unit studies; 1992 annual project report; Colorado River Fishes Recovery Program. 1992. 7 pp.

Nesler, T. P.; R. T. Muth; and A. F. Wasowicz. Evidence for baseline flow spikes as spawning cues for Colorado squawfish in the Yampa River. Colorado American Fisheries Society Symposium; 1988. 5: 68-79.

Osmundson, D. B.; and L. R. Kaeding. Recommendations for flows in the '15-mile reach' during October-June for maintenance and enhancement of endangered fish populations in the Upper Colorado River; final report. Grand Junction, Colorado: Region 6, U. S. Fish and Wildlife Service, U.S.D.I.; 1991. 81 pp.

--------. Studies of Colorado squawfish and razorback sucker use of the '15-mile reach' of the Upper Colorado River as part of conservation measures for the Green Mountain and Ruedi Reservoir water sales; final report. Grand Junction, Colorado: U. S. Fish and Wildlife Service, U.S.D.I.; 1989.

Paulin, K.; H. Tyus; and C. Williams. Responce of young Colorado squawfish and razorback suckers to water flow and light intensity; unpublished report. Vernal, Utah: U. S. Fish and Wildlife Service; 1990.

Perry, J. A.; and D. J. Schaeffer. The longitudinal distribution of riverine benthos: A river dis-continuum? Hydrobiologia. 1987; 148: 257-268.

Pucherelli, M. J.; R. C. Clark; and R. D. Williams. Mapping backwater habitat on the Green River as related to the operation of Flaming Gorge Dam using remote sensing and GIS. Denver, Colorado: United States Bureau of Reclamation Research and Laboratory Services Division report; 1990; R-90-18. 11 pp.

Quartarone, F. Historical accounts of Upper [Colorado] Basin endangered fish. Denver, Colorado: Colorado Division of Wildlife; 1993.

Seethaler, K. H. Life history and ecology of the Colorado squawfish (*Ptychocheilus lucius*) in the Upper Colorado River Basin [Masters Thesis]. Logan, Utah: Utah State University; 1978. 155 pp.

Seethaler, K. H.; C. W. McAda; and R. S. Wydoski. Endangered and threatened fish in the Yampa and Green Rivers of Dinosaur National Monument. Pages 605-612 In R. M. Linn: editor. Proceedings of the First Conference on Scientific Research in National Parks. National Park Service, Transactions and Proceedings Series Number 5: U.S.D.I.; 1979.

Stalnaker, C. B.; and P. B. Holden. Changes in native fish distribution in the Green River system, Utah-Colorado. Proceedings of the Utah Academy of Science; 1973. 50(1): 25-32.

Stanford, J. A.; and J. V. Ward. Fish of the Colorado system. In: Davies, B. R.; and K. F. Walker, eds. The ecology of river systems. Dordrecht, The Netherlands: Dr. W. Junk Publishers; 1986: 385-402.

Thompson, J. M.; and E. P. Bergersen. Role of size, condition, and lipid content in the overwinter survival of age-0 Colorado squawfish. Transaction of the American Fisheries Society. 1991 May 1; 120(3): 346.

Tyus, H. M. Distribution, reproduction, and habitat use of the razorback sucker in the Green River, Utah, 1979-1986. Transactions of the American Fisheries Society; 1987. 116: 111- 116.

--------. An instream flow philosophy for recovering endangered Colorado River fishes. Rivers: studies in the science, environmental... 1992 Jan 1; 3(1): 27.

--------. Loss of stream passage as a factor in the decline of the endangered Colorado squawfish. Pages 138-144 In: Issues and Technology in the Management of Impacted Western Wildlife; Proceedings of a national symposium. Boulder, Colorado: Thorne Ecological Institute Technical Publication 14; 1984.

--------. Management of Colorado squawfish. Pages 379-402 In: W. L. Minckley and J. E. Deacon, editors. Battle Against Extinction. Tucson, Arizona: University of Arizona Press; 1991A.

--------. Movement and habitat use of young Colorado squawfish in the Green River, Utah. Journal of Freshwater Ecology. 1901 Mar; 6(1): 43-51.

Tyus, H. M.; and G. B. Haines. Distribution, habitat use, and growth of age-0 Colorado squawfish in the Green River Basin, Colorado and Utah. Transaction of the American Fisheries Society. 1991 Jan 1; 120(1): 79.

--------. Fish associations and environmental variables in age-0 Colorado sqauwfish habitats, Green River, Utah. Journal of Freshwater Ecology. 1990 Dec 1; 5(4): 427.

Tyus, H. M.; and C. A. Karp. Habitat use and streamflow needs of rare and endangered fishes, Yampa River, Colorado. Vernal, Utah: U. S. Fish and Wildlife Service, U.S.D.I.; 1989; FWS Biological Report 89 (14). 27 pp.

--------. Habitat use and streamflow needs of rare and endangered fishes, Green River, Utah. Vernal, Utah: U. S. Fish and Wildlife Service, U.S.D.I.; 1991. 54 pp.

Tyus, H. M.; and C. W. McAda. Migration, movements and habitat preferences of Colorado squawfish, *Ptychocheilus lucius*, in the Green, White, and Yampa Rivers, Colorado and Utah. The Southwestern Naturalist. 1984; 29: 289-299.

Tyus, H. M.; and E. Wang. Potamodromy and reproduction of Colorado squawfish in the Green River Basin, Colorado and Utah. Transaction of the American Fisheries Society. 1990 Nov 1; 119(6): 1035.

Tyus, H. M.; and C. A. Karp. Spawning and movement of razorback sucker, *Xyrauchen texanus*, in the Green River Basin of Colorado and Utah. The Southwestern Naturalist. 1990 Jan; 35(4): 427.

U. S. Fish and Wildlife Service, U.S.D.I. Bonytail chub Recovery Plan. Denver, Colorado: Prepared by Colorado Fishes Recovery Team for U. S. Fish and Wildlife Service; 1990A. 35 pp.

--------. Colorado River Storage Project, Bostwick Park Project, Colorado (BR): Bureau of Sport Fisheries and Wildlife report. Albuquerque, N.M.: U. S. Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife, U.S.D.I.; 1959. 6 leaves.

--------. Colorado squawfish Recovery Plan. Denver, Colorado: Prepared by Colorado Fishes Recovery Team for U. S. Fish and Wildlife Service; 1991. 56 pp.

--------. Humpback chub Recovery Plan. Denver, Colorado: Prepared by Colorado Fishes Recovery Team for U. S. Fish and Wildlife Service; 1990B. 43 pp.

--------. Overview of the proposed critical habitat designation for the four Colorado River endangered fishes, draft [part one of three part series], economic overview. Biologists: H. R. Maddux; W. R. Noonan; and L. A. Fitzpatrick; Economists: D. S. Brookshire; M. McKee; and G. Watts. Salt Lake City, Utah: U. S. Fish and Wildlife, Utah Field Office; 1993 Nov 4. 65 pp.

--------. Recovery implementation program for endangered fish species in the Upper Colorado River Basin, draft, fiscal year 1993 work plan. Denver, Colo.: Region 6, U. S. Fish and Wildlife Service; 1992 Aug.

U. S. Fish and Wildlife Service, U. S. D. I. Critical habitat designations proposed for four Colorado River fishes. Endangered Species Technical Bulletin. 1993; 18(2): 7-11.

Valdez, R. A. Characterization of the life history and ecology of the humpback chub in the Grand Canyon. Annual Report to the Bureau of Reclamation. Logan, Utah: Bio/West, Inc.; 1991; Report No. TR 250-02. 74 pp.

Valdez, R. A.; and M. Hugentobler, Editors. Characterization of the life history and ecology of the humpback chub (*Gila cypha*) in the Grand Canyon. Annual Report-1992 to Bureau of Reclamation. Logan, Utah: Bio/West, Inc. Report No. TR 250-06; 1993. 168 pp plus appendices.

Valdez, R. A.; and E. J. Wick. Natural vs. manmade backwaters as native fish habitat. Pages 519-536 In: V. D. Adams and V. A. Lamarra, Editors. Aquatic Resources Management of the Colorado River Ecosystem. Ann Arbor, Michigan: Ann Arbor Science; 1983.

Valdez, R. A.; and W. J. Masslich. Winter habitat study of endangered fish, Green River. Wintertime movement and habitat of adult Colorado squawfish and razorback suckers. Salt Lake City, Utah: Bio/West, Inc., prepared for the Bureau of Reclamation; 1989; Report No. 136-2. 184 pp.

Valdez, R. A.; P. B. Holden; and T. B. Hardy. Habitat suitability index curves for humpback chub of the Upper Colorado River Basin. Rivers. 1990; 1: 31-42.

Valdez, R. A.; P. G. Mangan; M. McInery; and R. P. Smith. Tributary report: fishery investigations o the Gunnison and Dolores Rivers. Pages 321-362 In: W. H. Miller, J. J. Valentine, D. L. Archer, H. M. Tyus, R. A. Valdez, and L. Kaeding, Editors. Part 2 - Field investigations. Colorado River Fishery Project. Salt Lake City, Utah: U. S. Bureau of Reclamation, U.S.D.I.; 1982A.

Valdez, R. A.; W. J. Masslich; and W. C. Leibfried. Characterization of the life history and ecology of the humpback chub (*Gila cypha*) in the Grand Canyon. Annual Report to Bureau of Reclamation. Logan, Utah: Bio/West, Inc. Report No. TR 250-04; 1992. 222 pp.

Vanicek, C. C. Ecological studies of native Green River fishes below Flaming Gorge Dam, 1964-1966 [Ph. D. Dissertation]. Logan, Utah: Utah State University; 1967. 124 pp.

Vanicek, C. D.; R. H. Kramer; and D. R. Franklin. Distribution of Green River fishes in Utah and Colorado following closure of Flaming Gorge Dam. The Southwestern Naturalist. 1970; 14: 297- 315.

Wick, E. J. River management and habitat restoration strategy: an issue paper on habitat development. Recovery Program - Endangered Fishes - Upper Colorado River: U. S. Fish and Wildlife Service Technical Paper in prep.; 1992.

Wick, E. J.; D. E. Snyder; D. Langlois; and T. Lytle. Colorado squawfish and humpback chub population and habitat monitoring. Federal Aid to Endangered Wildlife Job Progress Report. SE-3-2. Denver, Colorado: Colorado Division of Wildlife. 56 pp plus appendices.

Wick, E. J.; D.L. Stoneburner; and J. A. Hawkins. Observations on the ecology of Colorado squawfish (*Ptychocheilus lucius*) in the Yampa River, Colorado, 1982. Progress Report SE-3-5. Ft. Collins, Colorado: National Park Service, Water Research Field Support Laboratory Report No. 83-7, Colorado Division of Wildlife; 1983. 55 pp.

Wick, E. J.; J. A. Hawkins; and C. A. Carlson. Colorado sqawfish population and habitat monitoring 1983-1984. Final Report SE-3-7. Ft. Collins, Colorado: Colorado Division of Wildlife and Colorado State University, Larval Fish Laboratory; 1985. 48 pp.

--------. Colorado sqawfish population and habitat monitoring 1985. Final Report SE-3-8. Ft. Collins, Colorado: Colorado Division of Wildlife and Colorado State University, Larval Fish Laboratory; 1986. 80 pp.

Wick, E. J.; J. A. Hawkins; and T. P. Nesler. Occurrence of two endangered fishes in the Little Snake River, Colorado. The Southwestern Naturalist. 1991 Jun 1; 36(2): 251.

Wick, E. J.; T. A. Lytle; and C. M. Haynes. Colorado squawfish and humpback chub population and habitat monitoring, 1979-1980. Progress Report, Endangered Wildlife Investigations. SE-3-3. Denver, Colorado: Colorado Division of Wildlife; 1981. 156 pp.

Wiltzius, W. J. Some factors historically affecting the distribution and abundance of fishes in the Gunnison River: final report for fishery investigations of the lower Gunnison River drainage (administered by U.S. Bureau of Reclamation and Colorado Department of Natural Resources, Division of Wildlife). Fort Collins, Colorado: Colorado Division of Wildlife; 1978. 215 leaves.

Woodbury, A. M. Ecological studies of the flora and fauna of the Curecanti Reservoir Basins, Western Colorado. Salt Lake City: Dept. of Anthropology, University of Utah; 1962. 285 pp.

Young, C., ed. Gunnison flows boosted for native fish species. Recovery Program for the Endangered Fishes of the Upper Colorado, Newsletter (multiagency program). Colorado Division of Wildlife, 6060 Broadway, Denver, Co. 80216; 1992 Sep.

Geology / Geomorphology / Soils

Andrews, E. D. Effective and bankfull discharge of streams in the Yampa River basin, Colorado and Wyoming. Hydrology. 1980; 46: 311-330.

--------. Present and potential sediment yields in the Yampa River basin, Colorado and Wyoming. U. S. Geological Survey: Water Resources Investigations; 1978; 79-195. 33 pp.

--------. Sediment transport in the Colorado River Basin. in: Colorado River ecology and dam management, proceedings of a symposium; 1990 May 24; Santa Fe, New Mexico. Wash., D. C.: National Academy Press; 1990: 54-74.

Andrews, E. D.; and J. M. Nelson. Topographic response of a bar in the Green River, Utah to variation in discharge. S. Ikeda; and G. Parker, eds. River Meandering: American Geophysical Union Water Resources Monograph. 1989; 12: 463-485.

Armbrustmacher, T. J.; et al. Mineral resources of the Gunnison Gorge Wilderness Study Area, Montrose and Delta counties, Colorado. Washington, D. C.: U. S. Dept. of the Interior, U. S. Geological Survey; 1989. 14 pp. For sale by the Books and Open- File Reports Section, U. S. Geological Survey, Federal Center.

Asplund, K. K.; and M. T. Gooch. Geomorphology and the distributional ecology of Fremont Cottonwood (Populus fremontii) in a desert riparian canyon. Desert Plants. 1988; 9(1): 17.

Atwood, W. W.; and K. F. Mather. The grand canyon of the Gunnison River (abstract). Association of American Geographers. 1915; 5: 138-139.

Baker, V. R.; and D. F. Ritter. Competence of rivers to transport coarse bedload material. Geological Society of America Bulletin (Doc. no. 50714). 1975 Jul; 86: 975-978.

Beaumont, P.; and T. M. Oberlander. Observations on stream discharge and competence at Mosaic Canyon, Death Valley, California. Geological Society of America Bulletin. 1971; 82(6).

Beus, S. S.; and C. C. Avery; et al. (Northern Arizona University and others). The influence of variable discharge regimes on Colorado River sand bars below Glen Canyon dam: draft final report. Chapter 10: An integration of results from the GCES sand bar stability research project. Northern Arizona University, Flagstaff, Arizona: U.S. Dept. of Interior, National Park Service Cooperative Parks Study Unit; 1992. 19 pp.

Bradley, W. C.; and A. I. Mears. Calculations of flows needed to transport coarse fraction of Boulder Creek alluvium at Boulder, Colorado. Geological Soceity of America Bulletin. 1980 Mar; 91(Part 2): 1057-1090.

Branson, E. B. Course of the Gunnison River in Colorado. Geological Survey of America Bulletin. 1925; 36(1): 139.

Brayshaw, A. C. Bed microtopography and entrainment thresholds in gravel-bed rivers. Geological Society of America Bulletin. 1985; 96: 218-223.

Bridge, J. S.; and J. Jarvis. Velocity profiles and bed shear stress over various bed configurations in a river bend. Earth Surface Processes. 1977; 2: 281-294.

Bull, W. B. Relations of alluvial-fan size and slope to drainage- basin size and lithology in western Fresno County, California. Geological Survey Professional Paper 450-B, Article 19, pp. B-51 - B-53: U.S.G.S.; 1962; Geological Survey Research 1962, Short Papers in Geology, Hydrology, and Topography (Articles 1-59).

Butler, D. L.; et al. Reconnaissance investigation of water quality, bottom sediment, and biota associated with irrigation drainage in the Gunnison and Uncompahgre River basins and at Sweitzer Lake, west-central Colorado, 1988-89. Denver, Colorado: U.S.D.I., U. S. Geological Survey, Books and Open File Reports Section; prepared in cooperation with the U. S. Fish and Wildlife Service and the U. S. Bureau of Reclamation; 1991; 91-4103. 99 pp.

Butler, M. Minimum streamflow hydropgraphs and sediment transport in the Yampa River canyon reaches. Region 6 draft report: U.S. Fish and Wildlife Service; 1988.

Chase, K. J. Gunnison River thresholds for gravel and cobble motion, Black Canyon of the Gunnison National Monument. Fort Collins, Colorado: Colorado State University; 1992. 104 pp.
Masters thesis.

Colby, B. R.; and C. H. Hembre. Computations of total sediment discharge, Niobrara River near Cody, Nebraska. Water Supply Paper 1357: U. S. Geological Survey; 1955.

Colorado Agricultural Experiment Station. List and location of snow courses and soil moisture stations. Fort Collins, Colorado; 1971. 16 pp.

Costa, J. E. Paleohydraulic reconstruction of flash flood peaks from boulder deposits in the Colorado Front Range. Geological Society of America Bulletin. 1983; 94: 986-1004.

Costa, J. E.; and Jarrett, R. D. Debris flows in small mountain stream channels of Colorado and their hydrologic implications. Bulletin of the Association of Engineering Geologists. 1981; 18: 309-322.

Davis, A.; and R. L. Olsen. Distribution of metals between water and entrained sediment in streams impacted by acid mine discharge, Clear Creek, Colorado U. S. A. Applied Geochemistry: Journal of the International ... 1991; 6(3): 333.

Dekamps, H.; M. Fortune; F. Gazelle; and G. Pautou. Historical influence of man on the riparian dynamics of a fluvial landscape. Landscape Ecology. 1988; 1: 163-174.

Dolan, R.; A. Howard; and D. Trimble. Structural control of the rapids and pools of the Colorado River in the Grand Canyon. Science. 1978; 202(4363): 629-631.

Dolson, J. The Black Canyon of the Gunnison, a story in stone: the natural and human history of Black Canyon of the Gunnison National Monument. Boulder, Colorado: Pruett Publishing Co.; 1982. 53 pp.

Dowdy, D. R.; and V. A. Vanoni. Modeling alluvial channels. Water Resources Research. 1986; 22(9): 71S-81S.

Elliott, J. G.; and R. S. Parker. Potential climate-change effects on bed-material entrainment, the Gunnison Gorge, Colorado. 28th Annual Conference and Symposia of the American Water Resources Association; 1992 Nov; Reno, Nevada. 9 pp.

Emmett, W. W. Bedload transport in two large, gravel-bed rivers, Idaho and Washington. Third Federal Inter-Agency Sedimentation Conference. ; 1976: 4-101-4-114.

Fahnestock, R. K. Morphology and hydrology of a glacial stream - White River, Mount Rainier, Washington. Geological Survey Professional Paper 422-A; 1963. 70 pp.

Florsheim, J. L.; P. Goodwin; and Y. Rubin (Philip Williams & Associates, Ltd., Pier 35 The Embarcadero, S.F., CA 94133, and Dept. of Civil Eng., U. C., Berkley CA 94720). Historic changes in geomorphic and hydrologic processes in the Russian River, California. In managing regulated streams poster session. American Geophysical Union; 1992 Dec.

Fox, C. J.; and J. Y. Nishimura. Soil management report: Taylor River area, Gunnison National Forest. Denver, Colorado: U. S. Forest Service, Rocky Mountain Region, Division of Multiple Use, Soils and Watershed Management; 1965. 87 leaves.

Fox (F. M.) & Associates. Roaring Fork and Crystal Valleys: an environmental and engineering geology study --Eagle, Garfield, Gunnison and Pitkin counties, Colorado. Denver, Colorado: Colorado Geological Survey, Dept. of Natural Resources. Prepared for the Colorado Geological Survey and the Colorado Division of Planning; 1974.

Garde, R. Yampa River morphological characteristics. In: Simons, D.; R. Li; P. Lagasse; and R. Milhous. Workshop on downstream river channel changes resulting from diversions or reservoir construction. U.S. Fish and Wildlife Service; 1980: 29-46.

Gellis, A.; R. Hereford; and S. A. Schumm. Channel evolution and hydrologic variations in the Colorado River basin: factors influencing sediment and salt loads. Journal of hydrology. 1991 May 1; 124(3): 317.

Geologic map of the Black Canyon of the Gunnison and vicinity, western Colorado [U.S. Geological Survey Miscellaneous Geologic Investigations Map I-584]. Hansen, W. R. : U.S. Geological Survey; 1971. ; 1:24,000.

Girty, G. H.; and A. Armitage. Composition of Holocene Colorado River sand: An example of mixed-provenance sand derived from multiple tectonic elements of the Cordilleran Continental Margin. Journal of Sedimentary petrology. 1989 Jul 1; 59(4): 597.

Gomez, B.; and M. Church. An assessment of bed load sediment transport formulae for gravel bed rivers. Water Resources Research. 1989; 25(6): 1161-1186.

Graf, W. L. The effect of dam closure on downstream rapids. Water Resources Research. 1980; 16(1): 129-136.

--------. Late Holocene sediment storage in canyons of the Colorado Plateau. Geological Society of America Bulletin. 1987; 99: 261-271.

--------. Rapids in canyon rivers. Journal of Geology. 1979; 87: 533-551.

Gray, J. R.; and G. G. Fisk. Monitoring radionuclide and suspended-sediment trasport in the Little Colorado River basin, Arizona and New Mexico, USA. IAHS publication. 1992; (210): 505.

Hansen, W. R. The Black Canyon of the Gunnison in depth. Tucson, Arizona, USA: Southwest Parks and Monuments Association (Also U. S. Geological Survey Bulletin 1191); 1987. 58 pp.

--------. The Black Canyon of the Gunnison, Colorado. In: Beus, S. S., ed. Centennial field guide - Rocky Mountain section. Geological Society of America; 1987; 6: 321-324.

--------. Curecanti pluton, an unusual intrusive body in the Black Canyon of the Gunnison National Monument, Colorado. U.S. Geological Survey Bulletin. 1963; 1181-D: D1-D15.

--------. Geologic and physiographic highlights of the Gunnison River and vicinity, Colorado. In: New Mexico Geological Society Guidebook, pp. 145-154, 32nd Field Conference, Western Slope, Colorado; 1981.

Hansen, W. R.; and Z. E. Peterman. Basement-rock geochronology of the Black Canyon of the Gunnison, Colorado. U.S.G.S. professional paper: U.S. Geological Survey; 1968; 600-C. C80-C90.

Hubbell, D. W.; and D. Q. Matejka. Investigations of sediment transportation, Middle Loup River at Dunning, Nebraska. Geological Water-Supply Paper 1476; 1959.

Hunter, J. F. Pre-Cambrian rocks of Gunnison river, Colorado. Washington, D. C.: U. S. Government Printing Office; 1925. 94 pp.

Hunter, W. R. Soil survey of Paonia area, Colorado: parts of Delta, Gunnison, and Montrose Counties. Washington, D. C.: U. S. Dept. of Agriculture, Soil Conservation Service; 1981. 184 pp.

Hunter, W. R.; and C. F. Spears. Soil survey of Gunnison Area, Colorado, parts of Gunnison, Hinsdale, and Saguache Counties. Washington, D. C.: U. S. Govt. Print Off. U. S. Department of Agriculture, Soil Conservation Service, in cooperation with Colorado Agricultural Experiment Station; 1975. 85 pp.

Hupp, C. R. Plant ecological aspects of flood geomorphology and paleoflood history. In: Baker, V. R.; R. K. Kochel; and P. C. Patton, eds. Flood Geomorphology. Published by Wiley; 1988.

--------. Riparian vegetation recovery patterns following stream channelization: a geomorphic perspective. Ecology. 1992 Aug 1; 73(4): 1209.

Kaplinski, M. A.; J. Hazel; H. M. Mayes; S. S. Beus; and L. Stevens (Northern Arizona University, Geology Department, Flagstaff, AZ 86011-6030 and NPS-RMD, Grand Canyon, AZ 86023). The influence of variable discharge regimes on Colorado River sand bars below Glen Canyon dam. American Geophysical Union; 1992 Dec.

Karr, J. R.; and I. J. Schlosser. Water resources and the land- water interface. Science. 1978; 201: 229-234.

Kellerhals, R. Yampa River. Simons, D.; R. Li; P. Lagasse; and R. Milhous, editors. Workshop on downstream river channel changes resulting from diversions or reservoir construction. U.S. Fish and Wildlife Service; 1980: 47-54.

Knopf, F. L.; and M. L. Scott. Altered flows and created landscapes in the Platte River headwaters, 1840-1990. In: Sweeney, J. M., ed. Management of dynamic ecosystems. West Lafayette, Indiana, USA: The Wildlife Society, North Central Section; 1990: 47-70.

Komar, P. D. Applications of grain-pivoting and sliding analyses to selective particle entrainment of gravel and to flow- competence evaluations. Sedimentology.

--------. Flow-competence evaluations of the hydraulic parameters of floods: an assessment of the technique. British Geomorphology Research. Flood Volume.

--------. Sediment transport by floods. In: Baker, V. R.; R. C. Kochel; and P. C. Patton, eds. Flood Geomorphology. Wiley; 1988.

--------. Selective gravel entrainment and the empirical evaluation of flow competence. Sedimentology. 1987; 34: 1165- 1176.

Kondolf, G. M.; G. F. Cada; and M. J. Sale. Assessing flushing- flow requirements for brown trout spawning gravels in steep streams. Water Resources Bulletin. 1987; 23: 127-135.

Kostaschuk, R. A.; G. M. McDonald; and P. E. Putnam. Depositional processes and alluvial fan-drainage basin morphometric relationships near Banff, Alberta, Canada. Earth Surface Processes and Landforms. 1986; 11: 471-484.

Kovalchik, B. L.; and L. A. Chitwood. Use of geomorphology in the classification of riparian plant associations in mountainous landscapes of central Oregon, U. S. A. Forest Ecology and Management. 1990 Jun 1; 33/34(1/4): 605.

Krishna, J. H.; J. G. Arnold; and C.W. Richardson. Predicting water and sediment yields from agricultural and grassland watersheds. Modeling Agricultural, Forest, and Rangeland Hydrology, Proceedings of the 1988 International Symposium; 1988 Dec 12; Chicago, Illinois. American Society of Agricultural Engineers.

Lane, L. J.; M. H. Diskin; and K. G. Renard. Input-output relationships for an ephemeral stream channel system. Journal of Hydrology. 1971; 13(1): 22-40.

Larkin, R. G.; and J. M. Sharp Jr. On the relationship between river-basin geomorphology, aquifer hydraulics, and ground-water flow direction in alluvial aquifers. The Geographical Society of America Bulletin. 1992 Dec;

Laronne, J. B.; and M. A. Carson. Interrelationships between bed morphology and bed-material transport for a small gravel-bed channel. Sedimentology. 1976; 23: 67-85.

Laursen, E. M.; and E. Silverston. Hydrology and sedimentology of the Colorado River in Grand Canyon. Grand Canyon National Park Report Series: Colorado River Research Program Technical Report No. 13; 1976.

Laursen, E. M.; S. Ince; and J. Pollack. On sediment transport through the Grand Canyon. Proceedings of the Third Federal Inter-Agency Sedimentation Conference. ; 1976: 4-76-4-87.

Lehre, A. K. Sediment budget of a small California Coast Range drainage basin near San Francisco. In: Davies, T. R. H.; and A. J. Pearce. Erosion and Sediment Transport in Pacific Rim Steeplands, proceedings of the Christchurch Symposium; 1981 Jan. : IAHS-AISH Publication No. 132.

Leopold, L. B. The rapids and the pools - Grand Canyon. Geological Survey Professional Paper 669; 1969.

Lisle, T. E. Overview: channel morphology and sediment transport in steepland streams. In: Beschta, R. L. et al, eds. Erosion and Sedimentation in the Pacific Rim, Proceedings of an International Symposium at Oregon State University, Corvallis, OR; 1987 Aug 3. IAHS Publication No. 165; 1987.

Lohman, S. W. Abandonment of the Unaweep Canyon, Mesa County, Colorado, by capture of the Colorado and Gunnison Rivers. U.S.Geological Survey Research. 1961: B144-B146.

Lyons, J. Green River channel characteristics below Flaming Gorge. Denver, Colorado: U. S. Bureau of Reclamation, U.S.D.I.; 1989.

Lyons, J. K.; M. J. Pucherelli; and R. C. Clark. Sediment transport and channel characteristics of a send-bed portion of the Green River below Flaming Gorge Dam, Utah, USA. Regulated Rivers: Research and Management. 1992; 7: 219-232.

Madole, R. F. Geology of archeological sites in Middle Cottonwood Creek Valley and Taylor Park, Chaffee and Gunnison counties, Colorado. Denver, Colorado (?): U. S. Dept. of the Interior, U. S. Geological Survey; 1987. Books and Open-File Reports Section, distributor.

McAda, C. W.; and L. R. Kaeding. Physical changes in the Gunnison and Colorado Rivers resulting from construction of the Aspinall Unit and related projects, with hypotheses to assess the effects on the endangered fishes; final report. Grand Junction, Colorado: U. S. Fish and Wildlife Service, U.S.D.I.; 1991. 60 pp.

Mears, A. I. Flooding and sediment transport in a small alpine drainage basin in Colorado. Geology. 1978; 7(1): 53-57.

National Park Service, U.S.D.I. Black Canyon of the Gunnison channel processes study. WASO, WRD: NPS; 1990.

--------. Hydraulic features of the Gunnison River, Black Canyon of the Gunnison National Monument, Colorado. 6 pp.

--------. J. Riedel, project manager. Skagit River project (FERC No. 553) report on existing conditions of reservoir and streambank erosion. submitted by Seattle City Light; 1990. 96 pp.

O'Brien, J. S. Analysis of minimum streamflow and sediment transport in the Yampa River, Dinosaur National Monument. Fort Collins, Colo.: Colorado State University Engineering Research Center report; 1987. 21 pp.

Olander, H. C.; N. B. Lamm; and B. A. Florquist (Prepared for the Colorado Geological Survey and the Colorado Division of Planning by F. M. Fox & Associates). Roaring Fork and Crystal Valleys: an environmental and engineering geology study: Eagle, Garfield, Gunnison, and Pitkin Counties. Denver, Colorado: Colorado Geological Survey, Dept. of Natural Resources; 1974. 64 pp.

Olson, J. C. Geology and uranium deposits of the Cochetopa and Marshall Pass districts, Saguache and Gunnison counties, Colorado. Reston, Virginia (?): U. S. Dept. of the Interior, U. S. Geological Survey. For sale by the Books and Open-File Reports Section; 1988. 44 pp.

Olson, J. C.; D. C. Hedlund; and W. R. Hansen. Tertiary volcanic stratigraphy in the Powderhorn-Black Canyon region, Gunnison and Montrose Counties, Colorado. U.S. Geological Survey Bulletin No. 1251-C. 1968;

Osborn, H. B.; and J. R. Simanton. Gullies and sediment yield. Rangelands. 1989; 11(2).

Parker, R. S.; J. M. Nelson; J. G. Elliot; and W. P. Carey (United States Geological Survey, WRD, MS-415, Box 25046, DFC, Lakewood, CO 80225; 303-236-4882). Changes in bed mobility due to altered streamflows in cobble-bedded mountain streams in the Gunnison River Basin, Colorado. American Geophysical Union; 1992 Dec.

Pemberton, E. L. Channel changes in the Colorado River below Glen Canyon Dam. Proceedings of the Third Federal Inter-Agency Sedimentation Conference. 1976: 5-61-5-73.

Pemberton, E. L.; and T. J. Randle. Colorado River sediment in Grand Canyon. Proceedings of the Fourth Federal Inter-Agency Sedimentation Conference. 1986: 4-120-4-130.

Petit, F. Evaluation of grain shear stresses required to initiate movement of particles in natural rivers. Earth Surface Processes and Landforms. 1990; 15: 135-148.

Prather, T. Geology of the Gunnison country. 1st ed. Gunnison, Colorado: Western State College Foundation; 1982. 149 pp.

Pucherelli, M. J.; R. C. Clark; and R. D. Williams. Mapping backwater habitat on the Green River as related to the operation of Flaming Gorge Dam using remote sensing and GIS. Denver, Colorado: United States Bureau of Reclamation Research and Laboratory Services Division report; 1990; R-90-18. 11 pp.

Pugh, C. A. Hydraulic model studies of landslide-generated water waver-Morrow Point Reservoir. ; 1982. 60 pp.

Randle, T. J.; R. I. Strand; and A. Streifel. Engineering and environmental considerations of Grand Canyon sediment management. Denver, Colorado: United States Bureau of Reclamation report; 1993. 12 pp.

Reid, I.; and L.E. Frostick. Dynamics of bedload transport in Turkey Brook, a coarse-grained alluvial channel. Earth Surface Processes and Landforms. 1986; 11: 143-155.

Rubin, D. M.; J. C. Schmidt; and J. N. Moore. Origin, structure, and evolution of a reattachment bar, Colorado River, Grand Canyon, Arizona. Journal of Sedimentary Petrology. 1990 Nov 1; 69(6): 982.

Schmidt, J. C. Recirculating flow and sedimentation in the Colorado River in Grand Canyon, Arizona. The Journal of Geology. 1990; 98(5): 709-724.

Schwartz, S. S. (Interstate Commission on the Potomac River Basin, Rockville, MD; 301-984-1908). Functional analysis of transport criteria for river regulating reservoirs. American Geophysical Union; 1992 Dec.

Smillie, G. M.; W. L. Jackson; and D. Tucker (U.S. Dept. of Interior, National Park Service, Water Resources Division). Colorado River sand budget: Lees Ferry to Little Colorado River including Marble Canyon. Chapter 9 In: ? Fort Collins, Co., Washington, D.C.: NPS, Water Resources Div.; 1992. 8 pp.

Soil Conservation Service, U.S.D.A. Lower Gunnison Basin Unit, Montrose and Delta Counties, Colorado and Uintah Basin Unit, Duchesne, Wasatch and Uintah Counties, Utah. U. S. Dept. of Agriculture: Soil Conservation Service; 1982. 148 pp.

Stevens, M. A. AB Lateral hydropower project, changes in river morphology. Grand Junction, Colorado: HDR Engineering, Inc., and Bureau of Reclamation; 1988. 16 pp.

Tesky, R. O.; and T. M. Hinckley. Impact of water level changes on woody riparian and wetland communities. vol. 1: Plant and Soil Responses to Flooding. Office of Biological Sciences: U. S. Dept. of Interior, U.S. Fish and Wildlife Service; 1977; FWS/OBS-77/58.

Thornton, L. M. Applications of geomorphology to land-use planning and recreation at Blue Mesa Reservoir, Gunnison County, Colorado [thesis]. Lawrence, Kansas: University of Kansas; 1975. 99 leaves.

U. S. Geological Survey, U.S.D.I. Analytical results and sample locality map of stream-sediment, heavy-mineral-concentrate, and rock samples from the Gunnison gorge Wilderness Study Area (CO- 030-388), Delta and Montrose Counties. Denver, Colorado: U. S. Geological Survey; 1989; 89-439. (U. S. Geological Survey open- file report).

--------. Botanical evidence of floods and flood-plain deposition. ; 1964. 35 pp.

Webb, R. H.; P. T. Pringle; and G. R. Rink. Debris flows from the tributaries of the Colorado River, Grand Canyon National Park, Arizona. U. S. Geological Survey Open File Report 87-118: U. S. Geological Survey; 1987.

Webb, R. H.; P. T. Pringle; S. L. Reneau; and G. R. Rink. Monument Creek debris flow, 1984: implications for formations of rapids on the Colorado River in Grand Canyon National Park. Geology. 1988; 16(1): 50-54.

Wells, S. G.; and A. M. Harvey. Sedimentologic and geomorphic variations in storm-generated alluvial fans, Howgill Fells, Northwest England. Geologic Society of America Bulletin. 1987; 98: 182-198.

White, W. R.; and T. J. Day. Transport of graded gravel bed material. Hey, R. D.; J. C. Bathurst; and C. R. Thorn, eds. Gravel-bed Rivers, Fluvial Processes, Engineering and Management (published by John Wiley and Sons Ltd.). 1982;

Whittig, L. D.; et al. Delineation and correlation of salinity to landforms and geologic formations, Upper Colorado River Basin. Davis, California: University of California, Davis; 1985.

Wiberg, P. L.; and D. J. Smith. Calculations of the critical stress for motion of uniform and heterogeneous sediments. Water Resources Research. 1987; 23(8): 1471-1480.

Mapping / Photo Documentation

Black Canyon of the Gunnison: Black Canyon of the Gunnison National Monument, Colorado. Washington, D. C.: National Park Service, U. S. Dept. of the Interior; 1984. Map; 1:44,000.

Black Canyon of the Gunnison: Black Canyon of the Gunnison National Monument, Colorado. Wash., D. C.: National Park Service, U.S.D.I.; 1984. Map; 29 x 42 cm. on sheet 40 x 42 cm. folded to 10 x 21 cm., relief shown by shading and spot heights; 1:44,000.

Eckhardt, D. W.; and D. W. Litke. Estimation of reservoir surface areas using satellite imagery, Upper Gunnison River Basin, Colorado. ; 1988.

Geologic map of the Black Canyon of the Gunnison and vicinity, western Colorado [U.S. Geological Survey Miscellaneous Geologic Investigations Map I-584]. Hansen, W. R. : U.S. Geological Survey; 1971. ; 1:24,000.

Goettlicher, W. P.; and M. J. Pucherelli. Mapping instream habitat on the San Juan River as related to the Animas-La Plata Project using airborne videography; draft. Denver, Colorado: Applied Sciences Branch, Research and Laboratory Services Branch, Bureau of Reclamation, U.S.D.I.; 1992. 41 pp.

Gunnison Basin and American Flat/Silverton: wilderness study areas. U.S.D.I., Bureau of Land Management. Gunnison, Colorado: Bureau of Reclamation; 1986. ; 122 x 82 cm., on sheet 67 x 108 cm.; 1:50,000.

Gunnison National Forest, Colorado. Burrus, R. F.; and F. E. Washburn. Denver, Colorado: U. S. Forest Service, regional office; compiled from U.S.F.S. aerial surveys, B.L.M., U.S.G.S. and other surveys; 1955.

Gunnison National Forest, Colorado. --------. Denver, Colorado: U. S. Forest Service, regional office; compiled from U.S.F.S. aerial surveys, B.L.M., U.S.G.S. and other surveys; 1959.

Gunnison National Forest, Colorado. U. S. Forest Service, Rocky Mountain Region. Denver, Colorado: U. S. Forest Service; compiled and drawn at regional office, Denver, Colorado; 1965. 74 x 60 cm. fold. to 15 x 21 cm.; 1:250,000.

Josberger, E. G.; and E. Beauvillain. Snow cover of the Upper Colorado River Basin from satellite passive Microwave and visual imagery. Nordic hydrology. 1989; 20(2): 73.

McConnell, I. W. Topographic work in the grand canyon of the Gunnison. Water Supply Paper: U.S. Geological Survey; 1904; 95. 162-167.

Verdin, J. P.; L. Hall; J. Halls; and P. Davidson. Application of remote sensing and GIS to estimate irrigation water use in the Upper Gunnison River Basin in Colorado. 10 pp.

Warner, M. T.; and D. B. Walker. Through the Black Canyon. Ann Arbor, Michigan, USA: Braun-Brumfield; 1972.

Recreation / Economics

Arthur D. Little, Inc. Comprehensive overall economic development program for Gunnison-Uncompahgre region, Colorado; final report to Planning and Development Section, Colorado Division of Commerce and Development, Colorado Dept. of Employment [and] local liaison committees, Gunnison-Uncompahgre economic development program. Denver, Colorado: Planning and Development Section, Colorado Division of Commerce and Development; 1965. 200 pp.

Booker, J. F.; and R. A. Young. Economic impacts of alternative water allocation institutions in the Colorado River Basin. Completion report. 1991 Aug 1; (161).

Brown, T. C.; B. L. Harding; and E. A. Payton. Marginal economic value of streamflow: a case study for the Colorado River Basin. Water Resources Research. 1990 Dec 1; 26(12): 2845.

Bureau of Land Management, U.S.D.I. Recreation management plan for the Gunnison Gorge Recreation Lands. Montrose District: B.L.M., U.S.D.I.; 1985.

Carrier, J. Water and the West: the Colorado River. National Geographic. 1991 Jun 1; 179(6): 2.
Increasing demand and persistent drought have drawn down the reservoirs of the Colorado River system, a critical water source for seven states and part of Mexico.

Colorado Division of Commerce and Development. The Gunnison- Uncompahgre region, Colorado. Denver, Colorado (?): Colorado Division of Commerce and Development; 1965. 47 pp.

Colorado State Planning Division. A comprehensive plan for the Gunnison-Uncompahgre region, Colorado. Denver, Colorado: Colo. State Planning Division; 1962.

Denisov, P. P. An investigation of water-power regimes in stream- flow regulation. Water resources. 1991 Nov 1; 18(6): 599.

Droste, L. A. Economic future of the western slope: Northwest region, Colorado River region, Gunnison River region [and] San Juan Region. Boulder, Colorado: Bureau of Business Research, School of Business, Univeristy of Colorado; 1964.

Eckert, J. B.; and E. Wang. Effects of irrigation water supply variations on limited resource farming in Conejos County, Colorado. Water Resources Research. 1993 Feb 1; 29(2): 229.

Economic Research Service, U.S.D.A. Water and related land resources, Gunnison River Basin, Colorado: a report based on a cooperative study by Colorado Water Conservation Board and United States Department of Agriculture. Salt Lake City, Utah: U.S.D.A., prepared by Economic Research Service, U. S. Forest Service, Soil Conservation Service; 1962. 103 pp.

Espergen, G. G.; D. D. Miller; and R. B. Nehring. Modeling the effects of various angling regulations on trout populations in Colorado streams. Special Report Number 67: Colorado Division of Wildlife; 1990. 24 pp.

Federal Emergency Management Agency. Flood insurance study: Gunnison County, Colorado, unincorporated areas, Community number 080078. Washington, D. C. (?): Federal Emergency Management Agency; 1989. 13 pp.

Flug, M.; W. R. Walker; and G. V. Skogerboe. Optimal water use and salinity control for energy - Upper Colorado River Basin. Water Resources Bulletin. 1979; 15(4): 964-973.

Grand Valley on-farm programs protect Colorado River from salt. Irrigation Journal. 1991 Sep 1; 41(6): 8.
Over-irrigation and seepage from canals in the Grand Valley contribute more than 600,000 tons of salt annually to the Colorado River. On-farm programs developed by the SCA and the ARS are reducing the salt load.

Gunnison Basin livestock grazing environmental assessment. 20 pp.

Gunnison County Board of County Commissioners. Gunnison County land use resolution. Gunnison, Colorado: Gunnison County Board of County Commissioners; 1983.

Gunnison National Forest, Colorado. Burrus, R. F.; and F. E. Washburn. Denver, Colorado: U. S. Forest Service, regional office; compiled from U.S.F.S. aerial surveys, B.L.M., U.S.G.S. and other surveys; 1955.

Gunnison National Forest, Colorado. --------. Denver, Colorado: U. S. Forest Service, regional office; compiled from U.S.F.S. aerial surveys, B.L.M., U.S.G.S. and other surveys; 1959.

Gunnison National Forest, Colorado. U. S. Forest Service, Rocky Mountain Region. Denver, Colorado: U. S. Forest Service; compiled and drawn at regional office, Denver, Colorado; 1965. 74 x 60 cm. fold. to 15 x 21 cm.; 1:250,000.

Haas, G.; and J. B. Burley. Recreation and aesthetics study, Black Canyon of the Gunnison National Monument. ; 1991. 40 pp.

HDR Engineering, Inc. Phase I feasibility study for Upper Gunnison-Uncompahgre Basin, task memorandum no. 5, development and calibration of basin model comparison of existing supplies with future in-basin demands. HDR Engineering, Inc.; 1988.

--------. Phase I feasibility study for Upper Gunnison- Uncompahgre Basin, task memorandum no. 4, recreation and environmental enhancement opportunities. HDR Engineering, Inc.; 1988.

Howe, C. W.; J. K. Lazo; and K. R. Weber. The economic impacts of agriculture-to-urban water transfers on the area of origin: a casy study of the Arkansas River Valley in Colorado. American Journal of Agricultural Economics. 1990 Dec 1; 72(5): 1200.

Huner, J. V. Exploitation of freshwater crayfishes in North America. Fisheries. 1978; 3(6): 2-19.

Libecap, G. D. Markets for federal water: subsidies, property rights, and the Bureau of Reclamation. Journal of Economic Literature. 1991 Mar;

Little, A. D. Inc. Comprehensive overall economic development program for Gunnison-Uncompahgre region, Colorado; final report to Planning and Development Section, Colorado Division of Commerce and Development, Colorado Dept. of Employment [and] local liaison committees, Gunnison-Uncompahgre economic development program. Denver, Colorado: Planning and Development Section, Colorado Division of Commerce and Development; 1965. 200 pp.

Marsh, B. W. The Uncompahgre valley and the Gunnison tunnel: a description of scenery, natural resources, products, industries, exploration, adventures, &c. Montrose, Colorado: Marsh and Torrence; 1905: 13-151.

McKean, J. R.; D. M. Johnson; and R. G. Walsh. Gunnison County interindustry spending and employment attributed to fishing at Blue Mesa Reservoir. Fort Collins, Colorado: Colorado Water Resources Research Institute, Colorado State University; 1988; 53. 114 pp.

Miller, D. D. Application of a population simulation model to the selection of angling regulations for stream fisheries. ; 1992. 39 pp.

Mitchem, L. E. A social-economic profile of the Black Canyon region, Montrose District Office (Colorado), Bureau of Land Management. Boulder, Colorado: Resources Development Internship program, Western Interstate Commission for Higher Education; 1975. 202 pp.

National Park Service, U.S.D.I. Black Canyon of the Gunnison National Monument: South Rim Drive. Washington, D. C. (?): National Park Service; 1986. 10 pp.

--------. Instream flows for recreation: A handbook on concepts and research methods. Oregon State University: Cooperative Park Studies Unit, National Park Service Water Resources Division; 1993. 103 pp.

--------. Study plan, canyon floor access, Black Canyon of the Gunnison Monument, Colorado. BLCA: NPS; date?

Nehring, R. B. Fisherman use and catch evaluation of the Gunnison River and sport fish population analysis for 1988 from the east portal access area below Crystal Dam to the North Fork confluence. Fort Collins, Colorado: Colorado Division of Wildlife; 1988.

--------. Gunnison River sport fish population evaluation and fisherman use and catch study for the East Portal access area below Crystal Dam to the North Fork confluence. Fort Collins, Colo.: Colorado Division of Wildlife; 1983.

Nehring, R. B.; and R. Anderson. Stream fisheries investigations, Colorado Division of Wildlife, Federal Aid in Fish and Wildlife Restoration, F-51, job progress report. Fort Collins, Colorado: Colo. Div. of Wildlife; 1985.

Osmundson, D. B.; and L. R. Kaeding. Studies of Colorado squawfish and razorback sucker use of the '15-mile reach' of the Upper Colorado River as part of conservation measures for the Green Mountain and Ruedi Reservoir water sales; final report. Grand Junction, Colorado: U. S. Fish and Wildlife Service, U.S.D.I.; 1989.

Region 10 Economic Development District, Montrose, CO. Colorado Black Canyon area economic development district: regional profile. Montrose, Colorado: Region 10 Economic Development District; 1983. 24 pp. Region 10 Economic Development District, Drawer 849, Montrose, CO 81402.

Ryan, C. R. (District 10 Regional Planning Commission (Colorado)). Region 10 overall economic development program. Montrose, Colorado: District 10 Regional Planning Commission; 1977 Jun. 127 pp.

Shelby, B.; T. C. Brown; and R. Baumgartner. Effects of streamflows on river trips on the Colorado River in Grand Canyon, Arizona. Rivers: studies in the science, environmental ... 1992 Jul 1; 3(3): 191.

Soil Conservation Service, U.S.D.A. An appraisal of outdoor recreation potentials in Gunnison County, Colorado. U. S. Dept. of Agriculture: Soil Conservation Service; 1969. 77 pp.

Thornton, L. M. Applications of geomorphology to land-use planning and recreation at Blue Mesa Reservoir, Gunnison County, Colorado [thesis]. Lawrence, Kansas: University of Kansas; 1975. 99 leaves.

U. S. Bureau of the Census, Dept. of Commerce. Census of agriculture (1978), preliminary report, Gunnison County, Colo. Washington, D. C.: Dept. of Commerce, Bureau of the Census; 1980. 4 pp. For sale by Subscribers Services Section (Publications), Bureau of the Census, 1980.

U. S. Department of Interior, Assistant Secretary. Published by U. S. Government Printing Office, House Document No. 77, 88th Congress, 1st Session; 1963.
Letter transmitting a supplemental report and certification of economic justification on the Crystal Dam, reservoir, and power plant, which comprises a segment of the Curecanti unit, Colorado river storage project, in Colorado.

U. S. Fish and Wildlife Service, U.S.D.I. Colorado River Storage Project, Bostwick Park Project, Colorado (BR): Bureau of Sport Fisheries and Wildlife report. Albuquerque, N.M.: U. S. Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife, U.S.D.I.; 1959. 6 leaves.

--------. Overview of the proposed critical habitat designation for the four Colorado River endangered fishes, draft [part one of three part series], economic overview. Biologists: H. R. Maddux; W. R. Noonan; and L. A. Fitzpatrick; Economists: D. S. Brookshire; M. McKee; and G. Watts. Salt Lake City, Utah: U. S. Fish and Wildlife, Utah Field Office; 1993 Nov 4. 65 pp.

U. S. Forest Service; Soil Conservation Service; and Economic Research Services, U. S. D. A. Water and related land resources, Gunnison River Basin, Colorado. Salt Lake City, Utah: Economic Research Services, U.S.F.S., S.C.S.; 1962. 103 pp.

U. S. Senate, Committee on Interior and Insular Affairs, Environment and Land Resources Subcommittee. The preparation of the East River unit plan, Gunnison National Forest, Colorado: report together with additional and minority views of the Subcommittee on the Environment and Land Resources of the Committee on Interior and Insular Affairs, September 1976. Washington, D. C.: U.S.G.P.O.; 1976. 196 pp.

United Banks of Colorado, Inc., Economic Development Dept. Gunnison Colorado: an economic overview. Denver, Colorado: United Banks of Colorado, Inc., Economic Development Dept.; 1972.

--------. Gunnison, Colorado, an economic overview. Denver, Colorado: United Banks of Colorado, Inc. Economic Development Dept.; 1974.

Volkman, J. M. Within the Hundredth Meridian: western states and their river basins in a time of transition. University of Colorado Law Review. 1988 Jun; 59(3): 551.

Walsh, R. G.; et al. Wild and scenic river economics: recreation use and preservation values. ; 1985.

Young, R. A.; R. L. Gardner; and E. W. Sparling. Assessing strategies for control of irrigation-induced salinity in the Upper Colorado River Basin: reply. American Journal of Agricultural Economics. 1990 May 1; 72(2): 497.

Cultural Resources / History

Beidleman, R. G. Administrative history of the Black Canyon of the Gunnison National Monument. Rocky Mountain Regional Office: National Park Service; ? 234 pp.

--------. The Gunnison River diversion project. Colorado Magazine: The State Historical Society of Colorado. 1959; 36(3): 187-201 and 266-285.

Bowden, C. In search of a lost river: The Imperial National Wildlife Refuge preserves a flavor of the old, untamed Colorado. Arizona Highways. 1990 Apr 1; 66(4): 34.

Breternitz, D. A.; S. L. Carpenter; W. G. Gillespie; and M. A. Stiger. Inventory of archeological resources, Black Canyon of the Gunnison National Monument, Colorado. Lincoln, Nebraska: National Park Service Midwest Archeological Center; 1974. 119 pp.

Bruce, C. A. History of federal reclamation and its accomplishments on the Uncompahgre Project, Colorado. Gunnison, Colorado: Western State College (thesis); 1933.

Bureau of Land Management, U.S.D.I. Archeological resources of southwestern Colorado. Denver, Colorado: Colorado State Office, Bureau of Land Management; 1982. 523 pp.

Cline, P. A brief history of the Black Canyon of the Gunnison National Monument. Archeologist's Office: U.S. National Park Service; 1936. 26 pp.

Collins, S. M.; M. L. Albertson; R. T. Euler; L. K. Lewis; and J. E. Earl. Survey of cultural resources in the Lower Gunnison Basin unit, Colorado River Quality Improvement Program, Delta and Monroe Counties, Colorado. Fort Collins, Colorado: Colorado State University, Laboratory of Public Archaeology; 1981; CSULOPA-48. 230 pp.

Creer, L. H.; et al. The explorations of Gunnison and Beckwith in Colorado and Utah. Colorado Magazine: The State Historical Society of Colorado. 1853;

Dolson, J. The Black Canyon of the Gunnison, a story in stone: the natural and human history of Black Canyon of the Gunnison National Monument. Boulder, Colorado: Pruett Publishing Co.; 1982. 53 pp.

Hansen, W. R. The Black Canyon of the Gunnison, today and yesterday. U.S. Geological Survey Bulletin 1191: U.S.G.S., U.S.D.I.; 1965. 76 pp.

--------. The Black Canyon of the Gunnison in depth. Tucson, Arizona, USA: Southwest Parks and Monuments Association (Also U. S. Geological Survey Bulletin 1191); 1987. 58 pp.

Hupp, C. R. Plant ecological aspects of flood geomorphology and paleoflood history. In: Baker, V. R.; R. K. Kochel; and P. C. Patton, eds. Flood Geomorphology. Published by Wiley; 1988.

Jones, B. J. The Curecanti Archeological Project: 1980 investigations in Curecanti National Recreation Area, Colorado. Lincoln, Nebraska: Midwest Archeological Center; 1982. 181 pp.

Kerr, W. A. Gunnison National Forest: a brief history. Gunnison, Colorado: W. A. Kerr; 1982. 73 pp.

Levy, B. Curecanti Recreation Area, Colorado: historical background study. Washington, D. C.: Division of History, Office of Archeology [sic] and Historic Preservation; 1968. 40 leaves.

Madole, R. F. Geology of archeological sites in Middle Cottonwood Creek Valley and Taylor Park, Chaffee and Gunnison counties, Colorado. Denver, Colorado (?): U. S. Dept. of the Interior, U. S. Geological Survey; 1987. Books and Open-File Reports Section, distributor.

Markoff, D. R. History of the Gunnison Waterworks since 1906. Gunnison, Colorado: Western State College (thesis); 1966. 98 leaves.

Marsh, B. W. The Uncompahgre valley and the Gunnison tunnel: a description of scenery, natural resources, products, industries, exploration, adventures, &c. Montrose, Colorado: Marsh and Torrence; 1905: 13-151.

Miller, T. A history of the Gunnison Water Works: 1880-1906. Gunnison, Colorado: Western State College (thesis); 1966. 68 leaves.

Murphy, E. C. Discussion of flood conditions on Purgatory, Grand, and Gunnison rivers. In: Destructive floods in the United States in 1905. Water-Supply paper 162: U.S. Geological survey; 1906. 105 pp.

National Park Service, U.S.D.I. Proposed wilderness area, Black Canyon of the Gunnison National Monument, Colorado. NPS Midwest Region: Curecanti Group; 1973. 56 leaves.

Quartarone, F. Historical accounts of Upper [Colorado] Basin endangered fish. Denver, Colorado: Colorado Division of Wildlife; 1993.

Renaud, E. B. Classification and description of Indian stone artifacts. Gunnison, Colorado: The Colorado Archaeological Society; 1941. 36 pp.

River Basin Surveys. Preliminary survey of the archeological resources in the Gunnison-Arkansas Project, Colorado, east of the mountains. Washington, D. C. (?): River, Basin Surveys, Smithsonian Institution; 1949. 27 leaves.

Rossillon, M. P. The Curecanti Archeological Project: the archeology of Marion, an historic railroad camp in Curecanti National Recreation Area, Colorado. Lincoln, Nebraska: U. S. Dept. of the Interior, National park Service, Midwest Archeological Center; 1984. 167 pp.

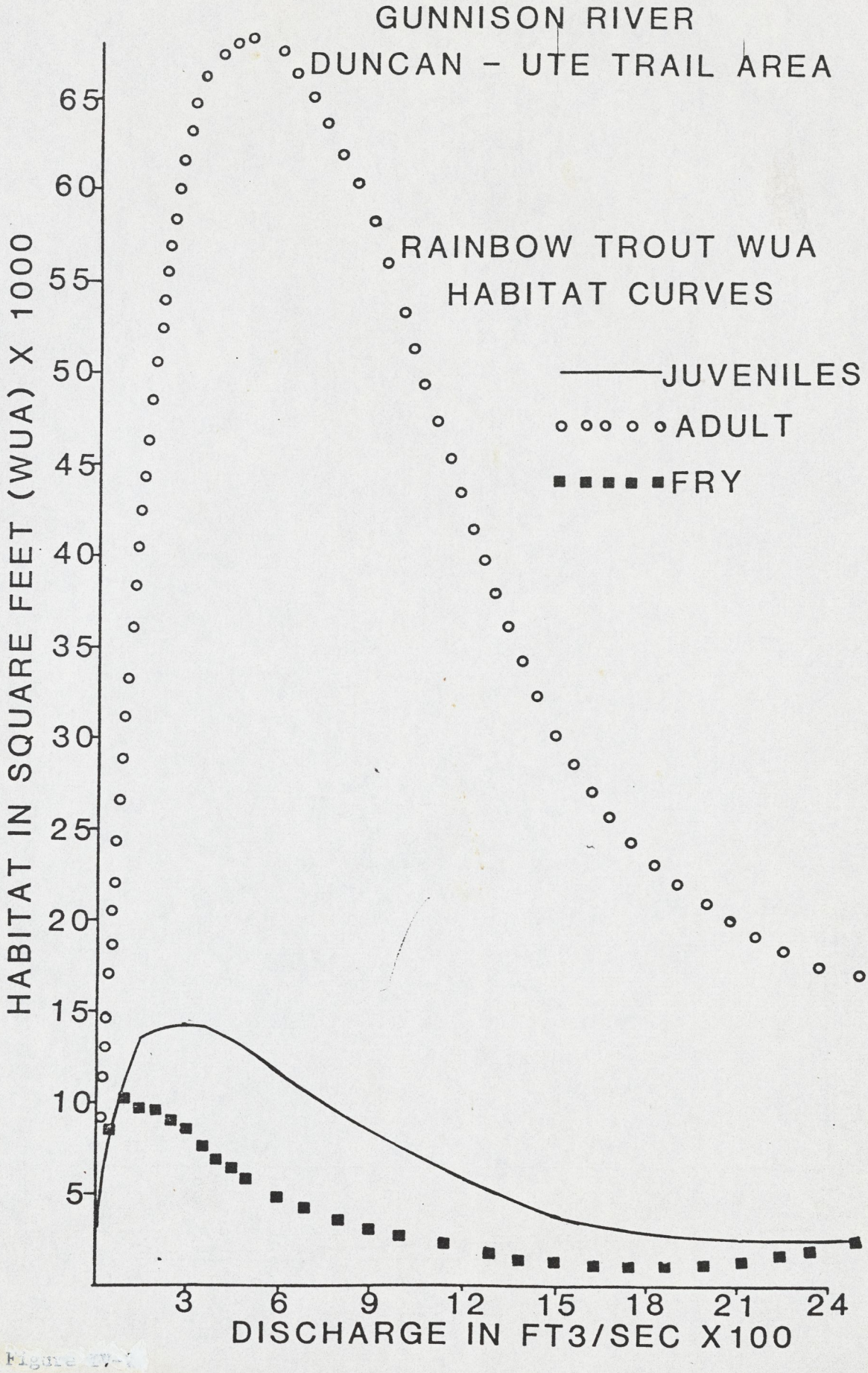
Schiel, J. H. W. Bachmann, F. W.; and W. S. Wallace, translators. The land between: Dr. James Schiel's account of the Gunnison-Beckwith expedition in the West, 1853-1854. Los Angeles, California: Westernlore Press; 1957. 162 pp. (Great West and Indian).

Stiger, M. A.; and S. L. Carpenter. Archeological survey of Black Canyon of the Gunnison National Monument and archeological inventory and evaluation of Curecanti Recreation Area (NPS Midwest Archeological Center Occasional Studies in Anthropology No. 7). Lincoln, Nebraska: National Park Service, Midwest Archeological Center; 1980. 102 pp.

Toll, R. W. [Letter to NPS Director]. ; 1932.
Letter recommending that the Black Canyon of the Gunnison River become a national monument.

Tonge, T. The Gunnison gold belt: and Gunnison County, Colorado. Denver, Colorado: Issued by the Passenger Department, South Park Line, and the Miners' and Merchants' Association of Gunnison County; 1896. 31 pp.

U. S. Geological Survey, U.S.D.I. Water resources of the State of Colorado. ; 1902.


GUNNISON RIVER
DUNCAN - UTE TRAIL AREA
RAINBOW TROUT WUA
HABITAT CURVES
JUVENILES
ADULT
FRY
HABITAT IN SQUARE FEET (WUA) X 1000
65
60
55
50
45
40
35
30
25
20
15
10
5
3
6
9
12
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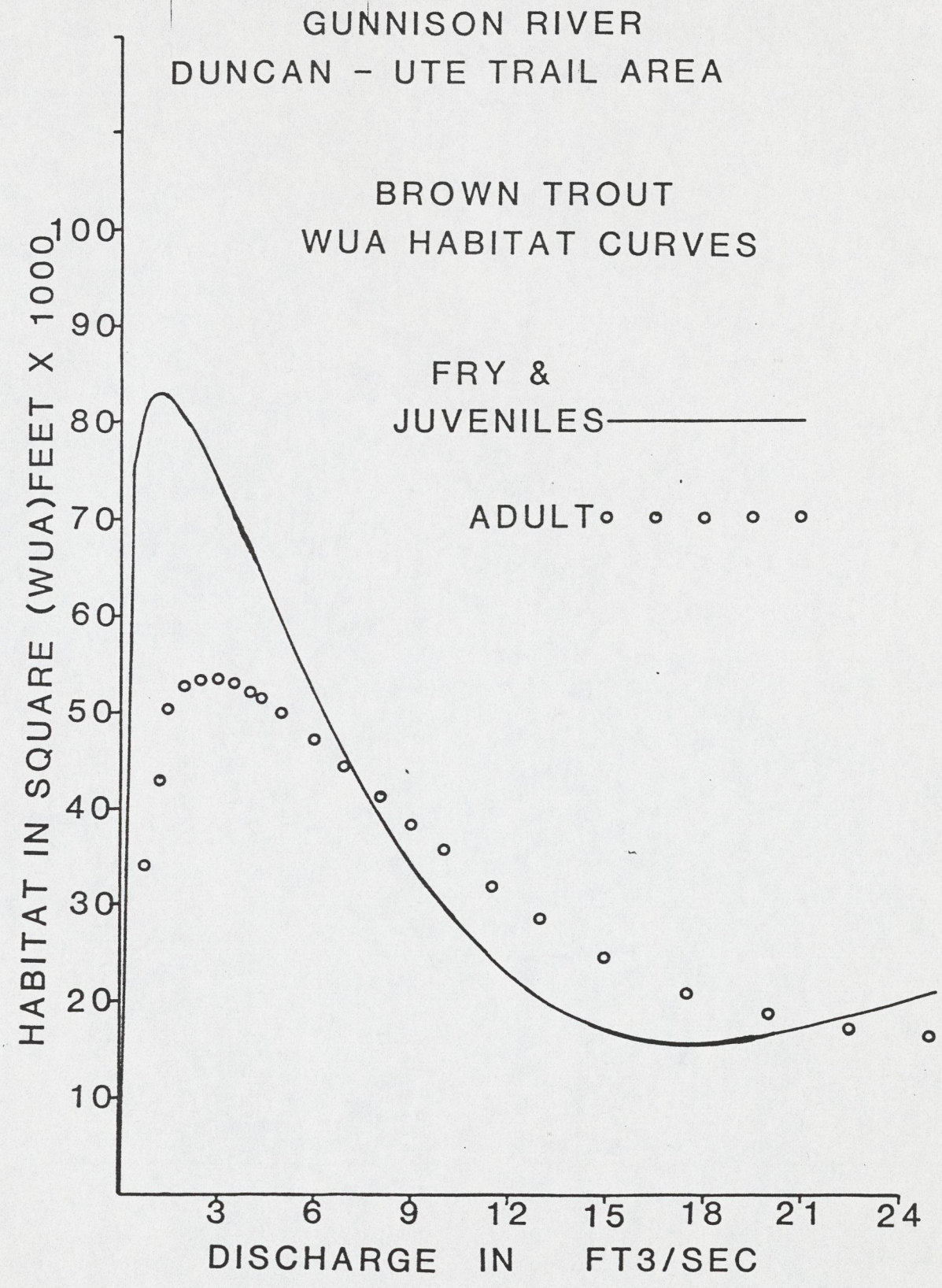
18
21
24
DISCHARGE IN FT3/SEC X100

Figure IV-


GUNNISON RIVER
DUNCAN - UTE TRAIL AREA
BROWN TROUT
WUA HABITAT CURVES
FRY &
JUVENILES
ADULT
HABITAT IN SQUARE (WUA)FEET X 1000
100
90
80
70
60
50
40
30
20
10
3
6
9
12
15
18
21
24
DISCHARGE IN FT3/SEC