

EFFECTS OF WILDERNESS LEGISLATION
ON WATER-PROJECT DEVELOPMENT IN COLORADO

by

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May 1983



Colorado State University
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Research Project Technical Completion Report

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ABSTRACT

Environmental policies embodied in the Wilderness Act, Wild and Scenic Rivers Act, and Endangered Species Act impose certain restrictions on the development of Colorado's water resources. Planning costs are unavoidably increased because time and personnel must be invested in complying with procedural requirements of the laws. Capital or operating costs may be increased because of construction delays, required engineering design changes, or spatial relocation of project facilities. In some cases, development opportunities will be completely foregone.

Approximately 2.6 million acres of land have already been designated under the Wilderness Act, and another 1.3 million acres have either been administratively endorsed or are being studied for their wilderness suitability. Several proposed projects could be affected by the land withdrawals because new construction works are not permitted within wilderness areas without a Presidential exemption. The Denver Water Department's proposed transmountain import projects could be built outside the Eagles Nest Wilderness, albeit at higher economic costs, or need for the projects might possibly be eliminated by pursuing other supply options. Prohibition against modifying the plant and snow cover within wilderness areas for the purpose of increasing natural water yield may create significant opportunity costs in the future. Major limitations on cloud seeding over wilderness areas would foreclose much of the state's cloud-seeding potential.

Recommendations to add portions of 11 rivers in Colorado to the national wild and scenic rivers system have either been submitted to Congress or are under final administrative review. Protection against development has expired for the Dolores, Encampment, and Gunnison Rivers because legislative action was not taken within the time period allotted for Congressional review,

and protection for the other rivers is uncertain because none of the study reports were completed by the mandated deadline of October 2, 1979. Designation of the Conejos, Elk, Encampment, Los Pinos, and Piedra Rivers would foreclose few, if any, development opportunities. Whether designation of the Colorado, Dolores, Green, and Yampa would actually constrain development is largely conditional upon final determinations yet to be made by the Fish and Wildlife Service regarding critical habitat and instream flow needs of the endangered Colorado River fishes. Designation of the Cache la Poudre would apparently exclude only the potential Gray Mountain-Idlywilde Project, since all of the other known project alternatives are either economically infeasible or would be located within existing wilderness areas. Designation of the Gunnison might exclude one of two proposed hydroelectric projects.

Fifteen endangered or threatened species are currently listed for Colorado. The only pervasive conflicts identified in this study involve the whooping crane and Colorado River fishes. New streamflow depletions in the Platte River system will adversely affect the whooping crane habitat in central Nebraska if such depletions occur between February 1-May 10 or September 16-November 15. Accordingly, new developments will be given nonjeopardy biological opinions only if they can meet the required flow regime, either by providing storage releases or replacement waters, or if they can offset the effects of small depletions by funding habitat improvement programs. Approval of projects affecting the Colorado River fishes have already been made contingent upon project operators adopting or funding various conservation measures, including the bypassing of minimum flows during critical months of the year. Preservation of both the whooping crane and endangered fishes could place Colorado in a competitive race with adjoining states to develop its unused compact entitlements to South Platte and Colorado River waters.

TABLE OF CONTENTS

	<u>Page</u>
Chapter 1. Introduction	1
Wilderness areas	3
Wild and scenic study rivers	11
Endangered and threatened species	16
Chapter 2. Legislative restrictions	17
Wilderness Act	17
Project exemptions	17
Administrative policies	18
Wild and Scenic Rivers Act	20
Protection of study rivers	21
Protection of designated rivers	24
Water rights	25
Preservation of instream flows	27
Proposed amendments	29
Endangered Species Act	30
Listing of species	30
Designation of critical habitat	31
Recovery planning	32
Consultation and limits on agency actions	32
Citizen suit provision	35
Exemption procedure	36
Chapter 3. Topical analysis of wilderness constraints	39
Whooping crane	39
Grays Lake flock	40
Wood Buffalo-Aransas flock	40
Constraints on project development	44
Colorado River fishes	48
Distinguishing characteristics and former range	49
Reasons for decline	51
Present distribution	53
Constraints on project development	57
Other listed species	64
Black-footed ferret	64
Eskimo curlew	64
American peregrine falcon	65
Arctic peregrine falcon	66
Bald eagle	66
Greenback cutthroat trout	67
Endangered and threatened plants	68
Future listings	69
Abrogating of state water rights	70
Constraints on streamflow augmentation	72
Cloud-seeding opportunities	75
Vegetation and snow management	77

Chapter 4. Regional analysis of wilderness constraints	81
Kansas River Basin	81
Trans-County Project	84
Arkansas River Basin	84
Rio Grande Basin	86
Wilderness areas	88
Conejos study river	88
Endangered and threatened species	89
North Platte River Basin	90
Wilderness areas	90
Encampment study river	90
Endangered and threatened species	92
South Platte River Basin	93
Wilderness areas	93
Cache la Poudre study river	97
Endangered and threatened species	99
San Juan River Basin	104
Wilderness areas	105
Los Pinos study river	105
Piedra study river	107
Endangered and threatened species	108
Dolores River Basin	108
Wilderness areas	108
Dolores and Lower Dolores study rivers	110
Endangered and threatened species	113
Gunnison River Basin	113
Wilderness areas	113
Gunnison study river	114
Endangered and threatened species	117
Colorado Mainstem Basin	119
Wilderness areas	119
Colorado study river	119
Endangered and threatened species	122
White River Basin	122
Wilderness areas	123
Endangered and threatened species	124
Yampa River Basin	126
Wilderness areas	126
Elk study river	128
Green study river	129
Yampa study river	130
Endangered and threatened species	130
Chapter 5. Summary and conclusions	133
Wilderness Act	133
Wild and Scenic Rivers Act	136
Endangered Species Act	143
References	149

LIST OF FIGURES

<u>Figure</u>		<u>Page</u>
1	Designated and endorsed wilderness areas	5
2	Wild and scenic study rivers	12
3	Platte River critical habitat, migration corridor, and confirmed sightings (1950-spring 1980) of whooping cranes in Nebraska	42
4	Endangered Colorado River fishes	50
5	Critical habitat segments for the endangered Colorado River fishes	56
6	Major river basins	82
7	Denver Water Department water supply and demand, 1981-2020	96

LIST OF TABLES

<u>Table</u>		<u>Page</u>
1	Wilderness components in Colorado	2
2	Forest Service designated, study, and further-planning wilderness areas	6
3	Bureau of Land Management wilderness study areas	8
4	National Park Service wilderness areas	10
5	Status of Colorado study rivers, January 1983	13
6	River segments in Colorado listed in the nationwide inventory	15
7	Classification criteria for wild, scenic, and recreational river areas	26
8	Comparison of Platte River flows at Overton and Grand Island, Nebraska	46
9	Critical habitat for the endangered Colorado River fishes	55
10	Summary of biological opinions for projects affecting the endangered Colorado River fishes	58
11	Virgin water yield from national forest lands in Colorado	74
12	Cloud-seeding potential in Colorado	76
13	Potential water yield increase by vegetation type	79
14	Population and water budget of major river basins	83
15	Wilderness components in the Arkansas River Basin	85
16	Wilderness components in the Rio Grande Basin	87
17	Wilderness components in the North Platte River Basin	91
18	Wilderness components in the South Platte River Basin	94
19	Summary of Cache la Poudre Project alternatives	98
20	Summary of project alternatives in the South Platte River Basin	103
21	Wilderness components in the San Juan River Basin	106
22	Wilderness components in the Dolores River Basin	109
23	Annualized costs and benefits of eight Bureau of Reclamation West Slope water projects	112
24	Wilderness components in the Gunnison River Basin	115
25	Wilderness components in the Colorado Mainstem Basin	120
26	Wilderness components in the White River Basin	124
27	Wilderness components in the Yampa River Basin	127
28	Known opportunity costs of designating Colorado's wild and scenic study rivers	139

CHAPTER 1

INTRODUCTION

The last two decades have witnessed increasing competition between development and preservation of Colorado's water resources. This report examines one component of this conflict, namely, the development limitations created by national policy embodied in the Wilderness Act of 1964, the Wild and Scenic Rivers Act of 1968, and the Endangered Species Act of 1973. Each of these legislative mandates potentially restricts the ability of Colorado to develop its water resources for hydroelectric power and offchannel consumptive uses. Such restrictions become especially important when viewed in the context that Colorado, because of long-standing legal commitments, must deliver more than half of its natural runoff to downstream states (Colo. Energy Research Inst., 1981, p. 9). Most of the runoff allocated for instate consumption in the Rio Grande, Kansas, and Arkansas River Basins is already being utilized. Curtailment of development opportunities in the three surplus basins, the North Platte, South Platte, and Colorado, will reduce the options available for meeting the incremental water demands of future population and economic growth.

Wilderness features of direct concern to this study include 2.6 million acres of congressionally designated wilderness land, another 1.3 million acres of potential wilderness land, 12 wild and scenic study rivers, 15 threatened or endangered species currently listed by the Fish and Wildlife Service, and an unknown number of threatened or endangered species that may be listed in the future (Table 1). This report analyzes only the constraints imposed by wilderness preservation on water-project development; it does not consider the beneficial aspects of wilderness preservation on water quality, instream recreation, or other resource values that would accrue without development.

Table 1. Wilderness Components in Colorado
DESIGNATED AND POTENTIAL WILDERNESS AREAS

Agency	Acres			Total
	Designated	Administratively Endorsed	Further Study	
Forest Service	2,571,410	350,940	0	2,922,350
Bureau of Land Management	0	115,825	447,103	562,928
National Park Service	55,687	422,256	0	477,943
	<u>2,627,097</u>	<u>889,021</u>	<u>447,103</u>	<u>3,963,221</u>

WILD AND SCENIC STUDY RIVERS

River (Drainage Basin)	Stream Miles			Total
	Wild	Scenic	Recreational	
Cache la Poudre (South Platte)	25.0		44.0	69.0
Colorado (Colorado) ^a		20.7		20.7
Conejos (Rio Grande)	25.6		11.2	36.8
Dolores (Colorado) ^b	33.0	41.0	31.0	105.0
Lower Dolores (Colorado) ^a		8.5		8.5
Elk (Colorado)	16.7	12.4		29.1
Encampment (North Platte)	19.5			19.5
Green (Colorado) ^a	22.0		18.0	40.0
Gunnison (Colorado)	26.0			26.0
Los Pinos (Colorado)	54.0			54.0
Piedra (Colorado)	21.5	7.9		29.4
Yampa (Colorado)	47.0			47.0
	<u>290.3</u>	<u>90.5</u>	<u>104.2</u>	<u>485.0</u>

^aExcludes adjoining segments in Utah.

^bExcludes the 35-mile segment of the West Dolores River recommended for recreational status by the State of Colorado but found ineligible by the Federal Study Team.

FEDERALLY LISTED THREATENED AND ENDANGERED SPECIES

Species	Date Listed	Distribution
Mammals:		
Black-footed ferret	1967, 1970	Last confirmed sightings near Denver and near Mancos in 1953.
Birds:		
American peregrine falcon	1970	Colorado River Basin and headwaters of East Slope drainages.
Arctic peregrine falcon	1970	Occasional migrant in Great Plains and foothills zone.
Bald eagle ^a	1978	Associated with riparian habitats.
Eskimo curlew	1967, 1970	Last reported sighting near Denver in 1882.
Whooping crane	1967, 1970	Designated habitats: Alamosa and Monte Vista National Wildlife Refuges in the San Luis Valley and the Platte River bottomlands between Lexington and Shelton, Nebraska.
Fish:		
Bonytail chub	1980	Green River (Utah).
Colorado squawfish	1967	Green, Yampa, White, Gunnison and Colorado Mainstem Rivers.
Greenback cutthroat trout ^a	1967, 1978	Headwaters of South Platte and Huerfano Rivers.
Humpback chub	1967	Green, Yampa, and Colorado Mainstem Rivers.
Plants:		
Knowlton miniature cactus	1979	Near Navajo Reservoir in the San Juan River Basin.
Mesa Verde cactus ^a	1979	Portions of Dolores and San Juan River Basins.
Northpark phacelia	1982	Adjacent to North Platte and Michigan Rivers.
Spineless hedgehog cactus	1979	Portions of Dolores, Gunnison, and Colorado Mainstem Basins.
Uinta Basin hookless cactus ^a	1979	Lower portions of Gunnison and Colorado Mainstem Basins.

^aThreatened species; all others are endangered.

In passing the Wilderness Act, Wild and Scenic Rivers Act, and Endangered Species Act, Congress explicitly recognized that development of natural resources for immediate private gain should be complemented by a national policy which preserves some ecological resources for long-term public use and enjoyment. Acceptance of a preservation policy is strongly resisted by some interest groups who, in the extreme, appear to believe that every drop of water allocated to Colorado should be impounded, diverted through a hydroelectric turbine, and then consumptively withdrawn for agricultural, industrial, commercial, or residential use. This Midas philosophy, that every drop of streamflow should be touched and turned into gold, is no less absurd than the opposite belief that every stream should be left untouched. The emphasis of this report on wilderness constraints is not intended to promote development to the exclusion of preservation; rather, the study should be viewed as contributing to the larger information base needed by Coloradans if they are to make rational tradeoffs between these two beneficial, but oftentimes conflicting, water uses.

The remainder of this chapter profiles the wilderness features that could affect water-project development in Colorado. Chapter 2 reviews the legislative provisions and administrative regulations governing the three wilderness acts. Chapter 3 examines the effects of wilderness preservation on project development within a topical framework, and Chapter 4 extends the discussion to a river basin accounting system. Chapter 5 presents a summary and conclusions.

Wilderness Areas

The Wilderness Act of 1964 established a national preservation system of roadless areas that have been little modified by man. Nearly all types of water-development activity within such areas requires either a Presidential

or Congressional exemption. More than 2.6 million acres of land in Colorado have already been placed in the national system, an additional 899,000 acres have been endorsed for inclusion, and another 447,000 acres are currently being studied for their wilderness suitability (Table 1). Administrative responsibility for the affected acreage rests with the Forest Service, Bureau of Land Management, and National Park Service.

Most of the Forest Service wilderness is located above 9,000 to 10,000 feet elevation in the alpine-subalpine watersheds (Fig. 1). The 24 designated units comprise more than 2.5 million acres (Table 2), or approximately one-fifth of all national forest lands in Colorado and 4 percent of the state's entire land area. Reports have now been published for the 18 wilderness study and further-planning areas. An endorsement for the Spruce Creek area was submitted to Congress on September 13, 1982, but recommendations for the other areas are still subject to review by the Chief of the Forest Service, the Secretary of Agriculture, and the President's Office of Management and Budget. Final recommendations must be submitted to Congress by December 2, 1983. At a maximum, it appears that an additional 351,000 acres might be added to the existing wilderness system. This excludes the possibility that other areas could be considered for their wilderness suitability at some future time, either through a Congressional request or as part of the Forest Service's periodic updating of forest management plans.

The Bureau of Land Management has completed the first phase of its wilderness review process, as required by the Federal Land Policy and Management Act of 1976. The first phase resulted in the selection of 60 roadless areas totaling about 787,000 acres, or nearly 10 percent of all BLM lands in the state (Table 3). Phase II, currently in progress, will be completed between 1983-1986 as part of the Bureau's regional comprehensive land-use plans.

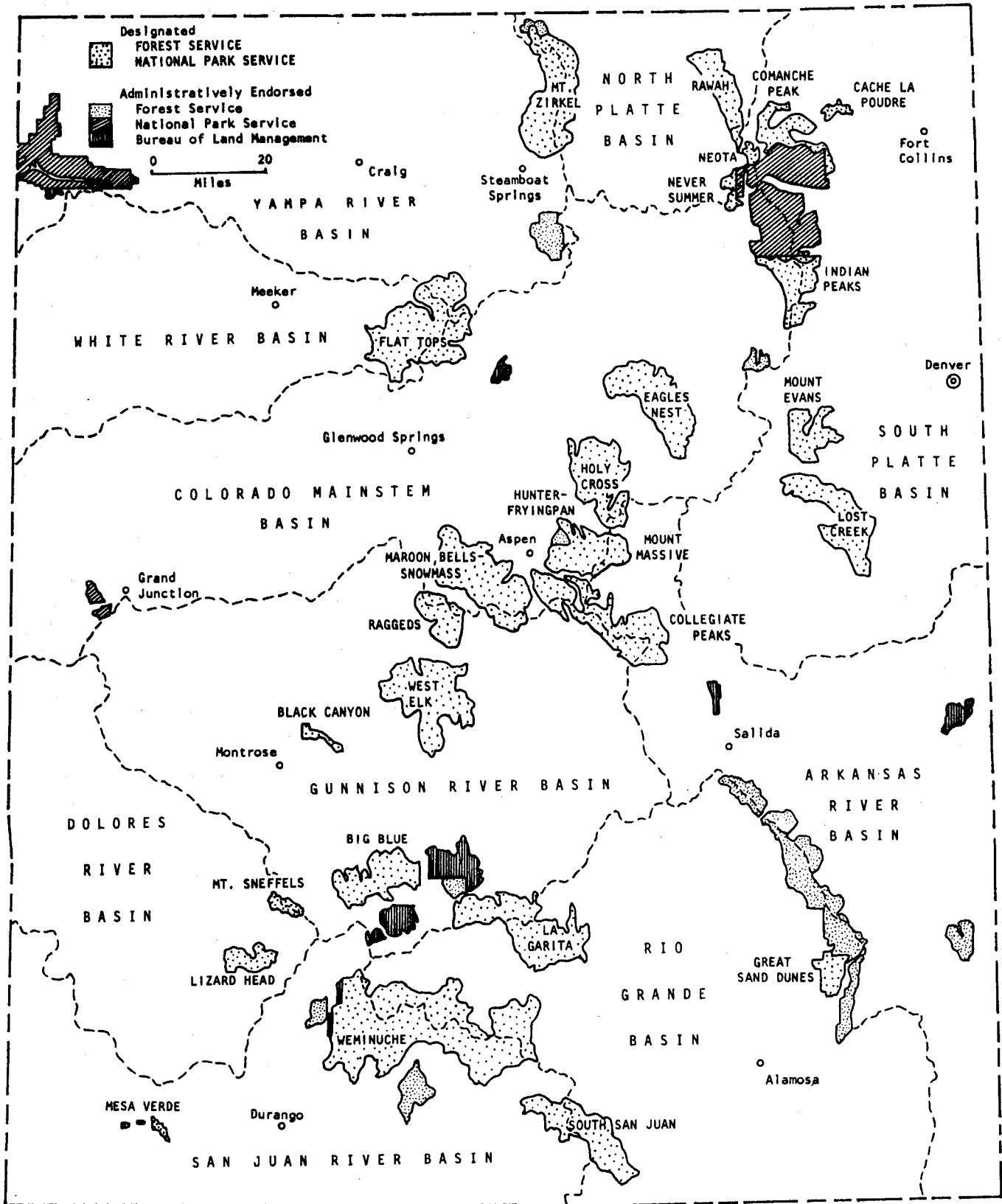


Figure 1. Designated and Endorsed Wilderness Areas

Table 2. Forest Service Designated, Study, and Further Planning Wilderness Areas

DESIGNATED WILDERNESS AREAS

Name of Area	National Forest	Gross Acres	Law and Date Established
Big Blue	Uncompahgre	97,700	P.L. 96-560, 12/22/80
Cache La Poudre	Roosevelt	9,400	P.L. 96-560, 12/22/80
Collegiate Peaks	Gunnison	48,000	P.L. 96-560, 12/22/80
	San Isabel	81,450	
	White River	30,450	
	Total	159,900	
Comanche Peak	Roosevelt	67,500	P.L. 96-560, 12/22/80
Eagles Nest	Arapaho	82,810	P.L. 94-352, 7/12/76
	White River	51,105	
	Total	133,915	
Flat Tops	Routt	38,870	P.L. 94-146, 12/15/75
	White River	196,360	
	Total	235,230	
Holy Cross	San Isabel	9,020	P.L. 96-560, 12/22/80
	White River	107,850	
	Total	116,870	
Hunter-Fryingpan	White River	74,450	P.L. 95-237, 2/24/78
Indian Peaks	Arapaho	40,180	P.L. 95-450, 10/11/78;
	Roosevelt	30,714	P.L. 96-560, 12/22/80
	Total	70,894	
La Garita	Gunnison	77,122	P.L. 88-577, 9/3/64;
	Rio Grande	24,164	P.L. 96-560, 12/22/80
	Total	101,286	
Lizard Head	San Juan	20,939	P.L. 96-560, 12/22/80
	Uncompahgre	20,557	
	Total	41,496	
Lost Creek	Pike	106,000	P.L. 96-560, 12/22/80
Maroon Bells-Snowmass	Gunnison	19,850	P.L. 88-577, 9/3/64;
	White River	154,579	P.L. 96-560, 12/22/80
	Total	174,429	
Mount Evans	Arapaho	37,850	P.L. 96-560, 12/22/80
	Pike	35,150	
	Total	73,000	
Mount Massive	San Isabel	26,000	P.L. 96-560, 12/22/80
Mount Sneffels	Uncompahgre	16,200	P.L. 96-560, 12/22/80
Mount Zirke	Routt	139,898	P.L. 88-577, 9/3/64;
			P.L. 96-560, 12/22/80
Neota	Roosevelt	10,000	P.L. 96-560, 12/22/80
	Routt	220	
	Total	10,220	
Never Summer	Arapaho	7,441	P.L. 96-560, 12/22/80
	Routt	6,659	
	Total	14,100	
Raggeds	Gunnison	42,200	P.L. 96-560, 12/22/80
	White River	17,000	
	Total	59,200	
Rawah	Roosevelt	72,437	P.L. 88-577, 9/3/64;
	Routt	1,462	P.L. 96-560, 12/22/80
	Total	73,899	
South San Juan	Rio Grande	87,847	P.L. 96-560, 12/22/80
	San Juan	39,874	
	Total	127,721	

Table 2. (continued)

Name of Area	National Forest	Gross Acres	Law and Date Established
Weminuche	Rio Grande	167,715	P.L. 93-632, 1/3/75;
	San Juan	297,975	P.L. 96-560, 12/22/80
	Total	465,690	
West Elk	Gunnison	176,412	P.L. 88-577, 9/3/64; P.L. 96-560, 12/22/80
Total		2,571,410	

WILDERNESS STUDY AND FURTHER-PLANNING AREAS

The following areas were designated for wilderness study by the Colorado Wilderness Act of 1980 (P.L. 96-560), by earlier Congressional mandate (P.L. 95-237 for Spruce Creek), or by the Forest Service's RARE II process. The status of each area is given as of January 1, 1983. Except for Spruce Creek, the recommendations are preliminary and subject to further review. Final recommendations will be submitted to Congress by December 22, 1983.

Name of Area	National Forest	Preferred Alternative--Acres	
		Wilderness	Nonwilderness
Buffalo Peaks	San Isabel, Pike		56,950
Cannibal Plateau	Gunnison	14,150	17,840
Davis Peak	Routt	8,100	
Fossil Ridge	Gunnison		54,700
Greenhorn Mountain	San Isabel	22,330	
Oh-Be-Joyful	Gunnison		5,500
Lost Creek	Pike		23,000
Piedra	San Juan	41,500	
Sangre de Cristo	Rio Grande	125,600	5,100
	San Isabel	62,800	24,400
		188,400	29,500
Service Creek	Routt	39,860	
South San Juan Expansion	San Juan		32,800
Spanish Peaks	San Isabel		19,570
Spruce Creek	White River	8,000	
St. Louis Peak	Routt		12,800
Vasquez Peak	Arapaho	12,800	
West Needle	San Juan	15,800	
Wheeler Geologic	Rio Grande		11,390
Williams Fork	Arapaho		53,888
Total		350,940	317,938

Source: U.S. Forest Service (personal comm., 1983).

Table 3. Bureau of Land Management Wilderness Study Areas^a

District and Area	Acres		Study Not Completed	Completion Date
	Preferred Wilderness	Alternative Nonwilderness		
CANON CITY				
Beaver Creek	17,000	9,150		
Black Canyon ^b		2,300		
Browns Canyon	6,614			
Lower Grape Creek		11,220		
McIntyre Hills		16,800		
Papa Keal ^b		1,020		
Sand Castle ^b		1,644		
San Luis Hills		10,240		
South Piney Creek ^b		870		
Upper Grape Creek		10,200		
Zapata Creek ^b		720		
Subtotal	23,614	64,164	0	
CRAIG				
Black Mountain		9,932		
Bull Canyon ^c	11,035	742		
Cold Springs West ^c			14,352	1985
Cross Mountain			14,081	1983
Diamond Breaks ^c			31,480	1985
Dinosaur Adjacent-Northern Boundary				
224 ^b		4,340		
224A ^b		1,320		
226 ^b		4,880		
228			5,200	1985
229D			6,900	1985
Oil Spring Mountain		17,740		
Skull Creek		13,740		
Troublesome			8,250	1983
Willow Creek		13,368		
Windy Gulch		12,274		
Subtotal	11,035	78,336	80,263	
GRAND JUNCTION				
Black Ridge Canyons			18,150	1986
Black Ridge Canyons West ^c			49,200	1986
Bull Gulch	10,415	4,585		
Castle Peak		11,940		
Demaree Canyon			21,050	1986
Dominguez Canyon ^d			31,990	1986
Eagle Mountain ^b		330		
Hack Lake ^b		3,360		
Little Bookcliffs/Wildhorse			26,525	1986

(continued)

Table 3. (continued)

District and Area	Wilderness	Nonwilderness	Study Not Completed	Completion Date
Sewemup Mesa ^d			17,480	1986
The Palisade			26,050	1986
Subtotal	10,415	20,215	190,445	
MONTROSE				
Adobe Badlands			10,560	1986
American Flats ^b		4,710		
Bill Hare Gulch ^b		370		
Cahone Canyon			8,385	1984
Camel Back			10,900	1986
Cross Canyon ^c			8,440	1984
Dolores River Canyon/ Coyote Wash			25,550	1984
Dominguez Canyon ^d			43,810	1986
Gunnison Gorge			19,560	1986
Handies Peak	7,120	11,740		
Larson Creek ^b		900		
McKenna Peak			21,900	1984
Menefee Mountain			7,360	1984
Needle Creek ^b		4,540		
Powderhorn Instant	44,951			
Red Cloud Peak	11,140	29,435		
Sewemup Mesa ^d			1,660	1986
Slumgullion Slide ^b		1,640		
Sparling Gulch/ Friends Creek ^b		1,840		
Squaw-Papoose Canyon ^c			4,680	1984
Tabeguache Creek			7,270	1986
Weber Mountain			6,320	1984
Weminuche Contiguous ^b		1,980		
West Needles				
Contiguous	5,780			
Whitehead Gulch	1,770	4,430		
Subtotal	70,761	61,585	176,395	
STATE TOTAL	115,825	224,300	447,103	

^a Areas listed in the November 18, 1981, Federal Register (U.S. Bur. Land Mgnt., 1981). Maps of individual areas are contained in U.S. Bur. Land Mgnt. (1980).

^b Areas withdrawn from wilderness consideration in January 1983 because they do not meet the minimum 5,000 acre criterion.

^c Excludes adjoining areas in Utah.

^d Located in both Grand Junction and Montrose Districts.

Final recommendations for all study units must be submitted to the President no later than October 21, 1991, and thence to Congress by October 21, 1993. At the time of this writing, BLM has completed studies for 36 of the study areas and has provisionally endorsed 224,300 acres for inclusion in the national preservation system.

The wilderness acreage located within national park boundaries (Table 4) is of minor concern to this study because the affected lands would be managed as de facto wilderness even without Congressional designation. Administrative endorsements to enlarge the existing wilderness acreage have been pending before Congress since 1972 or 1974. Senator William Armstrong sponsored legislation for the proposed acreage in 1982, but no action was taken on the bill. Boundaries of the proposed area in Rocky Mountain National Park lie close to, but exclude, several existing water-control facilities.

Table 4. National Park Wilderness Areas

Unit	Acres			Total
	Designated	Proposed ^a	Potential Additions ^b	
Black Canyon of the Gunnison National Monument	11,180 ^d			11,180
Colorado National Monument		13,842	937	14,779
Dinosaur National Monument ^c		165,988	3,202	169,190
Great Sand Dunes National Monument	33,490 ^d		2,530	36,020
Mesa Verde National Park	8,100 ^d			8,100
Rocky Mountain National Park	2,917 ^e	235,668	89	238,674
Total	55,687	415,498	6,758	477,943

^aAdministrative recommendations submitted to Congress in 1972 or 1974.

^bPrivate inholdings.

^cExcludes adjoining lands in Utah.

^dP.L. 94-567, 10/20/76.

^eP.L. 96-560, 12/22/80.

Wild and Scenic Study Rivers

On January 3, 1975, Congress directed that twelve rivers in Colorado be studied for potential inclusion in the national wild and scenic rivers system (P.L. 93-621; U.S. Senate-House Conf. Comm., 1974). Draft or final reports, including separate assessments of the Dolores River above and below the town of Gateway, have been published for each study corridor. The report for the Big Thompson River in Rocky Mountain National Park declared the entire study segment to be ineligible because of its short length and lack of outstanding features to compensate for the length criterion (U.S. Heritage Conserv. and Recreational Service, 1978). Recommendations for the other study corridors are summarized in Table 1. Nine of the eligible rivers and about three-fourths of the stream mileage are located on the West Slope in the Colorado River Basin (Fig. 2).

Study rivers are explicitly protected against water-resource development during the period which Congress allocates for their study and for an additional three-year period after the study reports are completed and submitted to Congress. Such protection has expired for the Dolores, Encampment, and Gunnison Rivers because Congress failed to designate the rivers within the grace period allowed for consideration of the completed reports. Protective status of the other nine rivers is uncertain because the enabling legislation established a deadline of October 2, 1979, for submittal of the study reports. As shown in Table 5, those for the Conejos, Elk, Los Pinos, and Piedra were not transmitted to Congress until September 13, 1982, and reports for the Cache la Poudre, Colorado, Lower Dolores, Green, and Yampa are still under administrative review. Responsibility for recommending the Colorado, Lower Dolores, Green, and Yampa rests with the Secretary of the Interior. Whether delay in forwarding the reports to Congress involves substantive issues or

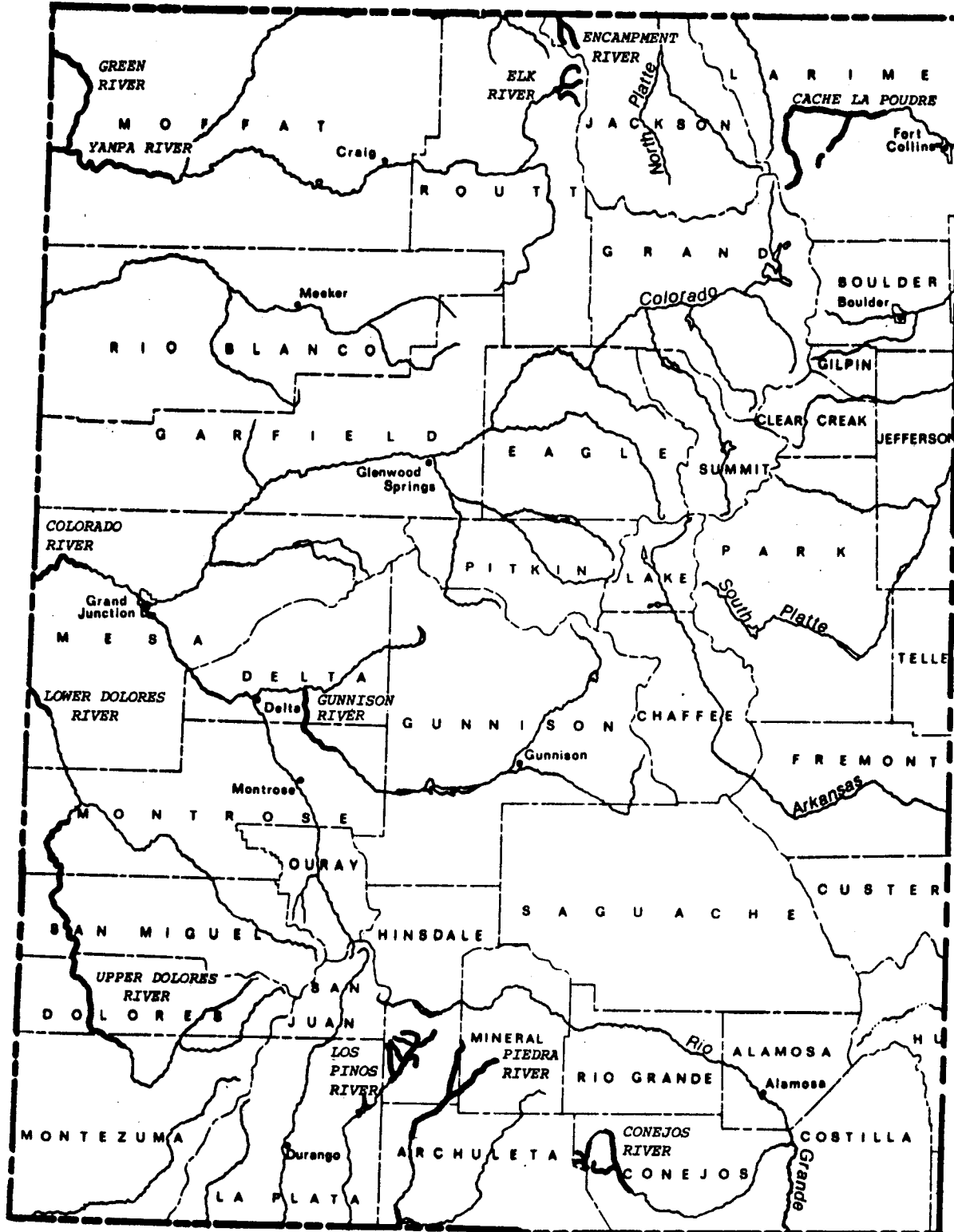


Figure 2. Wild and Scenic Study Rivers

Table 5. Status of Colorado Study Rivers, January 1983

River	Administrative Agency	Status
Big Thompson	National Park Service	Secretary's report, declaring the river to be ineligible, transmitted to the President on 10/2/79.
Cache la Poudre	Forest Service	Final report under review by the Secretary.
Colorado	Bureau of Land Management	Secretary's report transmitted to the President on 2/5/80; returned to the Secretary in 1981 for review.
Conejos	Forest Service	President's report transmitted to Congress on 9/13/82.
Elk	Forest Service	President's report transmitted to Congress on 9/13/82.
Encampment	Forest Service	President's report transmitted to Congress on 10/2/79.
Dolores	Forest Service, Bureau of Land Management	President's report transmitted to Congress on 5/23/77.
Green	National Park Service, Fish and Wildlife Service	Secretary's report transmitted to the President in 1980; returned to the Secretary in 1981 for review.
Gunnison	National Park Service, Bureau of Land Management	President's report transmitted to Congress on 10/2/79.
Los Pinos	Forest Service	President's report transmitted to Congress on 9/13/82.
Lower Dolores	Bureau of Land Management	Secretary's report transmitted to the President on 2/5/80; returned to the Secretary in 1981 for review.
Piedra	Forest Service	President's report transmitted to Congress on 9/13/82.
Yampa	National Park Service	Secretary's report transmitted to the President in 1980; returned to the Secretary in 1981 for review.

Source: U.S. National Park Service (telephone comm., 1983).

bureaucratic procrastination cannot be determined (Haubert, telephone comm., 1983). Responsibility for recommending the Cache la Poudre River rests with the Secretary of Agriculture. The Reagan Administration has submitted a proposal to Congress that would defer transmittal of the delinquent reports until January 1, 1986 (Interagency Task Force, 1982).

At least two legislative attempts have been made to designate some study rivers. Senator Henry Jackson of Washington sponsored bills in the 96th Congress for the Dolores (S. 2342), Encampment (S. 2344), and Gunnison Rivers (S. 2343); and Representative Hank Brown of Colorado's Fourth District sponsored legislation for the Elk and Encampment Rivers (H.R. 6980) in the 97th Congress. In both instances the bills died in committee. Because of redistricting preceding the November 1982 election, all study rivers except the Cache la Poudre are now located in the Third Congressional District served by Representative Ray Kogovsek. Representative Kogovsek has made only minimal effort in the past to sponsor designation of rivers in his district. The general lack of support given by Colorado's congressional delegation undoubtedly reflects the political sensitivity of water issues in the state. If designated, the rivers would be permanently protected against new developments that would unreasonably diminish their ecological values.

The National Park Service recently completed an inventory of rivers in the conterminous United States that identifies those which may possess sufficient natural or cultural attributes to qualify for the national wild and scenic rivers system. Table 6 lists the river segments located in Colorado that are additional to the twelve which Congress designated for study in 1975. Conceivably, some of the listed river segments might be recommended for inclusion in the national system at some future time.

Table 6. River Segments in Colorado Listed in the Nationwide Inventory

River Basin and River	Segment	County Location	Length (Miles)
ARKANSAS			
Arkansas River	Canon City to Salida	Chaffee, Fremont	52
Arkansas River	Salida to Pine Creek	Chaffee	39
Badger Creek	Arkansas River to source	Fremont, Park	25
Chacuaco Canyon	Purgatoire River to Highway 160	Las Animas	37
Huerfano River	Huerfano Cucharas Ditch diversion to Cucharas River	Pueblo	9
Purgatoire River	Arkansas River to Smith Canyon	Bent, Otero	42
Purgatoire River	Smith Canyon to Trinchera Creek	Otero, Las Animas	75
COLORADO			
Colorado River	State Bridge to Blue River	Grand, Eagle	23
Animas River	Animas City to Mineral Creek	San Juan, La Plata	45
Crystal River	National Forest boundary to sources of North and South Forks	Gunnison, Pitkin	45
East River	Gunnison River to source	Gunnison	20
North Fork White River	White River to source	Rio Blanco, Garfield	25
South Fork White River	White River to source	Rio Blanco, Garfield	35
San Juan River	Fourmile Creek to sources of East and West Forks	Rio Grande, Mineral, Archuleta	50
Taylor River	Illinois Creek to source	Gunnison	21
Yampa	Little Snake River to Williams Fork	Moffat	83
KANSAS			
Arikaree River	State line to Alder Creek	Yuma	48
RIO GRANDE			
Rio Grande	State line to Lobatos Bridge	Conejos	8
SOUTH PLATTE			
North Fork Cache la Poudre	Dale Creek to source	Larimer	31
South Platte River	Cheesman Reservoir to Elevenmile Canyon Reservoir	Douglas, Teller, Park Jefferson	28

Source: U.S. National Park Service (1982).

Endangered and Threatened Species

The Endangered Species Act directs all federal departments and agencies to conserve those species of fish, wildlife, or plant which are in danger of extinction throughout all or a significant portion of their range (endangered species) and those species which are likely to become endangered within the foreseeable future (threatened species). Fifteen such species are currently listed for Colorado (Table 1). Three of the listed species--Colorado squawfish, humpback chub, and whooping crane--are known to jeopardize regional development opportunities in the state. Constraints imposed by other species are either unlikely because of the extremely rare occurrence of the species or would be limited to local areas.

CHAPTER 2
LEGISLATIVE RESTRICTIONS

The purpose of this chapter is to review those provisions of the Wilderness Act, Wild and Scenic Rivers Act, and Endangered Species Act which may preclude or otherwise affect development of Colorado's water resources. The term "development" is used in a broad sense to include the building of new diversion, storage, conveyance, or hydroelectric facilities; maintenance or enlargement of existing control structures; operational changes that would alter the quantity or timing of river flows; installation of stream gaging or hydrometeorological equipment; implementation of cloud seeding or other programs designed to augment natural water yield; pumpage of groundwater; or any other action associated with the lawful exercise of state water rights.

Wilderness Act

The Wilderness Act of 1964 (P.L. 88-577; 16 U.S. Code 1131-1136) created a national preservation system comprised of "undeveloped federal land retaining its primeval character and influence, without permanent improvements or human habitation, which is protected and managed so as to preserve its natural conditions and which (1) generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable; (2) has outstanding opportunities for solitude or a primitive and unconfined type of recreation; (3) has at least five thousand acres of land or is of sufficient size as to make practicable its preservation and use in an unimpaired condition; and (4) may also contain ecological, geological, or other features of scientific, educational, scenic, or historical value."

Project Exemptions

In general, the Act prohibits the presence of commercial enterprise, construction of permanent or temporary roads, use of mechanical transport,

construction of buildings or other installations, and any other activity that would adversely affect preservation of an area's wilderness character. Most types of water-resources development are therefore prohibited except as Congress may grant statutory exemptions in designating particular areas or as the President may grant exemptions under Section 4(d)(4)(1) of the Act. Two Congressional exemptions have been given for Colorado water projects: one in 1978 for completion of the Fryingpan-Arkansas Project in the Hunter-Fryingpan Wilderness (P.L. 95-237) and another in 1980 for completion of the Homestake Project in the Holy Cross Wilderness (P.L. 96-560). Provisions for a Presidential exemption are specified in Section 4(d)(4)(1) of the Act, which reads as follows:

"Within wilderness areas in the national forests designated by this Act, the President may, within a specific area and in accordance with such regulations as he may deem desirable, authorize prospecting for water resources, the establishment and maintenance of reservoirs, water-conservation works, power projects, transmission lines, and other facilities needed in the public interest, including the road construction and maintenance essential to development and use thereof, upon his determination that such use or uses in the specific area will better serve the interests of the United States and the people thereof than will its denial."

Administrative Policies

Administrative policies affecting water-resource development are prescribed in Title 2300 of the Forest Service Manual. These are paraphrased below (U.S. Forest Service, 1973).

Water (2323.4). The objectives of water management in wilderness areas are identical with those on all National Forest watersheds. The important exception is that measures which modify plant cover and treat soil mantles, or other activities designated to supplement natural water yield, are inappropriate. Those considered vital must be consistent with wilderness objectives and be specifically approved by the Chief of the Forest Service on a project-by-project basis.

Water-Yield Improvement (2323.42-1). Overriding wilderness values and management objectives will generally preclude those practices which increase natural water yield or change the timing of runoff.

Water-yield improvement prescriptions, if contemplated, must be clearly compatible with maintenance of the wilderness resource.

New Water-Development Structures (2323.42-1). Establishment of new water-regulating structures, power installations, and related improvements (excluding those affecting range and wildlife waters) is subject to approval by the President under Section 4(d)(4) of the Wilderness Act. Forest Service recommendations for new developments will be based upon environmental analyses as prescribed by the National Environmental Policy Act. Any recommendation in favor of the proposal must be based upon a clear showing that the public values to be gained exceed the values that would be lost, and that the need cannot be met outside the wilderness. When a proposed structure is thus found to be in the public interest, consideration should also be given to recommending exclusion of the applicable area from wilderness.

Existing Structures (2323.42-3). Reservoirs, ditches, and related water-control facilities existing under valid permit or other authority at the time the land was designated as wilderness may be maintained if they are needed in the public interest or are a part of a valid existing right. Primitive means of transport and hand tools will be used in maintenance activities wherever and whenever feasible. Reconstruction of any structure or restoration of a natural water body to its original or historical level will be approved by the Chief, but any proposal to increase the storage capacity of a reservoir will be considered as a new structure and will be subject to approval by the President.

Gathering Water Resources Information (2323.43). Regional Foresters may approve any activity for gathering information about water resources, except actual drilling or digging to locate underground water supplies, provided such activities are carried on in a manner compatible with preservation of the wilderness environment. Such approval should be conditioned to show that it carries no precommitment for concurrence with a development project which may result from such activities.

Snow Measurement (2323.43a-1). No new data sites can be established unless they are parts of projects approved by the President under section 4(d)(4) of the Wilderness Act. Use of existing data sites may continue until adequate correlation can be established with sites outside the wilderness. Installation of automated equipment (sensing devices, data collection platforms, etc.) may be permitted on a temporary basis at existing sites to accelerate development of correlations with data sites outside the wilderness. The period of temporary occupancy will be determined by joint agreement between the Forest Service and the proponent prior to installation and will generally be less than 10 years, with provisions for extension in the event that adequate correlation is not established. Access will be by primitive means. However, where the use of a helicopter was an established practice, the practice may be continued.

Weather Modification (2323.44). Use of wilderness lands as target areas for weather modification activities will not be approved unless the following conditions are met:

1. The proponent can provide reasonable, scientifically supportable assurance that his activities will not produce permanent, substantial changes in natural conditions.

2. The proposal does not include any feature that might reasonably be expected to produce conditions incompatible in appearance with the wilderness environment or reduce its value for recreation, scenic, scientific, educational, conservation, or historical use.

This policy recognizes that the effects of weather modification activities may be permanent or temporary depending upon the type, duration, and degree of change in weather brought about by that activity. Generally, short-term weather-modification activities, which will produce only occasional, incidental, temporary, or transitory changes in the weather with carryover effects on the ground lasting only a few days beyond the seeding period, can be permitted over wildernesses because little or no permanent, identifiable ecological or physical impact is likely. Conversely, long-term weather modification programs, which will produce repeated or prolonged change in the weather during any part of successive years, are likely to have a direct and often substantial impact in terms of ecological and physical effects. Even though man's contribution to these impacts on the ecology and physical conditions on the ground may be obscured by the fact that he carries on these activities outside or above the wilderness, they nevertheless can be recognized to be the result of man's activities and therefore cannot be permitted where they will directly affect wilderness areas.

Regional Foresters will gather information relative to items 1 and 2 and make recommendations to the Chief on any activity or application. The Chief will approve activities or installations relative to weather modification affecting wilderness.

Wild and Scenic Rivers Act

The Wild and Scenic Rivers Act of 1968 (P.L. 90-542; 16 U.S. Code 1271-1287) established the national policy that selected rivers possessing "outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar values" should be preserved and protected in free-flowing condition for the benefit of present and future generations. Components of the national system may be designated by Congress (Sec. 3[a]) or, subject to approval of the Secretary of the Interior, by the act of a state legislature (Sec. 2[a][ii]). Federally-managed units are limited to narrow strips of land sufficient to insure protection of the river environment. Fee acquisition of lands is confined to an average of no more than 100 acres per river mile, and the

power of eminent domain is suspended if 50 percent or more of the acreage within a unit is already in public ownership. Scenic easements may be acquired to make the total area average not more than 320 acres per mile, equivalent to a river corridor averaging one-half mile in width.

Section 2(b) of the Act recognizes three classes of river corridors: wild, scenic, and recreational. Wild river corridors are generally inaccessible except by trail with watersheds or shorelines essentially primitive and waters unpolluted. Scenic river corridors are largely undeveloped but may be accessible in places by roads. Recreational river corridors are readily accessible by road, and shorelines may be extensively developed. Except in rare instances, both wild and scenic rivers must be free of impoundments. Any one of the three classifications may be applied to different segments of the same river.

Protection of Study Rivers

Restrictions on water-project development vary depending on whether the river has been designated a component of the national preservation system under Section 2(a)(ii) or 3(a) of the Act, or whether the river has been mandated for study under Section 5(a) to determine its feasibility for inclusion. All of the Colorado rivers are Section 5(a), or "study," rivers.

Study rivers are afforded protection against development by Sections 7(b) and 12(a) of the Act. Section 12(a) is a general directive which reads as follows:

"The Secretary of the Interior, the Secretary of Agriculture, and the head of any other Federal department or agency having jurisdiction over any lands which include, border upon, or are adjacent to, any river included within the National Wild and Scenic Rivers System or under consideration for such inclusion, in accordance with section 2(a)(ii), 3(a), or 5(a), shall take such action respecting management policies, regulations, contracts, plans, affecting such lands, following the date of enactment of this sentence (November 10, 1978), as may be necessary to protect such rivers in accordance with the purposes of this Act."

Explicit protection against water-project developments is given in Section 7(b). Relevant stipulations are paraphrased below, with underscoring used to emphasize key restrictions.

The Federal Power Commission (now the Federal Energy Regulatory Commission) shall not license the construction of any dam or other project works on or directly affecting any river.

No Federal department or agency shall assist by loan, grant, license, or otherwise in the construction of any water resources project that would have a direct and adverse effect on the values for which the river might be designated, as determined by the responsible Secretary.

No Federal department or agency shall license or assist development in upstream, downstream, or tributary areas of study rivers that would invade the area or diminish the scenic, recreational, and fish and wildlife values present on the date of approval of the Act (October 2, 1968).

No Federal department or agency shall recommend authorization or request appropriations to begin construction of any water resources project, whether heretofore or hereafter authorized, on any study river without advising the responsible Secretary and notifying the Congress of how construction would affect the values to be protected under the Act.

The protection given by Section 7(b) is clearly one of nondegradation of scenic, recreational, and fish and wildlife values, with the nondegradation rule applying equally to proposed construction works within the boundaries of the river corridor and to projects that would be located in upstream, downstream, or tributary areas (Regional Solicitor, 1976).

The applicability of both Sections 7(b) and 12(a) to the twelve Colorado study rivers is uncertain. As noted in Chapter 1, Public Law 93-621, which designated the rivers for potential addition to the national preservation system, set a deadline for completion and transmittal of study reports to the Congress of January 3, 1976, for the Dolores River and October 2, 1979, for the remaining rivers. Only the Gunnison and Encampment reports were submitted before the specified deadlines (Table 5). Hence it could be argued that failure to submit the other study reports within the time limits specified by Public

Law 93-621 has automatically terminated the legal status of these rivers as study rivers. Additionally, Section 7(b) itself carries a time limit of ten years following enactment of the 1968 legislation or three complete fiscal years following any Act designating a river for study purposes, whichever is later (subsection i), or for an additional three-year period following submittal of the study report to the President and the Congress (subsection ii). The ten-year deadline imposed in subsection (i) expired for all Colorado study rivers on October 2, 1979. The subsection (ii) three-year grace period allowed for Congressional consideration of study reports would seem to have expired on May 23, 1980, for the Dolores River and on October 2, 1982, for the Gunnison and Encampment Rivers.

Both the Forest Service and the Department of the Interior contend that study status and protection against development remain effective until Congress has had an opportunity to review the study reports (Snow, telephone comm., 1981). This position has been formalized in a proposed legislative amendment that would clarify Section 7(b) by applying protection from the date that Congress designates a river for study until three years after completion and transmittal of the study report to Congress, even if submittal of the report extends past the deadline that Congress mandated for completion (Interagency Task Force, 1982). Should Congress fail to act on the recommendations within the three-year review period, however, then study status would automatically terminate at the end of the period. The legislative proposal also extends the deadline for completion of study reports for the Cache la Poudre, Colorado, Green, and Yampa Rivers until January 1, 1986. If adopted by Congress, these amendments would terminate study status for the Dolores, Gunnison, and Encampment Rivers, but would clarify and uphold Section 7(b) protection for the other study rivers.

Protection of Designated Rivers

Once the river is designated a component of the national system, restrictions on water-resources development are then governed by Section 7(a). The directive of this section is identical to that of Section 7(b) for construction projects located within the boundaries of the river corridor; namely, the Federal Energy Regulatory Commission is prohibited from licensing any construction works on or directly affecting the river, and no Federal department or agency is permitted to assist construction projects that would have a direct and adverse effect on the values for which the river was established, as determined by the Secretary charged with its administration.

The restriction on construction projects located in upstream, downstream, or tributary areas is more liberal, however. Whereas Section 7(b) uses the language invade the area or diminish the scenic, recreational, and fish and wildlife values, Section 7(a) says invade the area or unreasonably diminish. Addition of the word "unreasonably" indicates that, once a river has been added to the system, the nondegradation standard is modified to permit greater discretionary judgment in deciding which projects are precluded (Regional Solicitor, 1976).

The flexibility of discretionary judgment would be limited if the river corridor is located within a wilderness area or national park system unit. Section 10(b) of the Act specifies that any portion of a component located within the national wilderness preservation system shall be subject to provisions of both the Wilderness Act and the Wild and Scenic Rivers Act, and in case of conflict the more restrictive provisions will apply. A similar stipulation is cited in Section 10(c) for any river component administered by the Secretary of the Interior through the National Park Service. Conflicts with

the Acts governing the national park system are to be decided in favor of the more restrictive provision.

Large project works or smaller obtrusive ones would undoubtedly be prohibited within all designated corridors, but construction of some minor facilities might be allowed in river corridors located outside wilderness areas. Table 7, abstracted from the final administrative Guidelines issued jointly by the Department of the Interior and the Department of Agriculture in September 1982, summarizes the discretionary character of the criteria used to determine eligibility for wild, scenic, and recreational designation. The management section of the Guidelines mentions water-control structures only in the context that "such features as trail bridges, fences, water bars and drainage ditches, flow measurement devices and other minor structures or management practices are permitted when compatible with the classification of the river area and provided that the area remains natural in appearance and the practices or structures harmonize with the surrounding environment" (U.S. Dept. Interior and U.S. Dept. Agr., 1982, p. 39459).

Water Rights

The issue of water rights is addressed by several provisions of Section 13 of the Act. These are paraphrased below:

- (a) Fishing shall be permitted on lands and waters administered as parts of the national system under applicable State and Federal laws and regulations.
- (b) The jurisdiction of the States and the United States over waters of any stream included within the national system shall be determined by established principles of law. Any taking by the United States of a water right which is vested under either State or Federal law at the time such river is designated shall entitle the owner thereof to just compensation. Nothing in this Act shall constitute an express or implied claim or denial on the part of the Federal Government as to exemption from State water laws.
- (c) Designation of any stream or portion thereof shall not be construed as a reservation of the waters of such streams for purposes

TABLE 7. CLASSIFICATION CRITERIA FOR WILD, SCENIC AND RECREATIONAL RIVER AREAS

ATTRIBUTE	WILD	SCENIC	RECREATIONAL
Water Resource Development	<p>River area should be essentially free of buildings, pipelines, powerlines, dams, pumps, generators, diversion works, rip-rap, and other modifications.</p>	<p>River area should be free of impoundments; any structures or concentration of structures must be limited to relatively short reaches of the total river corridor.</p>	<p>Some existing impoundment or diversion.</p> <p>The existence of low dams, diversions or other modifications of the waterway is acceptable, provided the waterway remains generally natural and riverine in appearance.</p>
Shoreline Development	<p>Essentially primitive. Little or no evidence of human activity.</p> <p>The presence of a few inconspicuous structures, particularly those of historic or cultural value, is acceptable.</p> <p>A limited amount of domestic livestock grazing or hay production is acceptable.</p> <p>Little or no evidence of past timber harvest. No ongoing timber harvest.</p>	<p>Largely primitive and undeveloped. No substantial evidence of human activity</p> <p>The presence of small communities or dispersed dwellings or farm structures is acceptable.</p> <p>The presence of grazing, hay production or row crops is acceptable.</p> <p>Evidence of past or ongoing timber harvest is acceptable, provided the forest appears natural from the riverbank.</p>	<p>Some development. Substantial evidence of human activity.</p> <p>The presence of extensive residential development and a few commercial structures is acceptable.</p> <p>Lands may have been developed for the full range of agricultural and forestry uses.</p> <p>May show evidence of past and ongoing timber harvest.</p>
Accessibility	<p>Generally inaccessible except by trail.</p> <p>No roads, railroads or other provision for vehicular travel within the river area. A few existing roads leading to the boundary of the river area is acceptable.</p>	<p>Accessible in places by road.</p> <p>Roads may occasionally reach or bridge the river. The existence of short stretches of conspicuous or longer stretches of inconspicuous roads or railroads is acceptable.</p>	<p>Readily accessible by road or railroad.</p> <p>The existence of parallel roads or railroads on one or both banks as well as bridge crossings and other river access points is acceptable.</p>
Water Quality	<p>Meets or exceeds Federal criteria or federally approved State standards for aesthetics, for propagation of fish and wildlife normally adapted to the habitat of the river, and for primary contact recreation (swimming) except where exceeded by natural conditions.</p>	<p>No criteria prescribed by the Wild and Scenic Rivers Act. The Federal Water Pollution Control Act Amendments of 1972 have made it a national goal that all waters of the United States be made fishable and swimmable. Therefore, rivers will not be precluded from scenic or recreational classification because of poor water quality at the time of their study, provided a water quality improvement plan exists or is being developed in compliance with applicable Federal and State laws.</p>	

Source: U.S. Dept. Interior and U.S. Dept. Agr. (1982)

other than those specified in this Act, or in quantities greater than necessary to accomplish these purposes.

(d) The jurisdiction of the States over waters of any stream included in the national system shall be unaffected by this Act to the extent that such jurisdiction may be exercised without impairing the purposes of this Act or its administration.

(e) Nothing contained in this Act shall be construed to alter, amend, repeal, interpret, modify, or be in conflict with any interstate compact made by any States which contain any portion of the national wild and scenic rivers system.

(f) Nothing in this Act shall affect existing rights of any State, including the right of access, with respect to the beds of navigable streams, tributaries, or rivers (or segments thereof) located in a national wild, scenic, or recreational river area.

The various study reports contend that placement of rivers in the national system would not jeopardize existing water rights vested under state law (e.g., U.S. Forest Service, 1980a, p. 52). The basis for this conclusion is never documented, but presumably derives from an interpretation of Section 13 of the Act. The claim that designation would not impair state water rights is clearly erroneous. Final water decrees could be negatively affected, either by placing regulatory constraints on the maintenance of existing water-control structures or by opposing requested changes in the place of diversion, place of use, timing of use, or type of use, if such changes would negatively alter the quantity or quality of river flows. Conditional water decrees and new appropriation filings would obviously be jeopardized by the protection stipulations of Section 7.

Preservation of Instream Flows

Study reports for the Colorado rivers make little or no attempt to quantify the instream flows needed to preserve the values for which the rivers might be designated. Presumably, instream flow needs and strategies for preserving such flows would be specified in the management plan which must be drawn up within one year following Congressional designation of the river.

Designation would automatically convey a federal reserved water right to the administrative agency, as noted in Section 13(c), with the appropriation date being the date of Congressional action. An earlier appropriation date could not be claimed simply because the river corridor might occupy federal lands that had been withdrawn in an earlier time period. At least this is true for river corridors located on lands administered by the Forest Service or Bureau of Land Management. In the Rio Mibres case (United States v. New Mexico, 98 S.Ct. 3012, 1978), the U.S. Supreme Court held that federal reserved rights on national forest lands apply only to the two limited purposes for which the national forests were originally created, namely, furnishing a continuous supply of timber and securing favorable water flows for downstream areas (Brooks, 1979). The Court held that reserved rights do not apply to preservation of minimum instream flows for aesthetic, recreational, wildlife-preservation, or stockwatering purposes. The Court's narrow definition of reserved rights confines their application to the minimal uses required to carry out the original purposes of a particular land withdrawal (King, 1982).

Similarly, an earlier appropriation date apparently cannot be claimed, at least for recreational boating, for the three river segments located in National Park units, namely, the Yampa and Green Rivers in Dinosaur National Monument and the Gunnison River in Black Canyon of the Gunnison National Monument. The Park Service attempted to adjudicate an instream flow right for the Yampa River under authority of the Park Service's enabling legislation of 1916 (39 Stat. 535) which directs the Service "to conserve the scenery and the natural and historic objects (of national park units) and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations." The Colorado Supreme Court ruled in November 1982, that although the federal

government may claim water rights for various recreational and aesthetic purposes, it cannot claim a minimum flow right in the Yampa River to protect recreational boating. The court explained that the legislation creating the monument in 1915 was "primarily concerned with scientific and historic purposes, not recreational purposes" (Cox, 1982).

Proposed Amendments

As noted earlier, the Reagan Administration has proposed a number of legislative amendments to the Wild and Scenic Rivers Act (Interagency Task Force, 1982). Those of particular concern to this study are as follows:

1. Extend the deadline for completion and submittal of study reports for the Cache la Poudre, Colorado, Green, and Yampa Rivers from October 2, 1979, to January 1, 1986.

2. Clarify Section 7(b) by stating that protection against water-project development for study rivers applies from the date that Congress mandates a study to three years after a report is submitted to Congress, even if submittal of the report is delayed beyond the deadline mandated for completion.

3. Establish a sunset clause so that study status will terminate within three years after a study report is submitted to Congress if no legislative action is taken.

4. Change the baseline date for determining possible impacts on river values by water-resource projects from the date the act was passed (October 2, 1968) to the date the river is designated.

5. Change the Section 7(b) standard of measuring effects of water projects on river values from "diminish" to the Section 7(a) standard of "unreasonably diminish."

Endangered Species Act

The Endangered Species Act of 1973 (P.L. 93-205; 16 U.S. Code 1531-1543) directs all federal departments and agencies to conserve those species of fish, wildlife, or plant which are in danger of extinction throughout all or a significant part of their range (endangered species) and those which are likely to become endangered within the foreseeable future (threatened species). The term "species" is defined to include any subspecies of fish, wildlife, or plant, and any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature. The term "fish, wildlife, or plant" means any member of the plant and animal kingdom except pest species of the Class Insecta whose protection would present an overwhelming and overriding risk to man.

Water-project development could be affected by Sections 4, 5, 7, and 11 of the Act. Section 4 instructs the Secretary of the Interior or, for most marine species, the Secretary of Commerce, to publish a list of threatened and endangered species; issue any regulations deemed necessary to protect the species; designate critical habitat, or geographical areas which are essential to conservation of the species; and develop recovery plans that will promote conservation and survival of listed species. Section 5 empowers the Secretary to promote recovery planning through the purchase of state water rights. Section 7 prohibits federal actions that might jeopardize endangered or threatened species and their habitats, establishes a required consultation process, and creates a two-step exemption procedure for projects that satisfy certain provisions. Section 11 allows any citizen to bring suit to enforce provisions of the Act.

Listing of Species

A species may be listed as endangered or threatened for any of the following reasons:

- (1) the present or threatened destruction, modification, or curtailment of its habitat or range;

- (2) overutilization for commercial, sporting, scientific, or educational purposes;
- (3) disease or predation;
- (4) inadequacy of existing regulatory mechanisms; or
- (5) other natural or manmade factors affecting its continued existence.

Unlisted species may be treated as endangered or threatened if the Secretary determines that, because of similar appearance, enforcement personnel would have substantial difficulty in distinguishing between the listed and unlisted species. Public notification of proposed listings is required, and a review of all listed species must be conducted at least once every five years for the purpose of determining whether any species should be removed from the list or changed in status. Interested persons can file a petition at any time for determination of the status of any listed or unlisted species.

Designation of Critical Habitat

For species listed following enactment of the 1978 Amendments (P.L. 95-632), the Secretary shall also designate critical habitat, which is defined as "any air, land, or water area and constituent elements thereof, the loss of which would appreciably decrease the likelihood of the survival and recovery of a listed species or a distinct segment of its population" (50 C.F.R. 402.02). Critical habitat may represent any portion of the present habitat of a listed species and may include additional areas for reasonable population expansion. In determining critical habitat, the Secretary must evaluate economic and other relevant impacts of specifying a particular area, and he may exclude any area if the benefits of such exclusion outweigh the benefits of designating the habitat, providing such action would not lead to extinction of the species. Critical habitat must be listed, "to the maximum extent prudent," concurrently with listing of a new species. Designation of critical habitat may be withheld if

public disclosure would facilitate unauthorized collecting or other destructive activities.

Recovery Planning

Section 4(g) directs the Secretary to develop and implement recovery plans for listed species, the goal being to return listed species to the point where they are no longer endangered or threatened, or to at least stabilize their status. Recovery methods may involve improving and managing present habitat, transplanting species to their former range, or propagating and maintaining captive reserve gene pools. If necessary, the Secretary is empowered under Section 5 to acquire suitable habitat by purchasing "lands, waters, or interests therein." Once acquired, such habitat is protected and maintained as part of the national wildlife refuge system.

Consultation and Limits on Agency Actions

Section 7 directs all Federal agencies to insure that actions "authorized, funded, or carried out" by them are not likely to jeopardize the continued existence of endangered or threatened species or result in the destruction or adverse modification of critical habitat. Jeopardize means "to engage in an activity or program which reasonably would be expected to reduce the reproduction, numbers, or distribution of a listed species to such an extent as to appreciably reduce the likelihood of the survival and recovery of that species in the wild" (50 C.F.R. 402.02; emphasis added). Each Federal agency must review its activities or programs and identify those that may affect listed species or their habitat. When an agency identifies any such activities or programs, the agency shall convey a written request for consultation to the Fish and Wildlife Service or, for most marine species, to the National Marine Fisheries Service.

Initiation of the consultation process conveys responsibilities to both the Federal agency and the Service (50 C.F.R. 402.04). The Federal agency has

primary responsibility for conducting the appropriate biological studies. Until consultation is completed, the agency is precluded from making any "irreversible or irretrievable commitment of resources" involving listed species or critical habitat that would foreclose formulating or implementing reasonable and prudent alternatives to the proposed action. The Fish and Wildlife Service is charged with conducting a "threshold examination" of the identified activity or program. After reviewing all available information, the Service then issues a "biological opinion" stating whether the proposed action is likely to jeopardize the species or adversely modify the critical habitat, and suggesting reasonable and prudent alternatives that can be taken by the Federal agency or the permit or license applicant. The biological opinion must be submitted within 60 days after consultation is initiated unless insufficient information exists for making a judgment.

On July 19, 1978, the Solicitor of the Department of the Interior issued an opinion which stated that:

...it is apparent that Congress intended that the Department not limit its consultation role to a piece-meal analysis of the impacts of individual projects or activities on endangered species habitat. Rather, a reasoned interpretation of these provisions requires an analysis of all pending impacts upon the ecosystem, before determining whether the more limited impacts of any one particular proposal will violate the prohibitions of Section 7 (Hobbs, 1982, p. 8).

The concept of "cumulative effects" was initially defined to include all pending project impacts, whether federal, state, or private, if such impacts could reasonably be anticipated to occur either before or after the completion of the project which is the subject of Section 7 consultation. Subsequent opinions dated August 27, 1981, and July 6, 1982, have clarified and modified the concept of cumulative effects, as follows (Associate Solicitor, 1981, 1982):

The first step in determining cumulative effects is to define the scope of the "project" under consultation. In the case of construction activities, a

project is both the proposed construction activity itself (e.g., a dam and reservoir) and any connected activity (e.g., the lattice work of irrigation canals served by the reservoir).

The second step is to determine the "environmental baseline" in the affected area. This involves considering (1) the past and present impacts of all projects and human activities in the area, whether federal, state, or private in nature; (2) the anticipated impacts of all proposed federal projects in the affected area which have previously been the subject of Section 7 consultation and received a favorable biological opinion; and (3) the anticipated impacts of state or private actions which are contemporaneous with the consultation in process. Anticipated impacts of future federal projects which have not been reviewed under Section 7 should be excluded from the environmental baseline.

The third step is to determine the anticipated impacts of future state or private actions where such actions are reasonably certain to occur prior to the completion of the federal project. A non-federal action is "reasonably certain" to occur if the action requires the approval of state or local agencies, such agencies have approved the action, and the project is ready to proceed. Other indicators include whether the project sponsors provide assurance that the action will proceed, whether contracting has been initiated, whether there is obligated venture capital, or whether state or local planning agencies indicate that grant of authority for the action is imminent. These indicators must show more than the possibility that the non-federal project will occur; they must demonstrate with reasonable certainty that it will occur.

The fourth step is to determine the direct and indirect impacts of the federal project under review. Completion of this step will have revealed whether any cushion of natural resources remains. A "cushion" is defined as water, air, vegetation, or other habitat resources upon which a listed species is

dependent, that could be utilized or consumed, without jeopardy to the continued existence of the species.

Finally, the federal project under review, together with future federal projects that become subject to Section 7 consultation, will be allowed to proceed on a first-in-time, first-in-right basis until the cushion of remaining resources is depleted. Once the cushion is allocated, additional federal projects must be given a jeopardy opinion unless the adverse effects are offset by other means, so that the net result is no further adverse impact on the species.

Although the Solicitor's opinion appears to differentiate among "federal," "state," and "private" projects (or actions), it should be made clear that the distinction is not valid in most cases because state and private projects generally involve federal funding or the acquisition of federal licenses or permits. In these cases, the state and private actions become federal actions. The only major exception would appear to be the drilling of wells, which seldom involves a federal nexus.

Citizen Suit Provision

The Section 7 consultation role of the Fish and Wildlife Service is merely advisory (Ausherman, 1978). Final authority to determine whether the project will jeopardize endangered or threatened species or their critical habitat rests with the action-taking federal agency. Since it is the prerogative of the Fish and Wildlife Service only to advise, an agency could proceed with a project against the recommendations of the Service. Resolution of any such conflict might then be subject to judicial review under Section 11(g) of the Act, which allows any citizen to bring suit to (1) enjoin any violator of the Act, including the action-taking federal agency; or (2) to compel the Secretary to enforce the prohibitions of the Act. The first provision effectively limits the discretionary powers of federal agencies. The second provision likewise limits the

otherwise broad discretion of the Secretary in implementing the legislation, including the listing of species and their critical habitat or the promulgation of regulations. In a word, the citizen suit provision creates substantial opportunity for intervention by either advocates or opponents of affected water projects (Ausherman, 1978; Hobbs, 1982).

Exemption Procedure

The consultation process is designed to resolve most conflicts, but should a conflict remain, then Section 7 also provides that the Federal agency, the governor of the affected state, or the permit or license applicant may apply for an exemption. The first step in the exemption procedure is to submit an application to a review board of three persons: one appointed by the Secretary, one appointed by the President after consideration of recommendations by the governor of the state, and one an administrative law judge selected by the Civil Service Commission. The board must determine by majority vote:

- (A) whether an irresolvable conflict exists, and
- (B) whether the Federal agency concerned and the exemption applicant has
 - (i) carried out its consultation responsibilities in good faith and made a reasonable and responsible effort to develop and fairly consider modifications or reasonable and prudent alternatives to the proposed agency action;
 - (ii) conducted any biological assessment required of it; and
 - (iii) refrained from making any irreversible or irretrievable commitment of resources prohibited by subsection (d).

If the above conditions are met, then the Review Board conducts a formal hearing and issues a report to the Endangered Species Committee. The report shall discuss:

- (A) the availability of reasonable and prudent alternatives to the agency action, and the nature and extent of the benefits of the agency action and of alternative courses of action consistent with conserving the species or the critical habitat;

- (B) a summary of the evidence concerning whether or not the agency action is in the public interest and is of national or regional significance;
- (C) appropriate reasonable mitigation and enhancement measures which should be considered by the Committee.

Final resolution of the conflict rests with the seven-member Endangered Species Committee, which is composed of the Secretary of Agriculture, Secretary of Army, Secretary of the Interior, Chairman of the Council of Economic Advisors, Administrator of the Environmental Protection Agency, Administrator of the National Oceanic and Atmospheric Administration, and a person appointed by the President at the recommendation of the governor of the affected state. After receiving the Review Board's report and hearing evidence on its own, the Committee makes the final determination whether or not to grant an exemption. Five members of the Committee vote to approve an exemption based on the criteria that:

- (i) there are no reasonable and prudent alternatives to the agency action;
- (ii) the benefits of such action clearly outweigh the benefits of alternative courses of action consistent with conserving the species or its critical habitat, and such action is in the public interest; and
- (iii) the action is of regional or national significance.

In granting an exemption, the Committee shall establish "such reasonable mitigation and enhancement measures, including, but not limited to, live propagation, transplantation, and habitat acquisition and improvement, as are necessary and appropriate to minimize the adverse effects of the agency action upon the endangered species, threatened species, or critical habitat concerned." Such measures are to be carried out and paid for by the party receiving the exemption. If a federal agency is involved, the mitigation and enhancement measures must be authorized by Congress prior to implementing the action and funded concurrently with all other project features. The Committee's final determination

and the final agency action are subject to judicial review in the Court of Appeals for any circuit in which the agency action would take place.

CHAPTER 3
TOPICAL ANALYSIS OF WILDERNESS CONSTRAINTS

The purpose of this chapter is to examine certain topical aspects of wilderness constraints on water-project development, namely (1) preservation of endangered and threatened species, especially the whooping crane and Colorado River fishes; (2) the abrogation of state water rights and interstate compacts; and (3) limitations on streamflow augmentation opportunities in national forest wilderness areas. The discussion provides general background for the regional analysis of Chapter 4, which details the effects of wilderness preservation on specific water projects within a river-basin accounting system.

Whooping Crane

The whooping crane (Grus americana) once inhabited a breeding area that extended from central Illinois northwestward through portions of Iowa, Minnesota, North Dakota, Manitoba, and Saskatchewan to the vicinity of Edmonton, Alberta (Whooping Crane Recovery Team, 1980). Habitat disruption by agricultural developments, shooting, and other human intrusions reduced the whooper population to a low point of only 21 birds by 1941 (U.S. Fish and Wildlife Service, 1982a). The known world crane population as of January 1983 numbered about 116 birds, divided among the wild flock that migrates between Wood Buffalo National Park in northern Canada and the Aransas National Wildlife Refuge in coastal Texas (71 birds), the foster-reared population that migrates between Grays Lake National Wildlife Refuge in Idaho and the Rio Grande Valley of New Mexico (13 birds), and captive birds at several locations (U.S. Fish and Wildlife Service, 1983).

Grays Lake Flock

The Grays Lake flock, which has been propagated by cross-fostering the whoopers with sandhill cranes, passes through northwestern and south-central Colorado and makes a major rest stop each spring and fall in the San Luis Valley. Both the Alamosa and Monte Vista National Wildlife Refuges have been designated as critical habitat under Section 4 of the Endangered Species Act (U.S. Fish and Wildlife Service, 1978a). Sightings of migratory birds along other portions of the Colorado flyway have been reported in the vicinity of Douglas Pass, Delta, Grand Mesa, Hotchkiss, the Craig-Steamboat Springs area, and even at Antero Reservoir in South Park (Goodman, personal comm., 1983; Graul, 1978; Licitis, 1980). Although protection of the Grays Lake flock poses no significant threat to water-project development at this time, the Fish and Wildlife Service (1981f) has expressed concern that continuing loss of wetlands along the flyway could become important as the flock increases in size.

Wood Buffalo-Aransas Flock

The main migration route for the Wood Buffalo-Aransas flock is nearly a straight line northward through central Kansas and Nebraska. Colorado is on the western edge of this flyway, and many cranes undoubtedly passed through the eastern counties more or less regularly when the whoopers were still abundant (Bailey and Niedrach, 1965, p. 297). Ranchers observed cranes in Kit Carson County in 1934 and casually thereafter, but none were recorded between at least October 1942 and 1964. The most recent documented sighting occurred in November 1973 in the Greeley area (Graul, 1978).

Several critical habitats have been designated for the Wood Buffalo-Aransas flock, including the Platte River Bottomlands in central Nebraska (U.S. Fish and Wildlife Service, 1978a). The habitat comprises a corridor about 3 miles wide and 53 miles long astride the Platte River between the communities

of Lexington and Shelton (Fig. 3). The western boundary of the habitat lies approximately 125 miles downstream from the South Platte River at the Colorado-Nebraska state line, 390 miles below the Laramie River at the Colorado-Wyoming state line, and 500 miles below the North Platte River at the Colorado-Wyoming state line. To date, the Fish and Wildlife Service has issued jeopardy opinions for three upstream water projects: Grayrocks Reservoir on the Laramie River near Wheatland, Wyoming; Wildcat Reservoir on a small tributary of the South Platte River near Brush, Colorado; and Narrows Reservoir on the South Platte mainstem near Fort Morgan (U.S. Fish and Wildlife Service, 1978b, 1979a, 1982a, 1983). All three opinions concluded that further depletions of streamflow would jeopardize continued existence of the whooping crane by adversely modifying its critical habitat.

Conservation of the Platte River habitat will require managing the timing of river flows. According to the Fish and Wildlife Service (1982a, 1983) flows are needed to maintain proper channel depth during the crane migration period, to maintain adjacent wet meadows, and to maintain channel width and thus prevent encroachment of woody vegetation on channel sandbars. A flow of approximately 1,100 cfs is recommended for the migration period, which usually extends between March 23-May 10 and September 16-November 15. A similar discharge is recommended for the period of February 1 to May 10, in order to initiate growth of wet meadow vegetation and invertebrate food populations before the cranes arrive on their spring migration. Maintenance of channel width could be accomplished by releasing scouring flows of 3,800 cfs for any 23 days of the year. Scouring flows are recommended because whooping cranes prefer open expanses of sand and gravel bars or very shallow water for nightly roosting. As channel width decreases due to flow reduction, vegetation becomes established

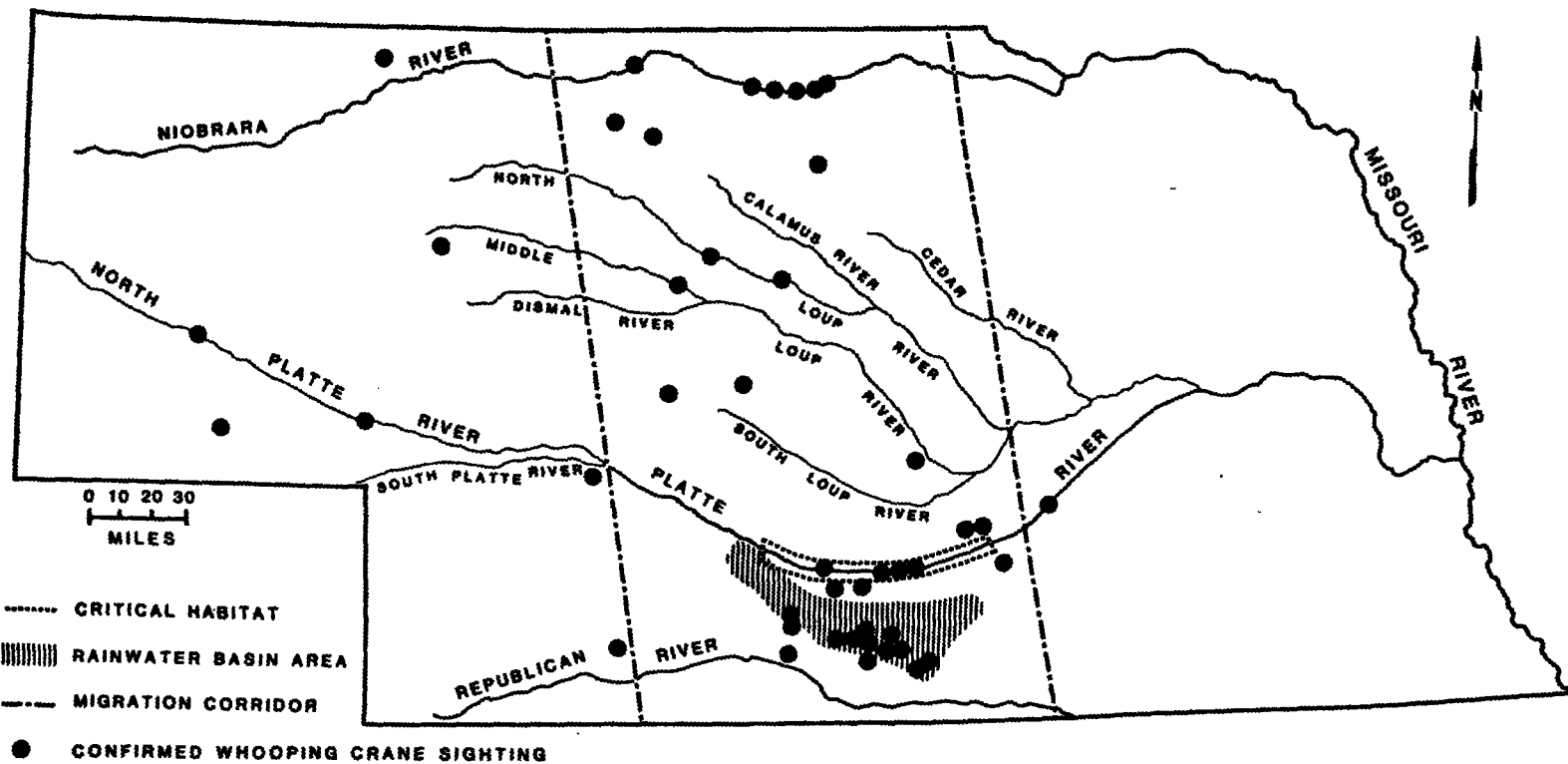


Figure 3. Platte River critical habitat, migration corridor, and confirmed sightings (1950-spring 1980) of whooping cranes in Nebraska (U.S. Fish and Wildlife Service, 1981b).

on the exposed channel and soon changes from low, scattered, herbaceous species to tall, dense stands of willows and cottonwoods.

Whooping crane use of the Platte River bottoms has apparently declined markedly in recent decades (U.S. Fish and Wildlife Service, 1981b, p. 37-38, 74-76). The number of confirmed sightings on or near the river per 30-year period equalled 17 from 1890-1919, rose to 65 from 1920-1949, then fell to only 5, or a total of 17 birds, from 1950 through spring-1980. Possible causes for the decrease in sightings include (1) reduction of observational and reporting efforts, (2) loss of observational visibility because of encroachment of woody vegetation, (3) reduction in crane population numbers, and (4) actual decrease in river use because of deteriorating habitat conditions. The weight of evidence points to changing habitat conditions caused by both streamflow reductions and by increased human activity in the area, especially adjacent to roads and bridges (U.S. Fish and Wildlife Service, 1981b; Williams, 1978). Cumulative stream depletions amounting to 80-85 percent of the pre-1930 mean flow have occurred in the reach near Brady, just above the critical habitat, with the result that this area no longer contains suitable roosting sites. Open water and sandbar habitat losses within the critical habitat itself totaled about 9,500 acres, or 62 percent, between 1938 and 1969. The acreage of wet meadows declined by about 39 percent between 1938 and 1976.

Further deterioration of the critical habitat poses several potential hazards because the crane population will be crowded onto a smaller land and water base (U.S. Fish and Wildlife Service, 1981b, 1982a, 1983). First, reduction of the habitat base and attendant crowding increase the possibility of catastrophic losses from such natural forces as hail storms and tornadoes. A small population resident in Louisiana, for example, is thought to have died out in the 1940s because of the decimating effects of a hurricane. Second,

crowding increases the likelihood that whoopers may not find adequate resting and foraging opportunities while enroute to their breeding grounds in Canada. This could lessen reproductive success since eggs are laid almost immediately upon their arrival. Third, crowding has already increased usage of the Rainwater Basin area, where major avian disease outbreaks have occurred in recent years. During both spring 1975 and spring 1979, whoopers were chased from wetlands experiencing cholera outbreaks, and on one of these occasions the birds settled on the Platte. Since disease outbreaks are likely to persist in the Rainwater Basin, the Platte River sanctuary becomes even more important.

Constraints on Project Development

As noted earlier, the Fish and Wildlife Service has issued jeopardy biological opinions for three upstream water projects. The Grayrocks Project in Wyoming, which received a jeopardy opinion in 1978, subsequently obtained an exemption from the Endangered Species Committee (1979) after agreeing to various stipulations, including the creation of a \$7.5 million trust fund to be used for habitat acquisition and management. Sponsors of the Wildcat Reservoir Project elected to file a lawsuit rather than accept the conservation measures recommended by the Fish and Wildlife Service. Initially, the Service recommended that the Corps of Engineers condition issuance of a 404 permit on providing replacement flows or combining a lesser volume of replacement flows with land acquisition and habitat manipulation (U.S. Fish and Wildlife Service, 1979a). A revised opinion concluded that the small size and distant location of the project made release of replacement flows infeasible, but the Service proposed to issue a nonjeopardy opinion if project sponsors would donate \$103,730 to the trust fund set up under the Grayrocks settlement, to be used to control vegetation encroachment along 1.7 miles of river corridor (Hobbs, 1982; U.S. Fish and Wildlife Service, 1982a). Rather than accept this stipulation, project sponsors

are pursuing a lawsuit claiming that denial of the 404 permit interferes with a state-created water right, Colorado's water allocation system, and Colorado's entitlements under the South Platte River Compact (Riverside Irrigation District v. Stipo, 658 F.2d, 10th Cir. 1981; Hobbs, 1982). Approval of the Narrows Project was made conditional upon release of channel and habitat maintenance flows, and funding of habitat improvement if further studies determine that such is needed (U.S. Fish and Wildlife Service, 1983).

Table 8 compares the management flows currently being recommended by the Fish and Wildlife Service for the Platte River at Overton and Grand Island, Nebraska, with the existing flow regime and the flow regimes projected under four alternative levels of development. The Overton gage is located near the upstream boundary of the 53-mile critical habitat reach, and the Grand Island gage is located approximately 20 miles below the downstream boundary. Definitions relevant to the table are as follows:

Management plan with scouring in February, March, or April--flow regime needed to maintain channel conditions during the crane migration period, to recharge and maintain the adjacent wet meadows, and to scour the channel and thus prevent encroachment of woody vegetation on channel sandbars. Scouring could be achieved during any month of the year, but is likely to be most effective during periods of ice breakup.

Management plan with no scouring flows--same as above, except that encroachment of woody vegetation would be controlled by artificial means.

Baseline condition--simulation of the 1947-1977 flow regime, adjusted to the 1977 level of river development plus the incremental depletion that will occur when Grayrocks Reservoir in Wyoming becomes fully operational.

Baseline with Narrows Project--baseline condition plus the incremental depletion effect of Narrows Reservoir (93,600 afy at Julesburg, Colorado, and 91,900 afy at the upstream border of the critical habitat).

Baseline with groundwater depletion--baseline condition plus the incremental depletion effect of developing all remaining irrigable lands in Nebraska that are accessible to tributary groundwater supplies.

Table 8. Comparison of Platte River Flows at Overton and Grand Island, Nebraska

	1,000 Acre-Feet							Annual
	Feb.	Mar.	Apr.	May 1-10	Sept. 16-30	Oct.	Nov. 1-15	
Management plan, scouring in February	184.0	67.5	65.3	21.8	32.7	67.5	32.7	471.5
Management plan, scouring in March	61.0	190.5	65.3	21.8	32.7	67.5	32.7	471.5
Management plan, scouring in April	61.0	67.5	188.3	21.8	32.7	67.5	32.7	471.5
Management plan, no scouring flows	61.0	67.5	65.3	21.8	32.7	67.5	32.7	348.5
Baseline condition								
Overton	(90.4)	(115.5)	(110.7)	35.5	<u>30.0</u>	71.2	36.2	971.7
Grand Island	(97.1)	(127.5)	(116.6)	35.5	<u>23.5</u>	<u>61.6</u>	<u>32.1</u>	934.6
Baseline with Narrows Project								
Overton	(80.4)	(107.4)	(100.7)	29.9	<u>28.1</u>	<u>65.7</u>	<u>34.9</u>	879.8
Grand Island	(87.1)	(119.4)	(106.7)	29.7	<u>21.4</u>	<u>56.0</u>	<u>30.6</u>	843.0
Baseline with groundwater development								
Overton	(65.0)	(87.2)	(85.0)	28.5	<u>23.3</u>	<u>53.0</u>	<u>27.1</u>	742.8
Grand Island	(63.9)	(92.5)	(84.9)	26.6	<u>14.8</u>	<u>35.7</u>	<u>18.8</u>	630.3
Baseline with surface water development								
Overton	<u>50.6</u>	(80.1)	(80.9)	22.0	<u>26.5</u>	<u>39.3</u>	<u>20.3</u>	624.0
Grand Island	<u>49.8</u>	(87.2)	(68.3)	<u>18.7</u>	<u>19.6</u>	<u>18.3</u>	<u>8.8</u>	496.8
Baseline with groundwater and surface water development								
Overton	<u>32.1</u>	<u>49.5</u>	<u>50.3</u>	<u>11.5</u>	<u>19.0</u>	<u>29.1</u>	<u>15.7</u>	(399.7)
Grand Island	<u>23.1</u>	<u>46.7</u>	<u>37.2</u>	<u>8.1</u>	<u>12.6</u>	<u>12.4</u>	<u>5.1</u>	<u>259.5</u>

(90.4) Flow less than management plan with scouring flows.
32.1 Flow less than management plan with no scouring flows.

Source: U.S. Bur. Reclamation (1982); U.S. Fish and Wildlife Service (1983).

Baseline with surface water development--flows in the Laramie River, Cache la Poudre River, and Lodgepole Creek fully depleted, the Narrows Project operational, and the Little Blue and Prairie Bend Projects in Nebraska operational. This scenario approaches full utilization of Colorado's remaining entitlement to South Platte River water under terms of the South Platte River Compact with Nebraska.

Baseline with groundwater and surface water development--worst case scenario of baseline condition with incremental depletion effects of both groundwater and surface water development.

Except for the worst-case scenario, the volume of annual flow through the critical habitat exceeds the recommended flow amount. The problem is therefore one of regulating the timing of river flows to coincide with the seasonal demands of the whooping crane and the competitive demands imposed by project development. As noted in the table, even the baseline flow regime is inadequate during the fall migration period and, if scouring flows are required, during one of the spring months. The spring management flows could be reduced by controlling woody vegetation through artificial means. The Wildcat Reservoir opinion (U.S. Fish and Wildlife Service, 1982a) suggests that this option might be allowed for one or more small developments, providing that project sponsors fund habitat improvement works. The Narrows opinion, on the other hand, indicates that large projects will either have to provide replacement water or devote a portion of their own storage to the provision of maintenance flows (U.S. Fish and Wildlife Service, 1983). Projects depleting any amount of streamflow may be asked to fund habitat manipulation or land acquisition programs, either within the critical habitat reach itself or elsewhere within the Big Bend segment of the Platte. The resource base of the critical habitat alone may not be sufficient to support the larger flock size that is called for in the whooping crane recovery plan. According to the plan, the Woods Buffalo-Aransas population will have to be increased from its present size of 71 birds to about 200 birds before the species can be reclassified from

endangered to threatened (U.S. Fish and Wildlife Service, 1983; Whooping Crane Recovery Team, 1980).

The ability of future Colorado projects to provide the desired river flows will depend partly on the incremental economic costs of providing the added storage and partly on the scheduling of construction relative to project developments in Wyoming and Nebraska. The competitive position of Colorado vis-a-vis Wyoming and Nebraska, which derives from the "cumulative effects" policy adopted by the Fish and Wildlife Service, is discussed in a later section.

Colorado River Fishes

Project development in the Colorado River Basin is conditional upon preservation of at least two, and possibly three, endangered fish species: the Colorado squawfish, humpback chub, and bonytail chub. A fourth species, the razorback sucker, was proposed for listing as "threatened" on April 23, 1973, but the proposal was subsequently withdrawn because of procedural changes in the Endangered Species Act mandated by the 1978 amendments (Johnson and Rinne, 1982). In lieu of repropoing the species, the Fish and Wildlife Service has negotiated agreements with Arizona and New Mexico to reintroduce razorback suckers into portions of their historical range. This reintroduction program is the first major cooperative effort at stocking native, nongame fish species in the basin. If successful, recovery will have been achieved at minimal cost. Conservation of the listed species, on the other hand, has already affected a number of water projects in Colorado. Further constraints are certain to occur, including restrictions on transmountain diversion of Colorado River water to the East Slope.

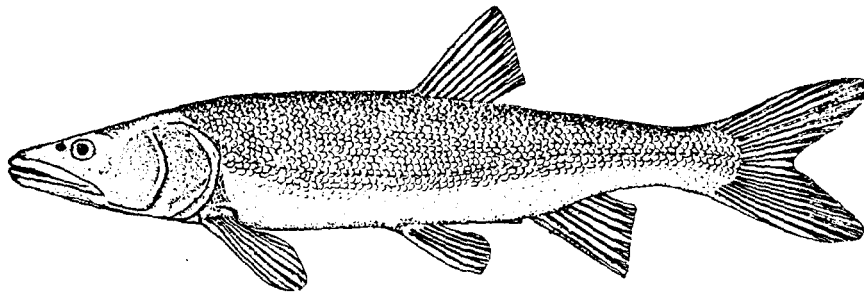
Information contained in this section has been abstracted from a variety of sources, including the series of reports issued recently by the Colorado

River Fishery Project Team (Miller, et al., 1982a, 1982b, 1982c; Tyus, et al., 1982; Valdez, et al., 1982a, 1982b). These reports present the results of field investigations conducted during 1979-1981 in the Colorado Mainstem, Green, White, Yampa, Gunnison, and Dolores River basins. Data from these investigations have been utilized by Fish and Wildlife personnel in their Section 7 consultations, and the data base is currently being synthesized into a recovery plan for the endangered fishes that is scheduled for publication in 1983.

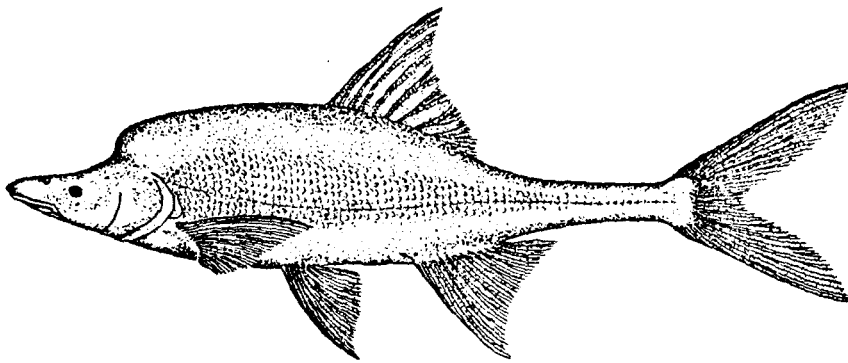
Distinguishing Characteristics and Former Range

All three species of endangered fish are endemic to the Colorado River Basin, which means that they occur nowhere else in the world (Behnke and Benson, 1980; Joseph, et al., 1977). The Colorado squawfish (Pytchocheilus lucius), which has the distinction of being the largest minnow native to North America (Fig. 4), was apparently once abundant throughout the Colorado Mainstem from the town of Green River, Wyoming, to the Gulf of California. The species was valued as a food fish by early settlers, who referred to it as "white salmon," and was even used as fertilizer when it became stranded in drainage ditches. Historical records indicate it once reached lengths of up to 6 feet and weights of 60 to 80 pounds, but specimens over 15 pounds or more than 3 feet in length have been rare in recent years. A gradual decline in abundance of squawfish was first noticed in the 1930s to 1950s, and sharper declines followed closure of the large dams in the 1960s.

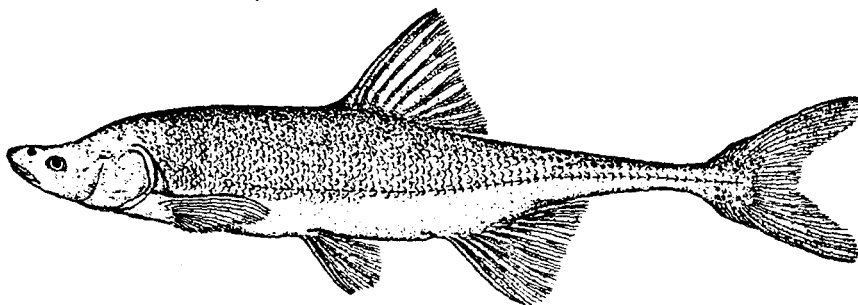
The humpback chub (Gila cypha Miller) is a large, grotesque-looking minnow characterized by a long fleshy snout, small eyes, prominent hump behind the head, and large wing-like fins. Adults reach a maximum length of about 20 inches and weight of approximately 2 pounds. The first known specimen of humpback chub was collected at the lower end of Grand Canyon in 1946 (Colo. River Fishes Recovery Team, 1979), and the most abundant population, in the



Colorado Squawfish



Humpback Chub



Bonytail Chub

Figure 4. Endangered Colorado River Fishes

Little Colorado River below Lake Powell, was not discovered until 1975 (Behnke and Benson, 1980). This late recognition, together with the limited and sporadic collection at present, suggests that the species was probably never abundant.

The bonytail chub (*Gila elegans*) is similar in appearance to the humpback chub, except that the dorsal hump is less pronounced in adults. Separation of the intergrade forms between these two species is difficult at all life stages. An additional problem arises from confusion in taxonomy between the bonytail and the roundtail chub (*Gila robusta robusta*). This is especially true in much of the older literature for the Lower Basin, which incorrectly reports the roundtail chub as the bonytail chub. Bonytail chub were collected with relative ease and often in considerable numbers near the turn of the century, but currently the species appears close to extinction.

Reasons for Decline

Possible factors contributing to the decline of the Colorado River fishes include habitat modification created by dams and their associated reservoirs; water quality changes induced by livestock grazing, irrigation return flows, and other effluent discharges; withdrawal and depletion of streamflow; competition and/or predation by exotic species; eradication programs to eliminate "trash" fish; hybridization; and parasites and disease (Behnke and Benson, 1980; Joseph, et al., 1977, p. 137-155). The last-named factor, parasites and disease, has probably not been a major threat except possibly for the Colorado squawfish.

Dam construction represents a key factor in the past and future preservation of the basin's native fishery. Most endemic species originally inhabiting a river segment disappear within a few years following reservoir impoundment, which changes the habitat from free-flowing, turbid conditions to a clear,

deep environment. Those caught in the flooded section either move slowly upstream or remain in the reservoir, fail to reproduce, and ultimately die of old age. Habitat below the dams is also adversely modified by the cold tailwaters and by altered daily and seasonal flows. Decrease in native fish populations in downstream reaches has been documented for both Glen Canyon and Flaming Gorge Dams (Joseph, et al., 1977, p. 142-143).

Exotic fishes may have negative impacts on native species through competition for food and space; as predators on eggs, larvae, and young fish; or through hybridization and loss of pure gene pools. Introduction of exotic fish has also been accompanied by purposeful efforts to eliminate the native species. Decline of the Colorado squawfish, for example, has been aided by past eradication programs which have included everything from dynamite to chemical control (Everhart and Seaman, 1971, p. 44). The most recent example of purposeful elimination is the rotenone treatments carried out on the Green River just prior to closure of Flaming Gorge Dam and a similar program on the San Juan River in conjunction with closure of Navajo Dam (Colo. River Fishes Recovery Team, 1978, p. 7).

Hybridization in fishes may be facilitated by the introduction of closely related species; by reduction in population size, which makes it difficult for individual fish to locate a conspecific mate; or by environmental alteration that eliminates or obscures specific niches and stimulates breeding between species which formerly maintained reproductive isolation. Verified and suspected hybrids of humpback, bonytail, and roundtail chubs have been collected in the Upper Basin (Joseph, et al., 1977, p. 148). Some investigators believe that hybridization was caused by natural factors; others suggest that interbreeding was facilitated by man-induced habitat modifications. In any event,

new habitat changes in the basin could increase the hybridization potential and thus speed the demise of the endangered chub populations.

Although documentation is lacking, water quality changes associated with livestock grazing, logging activities, and irrigation return flows may have contributed to the overall decline of rare fishes. Effluent discharges from municipal and industrial sources were probably not significant in the past (Joseph, et al., 1977, p. 151), but the greatly increased potential for new waste loads, particularly in conjunction with the mining and processing of coal, uranium, and oil shale, make it imperative that effective controls be implemented.

Withdrawal and consumptive use of water for irrigation, municipal, and industrial purposes has undoubtedly altered the basin's available fish habitat, and additional flow depletions could have both immediate and long-term adverse effects (Joseph, et al., 1977, p. 154-155). Immediate effects include reduction in space, change in temperature, and reduction in dissolved oxygen and substrate aeration. Distribution patterns clearly demonstrate that the endangered fishes are restricted by river size, which means that depleting flows below the critical level would eliminate suitable habitat. Long-term effects of flow reduction include channel hydraulic parameters that control stream bank cutting, meander patterns, backwater building, sediment transport capacity, and flow velocity.

Present Distribution

Investigations by the Colorado River Fishery Project Team have documented that Colorado squawfish currently range from Lake Powell as far upstream as DeBeque Canyon in the Colorado Mainstem, Dominguez Canyon in the Gunnison, Juniper Canyon in the Green-Yampa system, and the confluence with Piceance Creek in the White River (Fig 5; Miller, et al., 1982a; Valdez, et al., 1982a).

This widespread distribution reflects the migratory behavior of squawfish, whereby adults spawn in the middle and upper reaches, larvae and fry drift or migrate downstream into backwater nurseries, and juveniles begin moving back upstream after their first or second year. The most critical stream segments are therefore those that provide access or habitat for spawning and rearing. The Fish and Wildlife Service has provisionally identified 5 spawning and 4 rearing sites in the Upper Mainstem, Green, and Yampa Rivers (Table 9; Fig. 5). All of these sites are located near the Colorado-Utah state line or further downstream.

The largest population of humpback chub remaining in the Colorado River system occurs in the Little Colorado River and adjacent portions of the mainstem in Grand Canyon (Kaeding and Zimmerman, 1982). The only known major populations conclusively known to exist in the Upper Basin are located in the Black Rocks area of Ruby Canyon and in Westwater Canyon on the Colorado Mainstem near the Colorado-Utah state line (Fig. 5; Miller, et al., 1982a; Valdez, et al., 1982a). A poorly defined population exists in Gray Canyon on the Green River (Tyus, et al., 1982), and incidental captures have been reported from Cataract, Desolation, and Whirlpool Canyons on the Green River and Yampa Canyon on the Yampa River (Miller, et al., 1982a, 1982c). Specimens of humpback chub-like fish, tentatively identified as intermediates between G. cypha and G. robusta, have been captured in DeBeque Canyon about 20 miles upstream from Grand Junction (Valdez, et al., 1982a). Black Rocks and Westwater Canyon apparently support reproducing adults and are thus presently regarded as critical habitat for the species (Table 9).

A few senile pure specimens of bonytail chub continue to be collected from Lake Mohave in the Lower Colorado Basin, but the species appears close to extinction in the Upper Basin (Miller, et al., 1982a). The Colorado River

Table 9. Critical Habitat for the Endangered Colorado River Fishes

<u>Critical Areas (River Miles)^a</u>	<u>Fish Species and Life Stage</u>
<u>Colorado River Mainstem</u>	
Grand Junction to Black Rocks (137-170)	Squawfish spawning
Black Rocks (135-137)	Humpback chub spawning
Westwater Canyon (116-124)	Humpback chub spawning
Westwater to Salt Wash (75-112)	Squawfish spawning
Moab to Cataract Canyon (-3-60)	Squawfish rearing
<u>Green River</u>	
Split Mountain Canyon (319-327)	Squawfish spawning
Jensen to White River (249-290)	Squawfish rearing
White River to Sand Wash (212-249)	Squawfish rearing
Gray Canyon (146-156)	Squawfish spawning
San Rafael River to Colorado River (0-94)	Squawfish rearing
<u>Yampa River</u>	
Harding Hole to Green River (345-365)	Squawfish spawning

^aRiver miles upstream from the confluence of the Colorado Mainstem and Green Rivers.

Source: Terry Hickman (telephone comm., 1982).

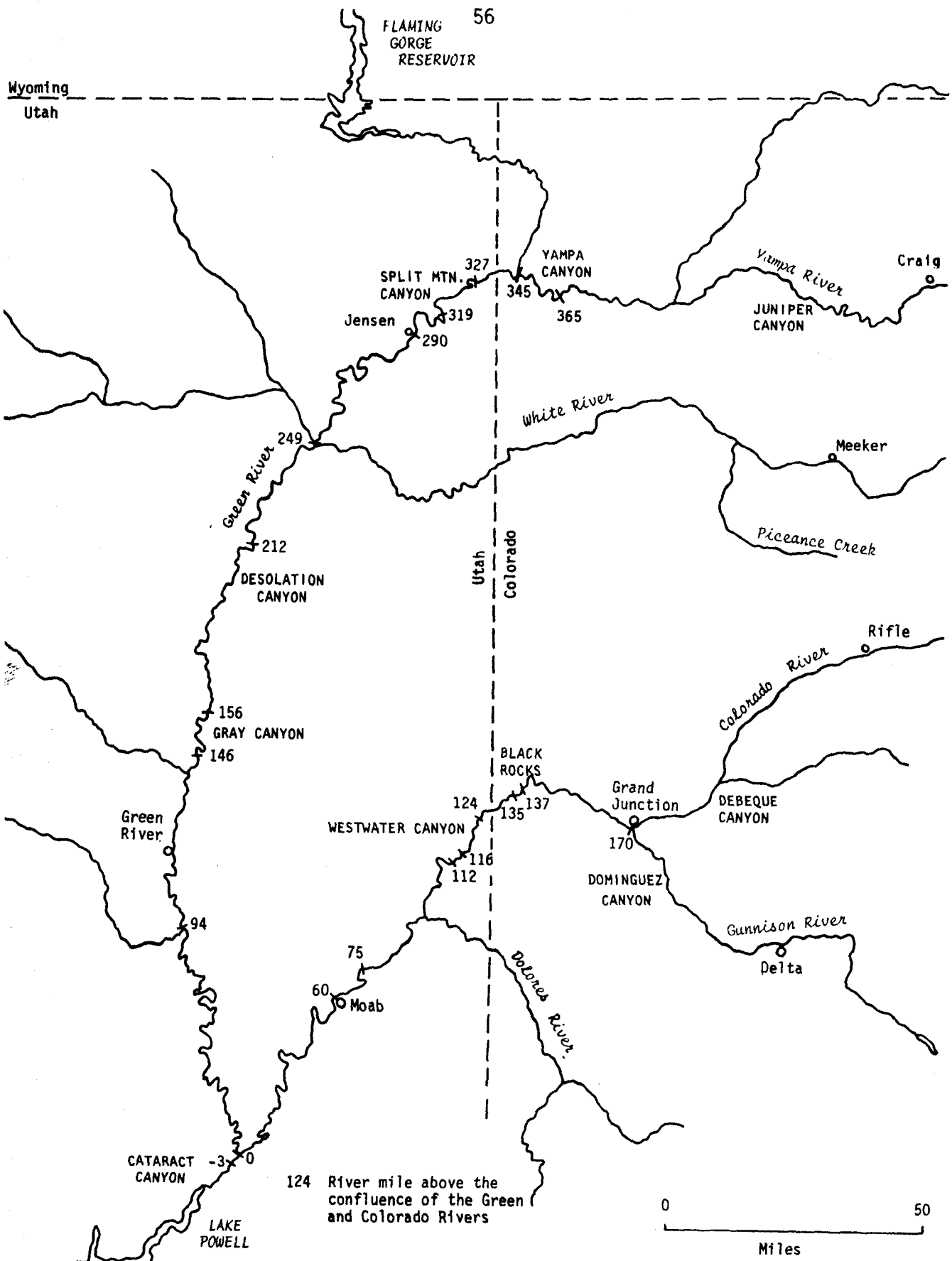


Figure 5. Critical habitat segments for the endangered Colorado River fishes

Fishery Project Team captured only 1 confirmed specimen during its investigations. This occurred at the lower end of Coal Creek Rapid in the Desolation-Gray Canyon segment of the Green River (Tyus, et al., 1982). No critical habitat has been proposed for the species.

Constraints on Project Development

Table 10 summarizes the biological opinions that have been issued to date for projects in Colorado and adjoining portions of Utah and Wyoming. All of the projects have been given nonjeopardy opinions, but construction of those involving new water depletions has been made contingent upon the project operator implementing or funding one or more types of conservation measures, namely: (1) bypassing of minimum flows or blending of water temperature releases, (2) determining the feasibility of fish passage around or through the dams, (3) research and monitoring of fish populations and habitat preferences, (4) habitat manipulation by gravel placement, creation of still-water areas, or other means, (5) establishing a fish culture and stocking program, and (6) establishing reservoir fisheries that do not compete with endemic species.

Some of the recommended conservation measures are site-specific; others will become part of a comprehensive management plan currently being devised for the Upper Basin by the Fish and Wildlife Service (Archer, 1982). The plan is expected to focus on conservation of the critical habitat river segments identified in Table 9 and shown in Figure 5. The term "critical habitat" is used here in an informal sense, as the Fish and Wildlife Service apparently does not intend to list the areas under the critical habitat provision of Section 4 of the Endangered Species Act, which would require detailed evaluation of the economic and other relevant impacts of specifying each site.

Table 10. Summary of Biological Opinions for Projects Affecting the Endangered Colorado River Fishes

Project Description	Biological Opinion
COLORADO MAINSTEM BASIN	
<p>Battlement Mesa Community Development Project: Sale of 1,186 af of water from Ruedi Reservoir, on the Fryngpan River, and its subsequent diversion from the Colorado Mainstem for domestic use at Battlement Mesa, a new residential community being built near the town of Parachute.</p>	<p>Nonjeopardy opinion conditional upon Battlement Mesa, Inc., agreeing to (1) fund conservation studies or programs designed by FWS, at an estimated cost of \$14,000, and (2) develop groundwater resources for use at Battlement Mesa that will not deplete flows in the Colorado Mainstem (U.S. Fish and Wildlife Service, 1981d).</p>
<p>Colony Oil Shale Project: Sale of 6,600 af of water from Ruedi Reservoir and its subsequent diversion from the Colorado Mainstem for industrial use.</p>	<p>Nonjeopardy opinion conditional upon Exxon Company, U.S.A. contributing \$32,000 to a habitat manipulation, fish culture, and monitoring and research program to be devised by FWS (U.S. Fish and Wildlife Service, 1982d; Hobbs, 1982).</p>
<p>Colorado-Big Thompson Project: Operational Bureau of Reclamation transmountain diversion of Colorado Mainstem water in Grand, Summit, and Larimer Counties.</p>	<p>No jeopardy to endangered fishes if operated at historical levels of diversion (U.S. Fish and Wildlife Service, 1981e).</p>
<p>West Divide Project: Bureau of Reclamation project, determined to be economically infeasible, that would obtain most of its water for irrigation and municipal use by pumping from the Colorado Mainstem near Silt and storing the water in tributary reservoirs. Depletion effect on the Colorado Mainstem would average 42,000 afy, or about 2 percent of the river flow at the Cameo gage, and would increase the frequency of no flow conditions below the Grand Valley Diversion.</p>	<p>Nonjeopardy opinion conditional upon releases and regulation of flows by one or more other Bureau of Reclamation projects to replace depletions caused by West Divide. Specific flow releases to be recommended when sufficient information becomes available from the Colorado River Fishery Project study (U.S. Fish and Wildlife Service, 1980a).</p>
<p>Windy Gap Project: Dam and reservoir sponsored by the Municipal Subdistrict of the Northern Colorado Water Conservancy District being built on the Colorado Mainstem about 1 mile below its confluence with the Fraser River. Diversion of the water through existing facilities of the Colorado-Big Thompson Project will deplete the flow of the Colorado Mainstem by 57,300 af in an average year and a maximum of 93,000 af in any one year.</p>	<p>Nonjeopardy opinion conditional upon project sponsors agreeing to (1) bypass minimum flows of approximately 11,000 afy, primarily to benefit trout habitat between Windy Gap Dam and the Blue River, but also to benefit the endangered fishes; (2) fund establishment of backwater habitat areas for Colorado squawfish along the Colorado Mainstem from the head of DeBeque Canyon to its confluence with the Green River; and (3) fund a three-year habitat monitoring and research program (U.S. Fish and Wildlife Service, 1981c). Funding commitment totals \$425,000 (Simpson, telephone comm., 1982).</p>
GUNNISON RIVER BASIN	
<p>Blue Mesa Peaking Power Study: Feasibility study of enlarging the generating capacity of Blue Mesa Dam, located on the Gunnison River, by 50 MW.</p>	<p>No jeopardy to endangered fishes (U.S. Fish and Wildlife Service, 1979b).</p>
<p>Dallas Creek Project: Bureau of Reclamation dam and reservoir being constructed on Uncompahgre River for purposes of augmenting irrigation supplies for the Uncompahgre Project and providing municipal water to the communities of Colona, Montrose, Olathe, and Delta.</p>	<p>Nonjeopardy opinion conditional upon release of replacement flows by one or more Bureau of Reclamation projects. Specific flow releases to be recommended when sufficient information becomes available from the Colorado River Fishery Project study (U.S. Fish and Wildlife Service, 1979c).</p>
<p>Dominguez Reservoir Project: Two proposed Bureau of Reclamation dams, reservoirs, and hydroelectric plants. The main dam, on the Gunnison River about 16 miles upstream from Grand Junction, would contain an 18-MW hydroelectric plant at its base and would inundate</p>	<p>Nonjeopardy opinion conditional upon (1) installation of multilevel outlets on Dominguez Dam to ensure that water temperatures approximate the natural flow, particularly from June through September; (2) release of minimum flows during critical periods for squawfish; (3) monitoring</p>

Table 10. (continued)

Project Description	Biological Opinion
26 miles of riverine habitat now occupied by Colorado squawfish; a smaller dam and reservoir on the canyon rim would be used to generate pumpback peaking power. Storage waters used for municipal and light industrial purposes would deplete the average flow of the Gunnison River by about 35,600 afy, or 3.5 percent.	of squawfish habitat on the Gunnison River below the dam; (4) funding of habitat improvement works if determined feasible by monitoring studies; (5) construction of a squawfish passage around or through the Redlands Diversion Dam, so that the lower 16 miles of the Gunnison can be used more freely by squawfish and help offset habitat losses above Dominguez Dam; (6) participation in forthcoming conservation plan for the endangered fishes, which may include funding of hatchery and fish stocking programs; and (7) development of a fishery in Dominguez Reservoir that will not compete with the endangered fishes (U.S. Fish and Wildlife Service, 1982e).
Lower Gunnison Salinity Control Unit, Stage I: Lining of canals and laterals in the Uncompahgre Valley for the purpose of reducing water seepage and thus reducing salt loading of the Colorado Mainstem.	No jeopardy to endangered fishes (U.S. Fish and Wildlife Service, 1981f).
WHITE RIVER BASIN	
Taylor Draw Dam and Reservoir Project: Proposed dam and reservoir, sponsored by Water Users Association No. 1 of the Colorado River Water Conservancy District, on the White River east of Rangely for the basic purpose of supplying M&I water to the town of Rangely. The project would deplete the average flow of the White River by 2,500 to 21,160 afy, or 0.5 to 4 percent; convert at least 6 miles of riverine habitat to lentic habitat; and potentially isolate 67 miles of known squawfish habitat above the dam site (about 9 percent of total known squawfish habitat) by blocking seasonal movement of the fishes.	Nonjeopardy opinion conditional upon project sponsors agreeing to (1) monitor squawfish populations below the dam and conduct habitat enhancement work if determined feasible by FWS, (2) monitor squawfish habitat above the dam and conduct habitat enhancement work if determined feasible by FWS, (3) determine feasibility of squawfish passage around or through the dam and implement fish passage plan if determined feasible by FWS, (4) participate in actions and measures to be identified in forthcoming plan for the endangered Colorado River fishes, and (5) develop a reservoir fishery that will not compete with the endangered fishes. Failure to maintain squawfish subpopulation above the dam site will not jeopardize the species (U.S. Fish and Wildlife Service, 1982c).
White River Dam Project, Utah: Proposed dam, reservoir, and 15-MW hydroelectric plant on the White River southwest of Bonanza, primarily for the purpose of providing water for oil-shale and thermal-electric power development. The project would deplete the average flow of the White River by 80,500 afy, convert at least 14 miles of riverine habitat to lentic habitat, and potentially isolate 80 miles of occupied squawfish habitat above the dam site (about 10 percent of total known squawfish habitat) by blocking seasonal movement of the fishes.	Nonjeopardy opinion conditional upon the State of Utah agreeing to (1) release waters from the dam that approximate the natural temperatures in the White River, (2) release specified flows to meet habitat needs of squawfish populations below the dam, (3) monitor the suspected squawfish spawning site located approximately 15 miles below the dam, (4) determine the feasibility of moving squawfish around or through the dam and implement a fish passage plan if determined feasible by FWS, (5) monitor squawfish habitat above the dam and possibly recover squawfish in this area for transport to the suspected spawning site or to a hatchery for broodstock, (6) carry out habitat enhancement work for adult squawfish above and below the reservoir if determined feasible by FWS, (7) participate in actions and measures to be identified in forthcoming conservation plan for the endangered Colorado River fishes, and (8) develop a fishery in White River Reservoir using native species only if determined feasible by FWS. Failure to maintain the squawfish subpopulation above the reservoir area will not jeopardize the species (U.S. Fish and Wildlife Service, 1982b).

Table 10. (continued)

Project Description	Biological Opinion
GREEN-YAMPA RIVER BASIN	
<p>Cheyenne Stage II Diversion Project: Proposed diversion of water from the North Fork of the Little Snake River in Wyoming for municipal use by the City of Cheyenne. Depletion effect on the Yampa River will average 15,800 af, or less than 1 percent.</p>	<p>Nonjeopardy opinion conditional upon the payment of \$138,000 by the Board of Public Utilities, City of Cheyenne, to help fund habitat manipulation, monitoring, and research (U.S. Fish and Wildlife Service, 1981g, 1982f).</p>
<p>Moon Lake Power Project, Utah: Proposed diversion of water from a collection well along the Green River near Jensen, Utah, for use by a coal-fired power plant to be built near Bonanza, Utah, and pumpage of four small-diameter wells adjacent to the White River near Rangely, Colorado, to supply the project's nearby coal mine. Project would deplete the annual flow of Green River by a maximum of 22,890 af, or 2.5 percent.</p>	<p>Nonjeopardy opinion conditional upon the Deseret Generation and Transmission Cooperative agreeing to either (1) negotiate a contract for purchase of up to 22,089 af of replacement water from Flaming Gorge Reservoir (option preferred by FWS), or (2) fund studies or programs designed by FWS to conserve the endangered fishes in an amount not to exceed \$500,000 (U.S. Fish and Wildlife Service, 1981h).</p>
DOLORS RIVER BASIN	
<p>Dolores Project: Bureau of Reclamation dam and reservoir, under construction on the Dolores River, that will divert about 131,000 af of water per year for irrigation, municipal, and industrial use in the San Juan Basin. Depletion of spring flows in the Dolores River by one-third could jeopardize Colorado squawfish and humpback chub in the Colorado River Main-between its confluence with Dolores River and Lake Powell.</p>	<p>Nonjeopardy opinion conditional upon release of replacement flows from the Dolores Project or other projects that regulate flows in the Colorado River Fishery Project Study (U.S. Fish and Wildlife Service, 1980b).</p>

According to the Fish and Wildlife Service (1981c, p. 3), the decline of native Colorado River fishes can be attributed mainly to habitat modification caused by reservoirs and consumptive water use. Construction of reservoirs that would inundate occupied habitat or block passage between spawning and rearing habitat is likely to be prohibited only in the lowermost portions of the Yampa and Colorado Mainstem Rivers. Reservoir impoundment of the Yampa River below Harding Hole would inundate the only documented spawning habitat for Colorado squawfish (Miller, et al., 1982c, p. 62), and impoundment of the Colorado Mainstem below Grand Junction would flood critical habitat for either squawfish or humpback chub. Placement of reservoirs on the lower White River will be permitted, since the Fish and Wildlife Service (1982b, 1982c) has already approved the White River Dam and Taylor Draw Projects, and has also acknowledged that complete loss of occupied habitat above Taylor Draw Dam will not jeopardize continued existence of the endangered fishes. Inundation of occupied habitat in the lower Gunnison River will also be permitted, as shown by the biological opinion for Dominguez Reservoir (U.S. Fish and Wildlife Service, 1982e). Multi-level outlets will likely be required for upstream hydroelectric or storage dams that would otherwise significantly alter flow temperatures through the critical habitat reaches.

Approval of new water depletions is likely to involve some restrictions regardless of their location in the Yampa, White, Colorado Mainstem, Gunnison, or Dolores River Basins. In this connection, it is important to note that the endangered fishes automatically enjoy some protection because consumptive water use in Colorado and other Upper Basin states is ultimately limited by provisions of the Colorado River Compact of 1922, the Upper Colorado River Basin Compact of 1948, and, possibly, by the Mexican Treaty of 1944.

Article XIII of the Upper Basin Compact prohibits Colorado from depleting the flow of the Yampa River at the Maybell Gaging Station below an aggregate of 5 million acre-feet for any consecutive ten-year period (Witmer, 1968, p. 349). Converted to an average annual basis, this represents approximately one-half of the virgin flow of the Yampa at the Maybell Gaging Station and two-thirds of the virgin flow of the Yampa at its confluence with the Green River (U.S. Dept. Agr., 1969, frontispiece 1). Streamflow depletion in the Yampa River is therefore limited by legal obligations to Utah irrespective of any threat to endangered fishes. Whether the required delivery to Utah will be adequate to ensure survival and recovery of the Colorado squawfish will depend on the timing as well as the volume of stream discharge.

Dewatering activities within the Colorado River system are further limited by Article III(d) of the 1922 compact, which prohibits the four Upper Basin states from depleting the flow of the Colorado mainstem at Lee Ferry, Arizona, below an aggregate of 75 million acre-feet for any consecutive ten-year period, or an average of 7.5 million acre-feet annually (Witmer, 1968, p. 54).^a Additionally, the Upper Basin states may be obliged to share half of the Mexican Treaty commitment of 1.5 million acre-feet per year, or 1.8 million acre-feet if evaporation losses below Lee Ferry and unavoidable overdeliveries are included (Ely, 1968, p. 239). Sharing of the Mexican Treaty burden is claimed by the Lower Basin states under Article III(c) of the 1922 Compact, but is denied by the Upper Basin States. If the Lower Basin claim is upheld, then the Upper Basin would be required to deliver at Lee Ferry a total of 8.4 million acre-feet annually (7.5 mafy + $\frac{1}{2}$ of 1.8 mafy). This is equivalent to 57 or 63

^aThe term "Upper Basin states" is used here synonymously with "States of the Upper Division," which is the legal term used in Article III(d) of the 1922 compact and which includes a small drainage area in Arizona upstream from Lee Ferry.

percent of the river's long-term virgin flow, depending on whether one selects the estimated flow of 14.8 million acre-feet for the historical period of record, 1896-1980, or the 13.4 million acre-feet prevailing since 1930 (Upper Colo. River Comm., 1980, p. 37). In either case, a major portion of the virgin flow originates in the State of Colorado upstream from the river segments inhabited by endangered fishes.

According to Behnke (1982), two-thirds of the virgin flow offers considerable leeway for preserving the endangered fishes, providing that operation of reservoirs storing peak runoff can be coordinated to maintain adequate flows during the critical periods of spawning and rearing of young. Fortunately, neither the 1922 or 1948 compacts specify which stream segments must contribute to the aggregate delivery requirement at Lee Ferry. This gives some flexibility in allocating flows in a manner that would benefit both the endangered fishes and the human inhabitants of the basin. Implementing such a program would be extraordinarily difficult because of competing political and economic interests.

The extent to which project development might be jeopardized will depend, to a considerable degree, on how much emphasis is given to recovery rather than mere survival of the species. According to Behnke and Benson (1980), prospects for restoring the abundance of bonytail chub to a semblance of their former numbers in any part of their original range must be viewed as dim. The outlook for restoration of humpback chub is more encouraging, especially in the two critical segments where self-sustaining populations already exist. Restoration of squawfish is probably the easiest task because of their greater numbers and more widespread distribution.

Other Listed Species

Black-Footed Ferret

The black-footed ferret (Mustela nigripes) is probably the rarest of all North American mammals (Torres, et al., 1978, p. 10). This member of the weasel family measures approximately two feet from nose to tail and is distinguished by a black mask over the eyes, black markings on the legs extending to the knees, and black tip of the tail. Its original range extended from Texas, New Mexico, and Arizona northward to Alberta and Saskatchewan (Black-Footed Ferret Recovery Team, 1978). The species may never have been abundant. Its current distribution is not well known but is probably limited by the occurrence and abundance of prairie dog towns. Ferrets feed mainly on prairie dogs and utilize prairie dog burrows for denning sites and shelter.

The black-footed ferret initially ranged over much of Colorado, but today it cannot be categorically stated whether or not the mammal still exists in the state (Bissell, 1978, p. 75). The last confirmed sightings occurred in the South Platte River Basin near Denver and in the San Juan Basin near Mancos (Fisher, 1980). At least twenty probable sightings were reported between 1970-1982 (Jobman and Anderson, 1981, 1983). The most likely breeding sites, based on recent probable sightings or the occurrence of prairie dog towns (Bissell, 1978), are located in the Pawnee and Comanche National Grasslands (South Platte-Arkansas Basins), North Park (North Platte Basin), San Luis Valley (Rio Grande Basin), Paonia-Hotchkiss area (Gunnison Basin), and Moffat, Routt, and Rio Blanco counties (White-Yampa Basins).

Eskimo Curlew

The Eskimo curlew (Numenius borealis Forster) is a medium-sized shorebird that formerly occurred in flocks of several thousand (U.S. Fish and Wildlife Service, 1972). The birds followed a double migration route from their

Arctic breeding grounds to wintering areas in southern Brazil, Uruguay, Argentina, and Chile. The fall migration route occurred over eastern Canada and the Atlantic Ocean; spring migration brought large numbers of birds to coastal Texas and Louisiana, thence northward through the Great Plains states. Because the curlew was an epicurean's delight, excessive harvesting drastically reduced the size of the flocks between 1870 and 1890. Very few curlew have been seen during migration at any one time over the last 50 years, and no sightings have been recorded in the interior Plains for many years. The only record for Colorado is two birds shot near Denver in 1882 (Bailey and Niedrach, 1965, p. 335). Potential existence of the Eskimo curlew should not jeopardize any project development opportunities.

American Peregrine Falcon

Three subspecies of peregrine falcon occur in North America: The American peregrine (Falco peregrinus anatum), which initially ranged from Mexico to northern Canada; the Arctic peregrine (F. p. tundrius), a migratory form which summers in the tundra region of Alaska, Canada, and western Greenland; and Peale's peregrine (F. p. pealei), found along the coast of British Columbia, southeastern Alaska, and the Aleutian Islands (Snow, 1972). Both the American and Arctic subspecies are listed as endangered.

Cooke (1897) considered the American peregrine falcon to be locally common in Colorado. Today, the state contains 12 of the 41 active nesting sites known to exist in the Great Plains-Rocky Mountain region (Rocky Mtns./Southwestern Peregrine Falcon Recovery Team, 1977, table 1, p. 11). Craig (1978a) has mapped the general distribution of active, inactive, and potential nesting locations in the state. All are situated on ledges or in potholes or small caves on precipitous cliff faces, usually at considerable heights above the

surrounding terrain, in the Colorado River system and in the headwater areas of East Slope drainages.

The 12 active nesting sites are located in the Dolores, Rio Grande, San Juan, South Platte, and Yampa River Basins (Goodman, personal comm., 1983). However, the State Division of Wildlife is currently sponsoring a program designed to reintroduce the falcon throughout its former range. Water-project development need not be deleterious to the falcon, since impoundments may increase prey diversity or availability (Craig, 1978a, p. 42).

Arctic Peregrine Falcon

The Arctic peregrine falcon, smaller and much lighter in coloration than its American counterpart, breeds in the arctic tundra of Alaska, Canada, and western Greenland. It migrates in the spring and fall, chiefly along the Atlantic and Gulf coasts, through Central America to as far south as Argentina and Chile (Snow, 1972; U.S. Fish and Wildlife Service, 1973). The species is a rare visitor to the eastern plains and foothills of Colorado (Craig, telephone comm., 1983) and is unlikely to jeopardize water-project development in the state.

Bald Eagle

Adult bald eagles (Haliaeetus leucocephalus) are large birds having a brown body with white head and tail (Snow, 1973). The known population of reproducing bald eagles nesting in Colorado consists of three pairs, one each in the San Juan, White, and Yampa River Basins (Goodman, personal comm., 1983). Most eagles are fall and spring migrants that reside here only during the winter. Winter residents begin arriving in September, slowly increase in numbers, and reach their maximum occupancy in December through March, when 500 to 600 birds may be in the state, concentrated mainly in the plains riparian zone of the

South Platte and Arkansas River Basins, the San Luis Valley portion of the Rio Grande, and the lower-elevation riparian zones of West Slope drainages (Goodman, 1982). The spring migration begins in late February, and most eagles have left Colorado by early April.

Water-project development can be beneficial to the eagle population. Construction of reservoir impoundments may encourage reoccupancy of some localities by both wintering and nesting birds if other factors, such as limited human activity and availability of perch sites, are favorable (Craig, 1978b, p. 46). In general, bald eagle nest sites are associated with riparian habitats, since fish constitute a major food item. Most nests are located within 0.5 mile of water, and many are considerably closer (Snow, 1973, p. 25). Reservoir construction may also improve downstream habitat if water releases create open water for waterfowl and increase fish populations (U.S. Fish and Wildlife Service, 1979c, p. 11).

On the other hand, project development may have minimal beneficial effects on wintering birds because reservoirs are seasonally frozen and thus offer limited prey. Project development may even be detrimental if it removes roost or perch sites from reservoir shorelines, destroys riverine habitat by depletion of downstream flows, or results in harassment of roost sites by increased human activity. The biological opinion for the proposed Narrows Project, for example, recommended that some cottonwood trees be preserved as roosts and perches near the reservoir and that project operations be monitored to assure continued bald eagle use of the area (U.S. Fish and Wildlife Service, 1982g).

Greenback Cutthroat Trout

The greenback cutthroat trout (Salmo clarki stomias) is the only trout native to the Arkansas and South Platte River drainages in Colorado (Greenback Cutthroat Trout Recovery Team, 1977). Decline of pure populations was

caused by massive introduction of exotic species, by streamflow depletions, and by water pollution associated with mining, logging, and domestic livestock grazing. Conservation efforts beginning in 1959 have been sufficiently successful that the species is now listed as threatened rather than endangered. Occupied range of the greenback trout presently includes the following waters in the South Platte and Arkansas River systems (Langlois, 1978, p. 7-8):

Black Hollow Creek, Hourglass Creek, and South Fork of Cache la Poudre River in Larimer County;

Como Creek in Boulder County;

Bear Lake, Caddi Lake, Big Thompson River, and Hidden Valley Creek in Rocky Mountain National Park; and

Cascade Creek and South Fork of Huerfano Creek in Huerfano County.

The occupied range presently totals about 50 acres of habitat. Approximately 600 acres of habitat in at least 50 headwater streams must be occupied before the species can be recommended for delisting (Langlois, 1978, p. 8).

Endangered and Threatened Plants

Four of the five listed plant species are members of the cactus family and occur only in the Colorado River Basin (Ecology Consultants, 1978a; Peterson, 1982; U.S. Fish and Wildlife Service, 1981a). Knowlton's miniature cactus (Pediocactus knowltonii) is known to occur only in New Mexico and Colorado in the vicinity of Navajo Reservoir near the Los Pinos River in the San Juan Basin. The Mesa-verde cactus (Scherocactus mesae-verdae) occurs in the southern portion of Mesa Verde National Park and adjoining Ute Mountain Indian Reservation, in Montezuma County, and in the Uncompahgre Plateau portion of Montrose County. The spineless hedgehog cactus (Echinocereus triglochidiatus var. inermis) occupies some mesa tops between 5,000-8,000 feet elevation in Mesa, Delta, Montrose, and Ouray Counties. The Uinta Basin hookless cactus (Scherocactus glaucus) has a bipartite distribution,

with one population center in northeastern Utah and one in west-central Colorado. The Colorado population occupies dry, gravelly, alkaline hill sites at about 5,000 feet elevation along the Gunnison River in Delta and Mesa Counties and along the Colorado River near DeBeque in Garfield County.

The other listed plant, Northpark phacelia (Phacelia formosula Osterhout), is a member of the waterleaf family. Its only known world occurrence is limited to sandstone exposures and adjacent areas of the Coalmont Formation along the Michigan and North Platte Rivers in Jackson County.

Future Listings

The Endangered Species Act promotes considerable uncertainty in water-development planning because additional species can be nominated for listing at any time, either by the Fish and Wildlife Service or by petition from any interested person, and because the time interval between nomination and final disposition of the review can be very lengthy. The listing process slowed to a virtual stop in 1979 because of inadequate staff, funds, and internal administrative policies (General Accounting Office, 1979) and because of new requirements imposed by Executive Order 12044 and the 1978 amendments to the Act (U.S. Fish and Wildlife Service, 1980c). Although the October 1982 amendments have streamlined the listing procedure somewhat, the identification and review of candidate species can still be very time-consuming.

The number of species that might be listed for Colorado at some future date cannot be determined, but could be substantial. Notices of review are currently effective for 2 species of fish, 8 species of birds, 2 species of mammals, and 52 species of plants (U.S. Fish and Wildlife Service, 1980d, 1982h). Five of the plant species may already be extinct. Additional biological information is being sought to determine the appropriate status of the remaining plants and vertebrate species.

Abrogation of State Water Rights

A pending lawsuit involving the Endangered Species Act raises two legal issues of major concern to water-project development: (1) the use of federal regulatory mechanisms to condition or prevent the exercising of state-administered water rights, and (2) whether Congress, without a clear statement of intent, can modify its consent to the terms of an interstate compact by enactment of subsequent legislation (Riverside Irrigation District v. Stipo, 658 F.2d 762, 10th Cir. 1981; Hobbs, 1982). The suit arose in 1979 when the Corps of Engineers denied a 404 permit to Riverside Irrigation District and Public Service Company for construction of Wildcat Reservoir in the South Platte Basin, on grounds that the proposed project would jeopardize the critical habitat of the whooping crane along the Platte River in central Nebraska. Although technical arguments of the lawsuit pertain only to enforcement of the Endangered Species Act, the issues raised are equally pertinent to provisions of the Wilderness Act and Wild and Scenic Rivers Act.

Use of federal regulatory powers to supercede state-administered water rights contradicts the generally established policy that federal entities must abide by state water law. For example, if water is to be left in a stream to benefit endangered species, or to preserve the values of a wild, scenic, or recreational river corridor, then it can be argued that the responsible federal agency should effectuate the desired streamflow, not by denying funds, permits, or licenses, but by purchase, condemnation, or adjudication of a water right under state law. Plaintiffs in the Stipo case specifically argue that the United States must obtain a state water right in order to keep water in the South Platte for benefit of the whooping crane (Hobbs, 1982). Compliance with state water law would protect the owners of existing water rights, either because the newly adjudicated right would be junior to all existing ones, or

because just compensation would have to be paid in the event of purchase or condemnation. As noted in Chapter 2, both the Endangered Species Act (Sec. 5) and the Wild and Scenic Rivers Act (Sec. 13) empower federal agencies to acquire state-administered water rights to effectuate the purposes of the acts. Unfortunately, these provisions are usually ignored in favor of using regulatory powers to condition or prevent project development.

The second issue, Congressional modification of interstate compact allocations, is especially relevant in the South Platte and Colorado River Basins. Both basins contain undeveloped compact flows that could not be fully utilized if future projects are not allowed to proceed. Neither the Wilderness Act nor the Endangered Species Act gives explicit recognition to this issue. Section 13(e) of the Wild and Scenic Rivers Act states that nothing in the legislation "shall be construed to alter, amend, repeal, interpret, modify, or be in conflict with any interstate compact made by any States which contain any portion of the national wild and scenic rivers system." Other sections of the act, however, notably the river protection stipulations of Sections 7(a) and 7(b), are clearly contradictory to this proviso.

The gravest threat to interstate compact allocations would appear to stem from enforcement of the cumulative effects regulation of the Endangered Species Act, whereby projects depleting the resource cushion in a given stream system will be allowed to proceed on a first-come, first-served basis (see "Consultation and Limits on Agency Actions" section of Chapter 2). This policy adds a new dimension to the "use-it-or-lose-it" argument advanced by certain water interests, which says that Colorado could lose its undeveloped Colorado River entitlement to California or Arizona, either through prior appropriation usage or political clout of the two states, unless Colorado moves rapidly to capture and utilize the affected river flows (Almirall, 1982, p. 29).

A similar argument, but involving different players, could be made regarding the cumulative effects policy of the Fish and Wildlife Service. Specifically, protection of the endangered Colorado River fishes could place Colorado, Utah, and Wyoming in a competitive race to develop their allocated shares of the river. As noted earlier (Table 10), many of the nonjeopardy opinions issued by the Fish and Wildlife Service are conditional upon release of minimum or replacement flows to offset depletion effects. Continuation of this policy will make it increasingly difficult for the three states to develop their compact apportionments, especially if they must compete for the same resource cushion. All three states share entitlements to the Yampa River, and both Colorado and Utah are entitled to divert additional flows from the Dolores, Colorado Mainstem, and White Rivers.

Protection of the whooping crane habitat in the Platte River system also places Colorado in competition with Nebraska and Wyoming (Hobbs, 1982; U.S. Bur. Reclamation, 1982; U.S. Fish and Wildlife Service, 1982a, 1983). In this case, Colorado's position could be distinctly inferior because of proposed additional groundwater developments in Nebraska that would deplete the flow of the Platte River at Overton by about 20 percent. Groundwater pumpage can be accomplished without the nexus of any federal permit or funding tie. Thus, protection of the whooping crane would fall on Colorado in a discriminatory manner because the state proposes to develop most of its remaining compact entitlement by constructing surface reservoirs that do involve federal participation.

Constraints on Streamflow Augmentation

The Wilderness Act requires a Presidential exemption for nearly all types of water development activity. Although the opportunity cost of this restriction has not been fully determined, it is clear that wilderness withdrawals can negatively affect management and development options that would otherwise

be available. The efficacy of forecasting runoff, for example, is reduced because snow gages cannot be installed in Weminuche, Flat Tops, and other large wilderness areas (Shafer, telephone comm., 1983). Exclusion of reservoir construction in wilderness areas may result in greater evaporation losses because of the higher temperatures prevailing at the alternate, lower elevation sites. In the case of project proposals by the Denver Water Department (see Chapter 4), exclusion of construction within wilderness boundaries would increase capital costs and impose substantial operating costs because of the need to pump water that could otherwise be conveyed by gravity flow. Hydroelectric development costs may be increased indirectly if transmission lines have to be routed around wilderness areas. Unit costs of transmission lines presently range from about \$100,000 to as much as \$753,000 per mile, depending on voltage, tower design, and terrain conditions (Colo.-Ute Electric Assoc., 1982).

Withdrawal of lands under the Wilderness Act automatically forecloses or limits the implementation of measures designed to augment streamflow within the affected watershed. Although relatively little effort is currently being made to increase Colorado's natural runoff through cloud seeding, vegetation management, or snowpack management, use of these water-supply options will become increasingly viable as demand on existing resources continues to escalate. The most promising opportunities for streamflow augmentation occur in the alpine-subalpine watersheds, most of which lie within national forest boundaries. Virgin annual runoff from all national forest lands in Colorado averages about 13.5 million acre-feet (Table 11), or roughly 90 percent of the 14.4 million acre-feet of yearly runoff originating in the entire state. Runoff from designated wilderness areas totals about 2.4 million acre-feet, or 16 percent of the statewide yield, assuming that unit runoff on wilderness

Table 11. Virgin Water Yield From National Forest Lands In Colorado

River Basin and Forest Unit	Annual Water Yield	
	Total Acre-Feet	Acre-Feet/Acre
North and South Platte River Basins		
Arapahoe N.F.	168,580	0.85
Pike N.F.	330,200	0.31
Roosevelt N.F.	664,510	0.61
Routt N.F.	443,813	1.41
San Isabel N.F.	<u>1,024</u>	<u>0.20</u>
Subtotal	1,608,127	0.60
Arkansas River Basin		
Pike N.F.	49,912	0.24
San Isabel N.F.	<u>776,164</u>	<u>0.63</u>
Subtotal	826,076	0.57
Rio Grande Basin		
Rio Grande N.F.	<u>1,485,297</u>	<u>0.78</u>
Subtotal	1,485,297	0.78
Colorado River Basin		
Arapahoe N.F.	879,692	0.98
Grand Mesa-Uncompahgre N.F.	1,135,834	0.81
Gunnison N.F.	1,589,139	0.90
Routt N.F.	1,331,392	1.53
San Isabel N.F.	1,820	1.00
San Juan N.F.	2,399,659	1.15
White River N.F.	<u>2,253,533</u>	<u>1.09</u>
Subtotal	9,591,069	1.05
Total	<u>13,510,569</u>	<u>0.90</u>

Compiled from data in U.S. Forest Service (1972).

lands equals 0.9 acre-feet per acre average for all national forests. If all eligible wilderness study areas were to be designated, then total runoff from the Forest Service wilderness areas would exceed 2.6 million acre-feet annually, or close to one-fifth of the statewide renewable water supply.

Augmentation of natural water yield in wilderness areas through vegetation or snowpack management would require a Presidential exemption. The extent to which cloud seeding might be allowed without a Presidential exemption

is problematical. Current Forest Service policy generally permits short-term seeding activities, but long-term programs are excluded unless proponents can provide scientifically supportable assurance that seeding will produce no permanent, substantial changes in natural ecological or physical conditions (U.S. Forest Service, 1973). The meaning of "permanent, substantial changes" is open to variable interpretation. The Bureau of Reclamation (1974) maintains that seeding should be permitted over wilderness and nonwilderness areas alike. According to the Bureau, probabilities and degrees of environmental change associated with cloud seeding are very small, presently recognized hazards such as avalanching or flooding can be mitigated by appropriate suspension criteria, and cessation of seeding or other safeguards can be taken if monitoring reveals unforeseen damaging effects. At least one attempt has been made to legislate approval of cloud-seeding over wilderness areas. The measure, H.R. 5623, introduced in the 96th Congress, was never reported out of the House Committee on Interior and Insular Affairs. Cloud-seeders here in Colorado must obtain a permit from the State Department of Natural Resources. The Department presently has no specific policy regarding cloud-seeding over wilderness areas (Welles, telephone comm., 1983) and could therefore conceivably issue a permit without concurrence of the Forest Service. However, the Forest Service could discourage seeding operations by refusing to allow the placement of ground-based generators or meteorological measuring devices within wilderness areas or on adjoining national forest land.

Cloud-Seeding Opportunities

Cloud-seeding opportunities in the Colorado mountains and adjoining portions of Wyoming and New Mexico are conservatively estimated to total at least 1.5 million acre-feet of incremental runoff per year, or roughly 10 percent of

the natural water yield. The spatial potential shown in Table 12 assumes that all seeding would be conducted in the Colorado River system, but that spillover of seeding material across the Continental Divide would also produce augmented runoff in the headwater areas of East Slope drainages. Whether the State of Colorado could claim all of the incremental runoff generated by cloud-seeding is problematical, especially if augmentation activities were funded by the federal government. The Colorado River Basin Act of 1968, for example, specifies that meeting the Mexican Treaty obligation constitutes the first priority of any water augmentation project planned pursuant to the act and authorized by Congress. Cloud-seeding is nonetheless an appealing water-supply alternative, not only because of its large potential, but also because of its low direct cost of only \$6-8 per acre foot of water produced for a full-scale program (U.S. Bur. Reclamation, 1983).

Table 12. Cloud-Seeding Potential in Colorado

River Basin	Incremental Runoff Thousand Acre-Feet/Year
Colorado River	
San Juan-Dolores ^a	435
Colorado Mainstem ^b	327
Gunnison	191
Yampa ^c	135
White	130
Subtotal	1,218
Rio Grande ^a	116
South Platte	115
North Platte ^c	66
Arkansas	25
Subtotal	322
Total	1,540

Source: U.S. Bur. Reclamation (1983)

^aIncludes adjoining portions of New Mexico.

^bIncludes Grand Mesa, part of which drains into the Gunnison River.

^cIncludes adjoining portions of Wyoming.

Historically, cloud seeding in Colorado has been limited to federally-sponsored experimental programs, state-sponsored emergency drought relief, and a few small-scale commercial projects funded mainly by ski areas and local water agencies (Welles, 1982). Formal efforts to initiate large-scale seeding have come about only recently. In both 1980 and 1981, the Colorado General Assembly considered bills that would have established a seven-year, state-supported research and demonstration program to evaluate the technical, economic, legal, and environmental issues of winter orographic seeding. Both bills were supported by various water conservation districts in hearings before the House Agriculture and Natural Resource Committee, but failed to receive hearings in the Appropriations Committee.

The proposed state effort would have complemented the Colorado River Enhanced Snowpack Test (CREST) now being formulated by the Bureau of Reclamation (1983). As currently envisioned, CREST would be an eight-year program designed to confirm the capability of cloud seeding to augment the flow of the Colorado River, so as to benefit the entire basin water-service area, including Mexico. Preferred sites for the demonstration tests are the Flat Tops Wilderness in the White River Plateau and the Weminuche Wilderness in the San Juan Mountains of Colorado. Successful implementation of the program and its operational extension to favorable target areas in Colorado would achieve the potential shown in Table 12, assuming that no restrictions would be imposed by the Forest Service to protect wilderness areas against possible ecological damage. All of the seeding target areas overlap to a greater or lesser degree with designated or endorsed wilderness areas.

Vegetation and Snow Management

Vegetation and snow management techniques include (1) reducing stand density by clearcutting, partial-cutting, or uniform thinning to reduce

transpiration and interception losses; (2) replacing high water-using cover types with those that consume less water; (3) creating openings in the forest cover to redistribute snow, thereby concentrating it to reduce evaporation and increase meltwater contribution to runoff; (4) planting trees or large shrubs in mountain grasslands to pile snow in large drifts, thereby reducing evaporation; and (5) erecting artificial fencing to create large snow drifts in alpine or mountain grassland watersheds (Hibbert, 1979). The principal objective of snowpack management may be to improve the timing of runoff rather than increase total annual streamflow (Martinelli, 1975).

Table 13 summarizes the maximum potential for augmenting water yield in each of 9 cover types occurring in the Upper Colorado River Basin. The first three types listed--alpine, subalpine, and aspen--comprise most of the acreage in national forest wilderness areas and the higher elevation BLM wilderness study units. Potential for increasing water yield in these areas appears considerable in terms of both unit water yield and treatable acreage. Actual yield increases would be something less than the potential because only a portion of each cover type could be treated economically, and consideration of other resource values would reduce both the area that could be treated and the effectiveness of treatment (Hibbert, 1979). Still, it is evident that wilderness withdrawals foreclose considerable opportunity to augment natural runoff in the state's high-yielding watersheds. Management plans currently being prepared by both the Forest Service and Bureau of Land Management contain proposed or potential water-yield programs for nonwilderness areas (e.g., U.S. Bur. Land Mgnt., 1983; U.S. Forest Service, 1982a).

Table 13. Potential Water Yield Increase by Vegetation Type

Vegetation Type	Potential Increase (Inches)
Alpine	2-5
Mountain Grassland	1.5-3
Subalpine	1.3
Aspen	3-5
Ponderosa pine	1-3
Mountain brush	1-3
Big sagebrush	0-1
Pinyon-juniper	0-0.5
Upstream riparian	6-24

Source: Hibbert (1979, table 1, p. 20).

CHAPTER 4

REGIONAL ANALYSIS OF WILDERNESS CONSTRAINTS

This chapter examines the constraints of wilderness legislation on water-project development within each of the state's major river basins. Drainage areas east of the Continental Divide are grouped into the North Platte, South Platte, Kansas, Rio Grande, and Arkansas River Basins (Fig. 6). Drainage areas west of the Continental Divide all contribute to the Colorado River system and are disaggregated into the San Juan, Dolores, Gunnison, Colorado Mainstem, White, and Yampa River basins. Table 14 summarizes the population size and generalized water budget of each river basin. The water budget data are incomplete since they do not include all reservoir evaporation losses, they do not include the large volume of groundwater currently being overdrafted in the Kansas River Basin, and they do not include Colorado's large downstream commitments under various interstate compacts and litigations.

Kansas River Basin

The Kansas River Basin comprises the headwater drainages of the Republican and Smoky Hill Rivers in easternmost Colorado. In areal terms the basin includes most of the Northern High Plains region as defined by the subsurface occurrence of the Ogallala aquifer. Consumptive use of the basin's small surface water supply is limited by terms of the Republican River Compact of 1942 (Witmer, 1968, p. 260-271). Most instate water demand is therefore being met by groundwater pumpage. Withdrawals in excess of recharge have been occurring for a number of years in the major irrigated areas. If current trends continue, irrigated acreage is projected to decline

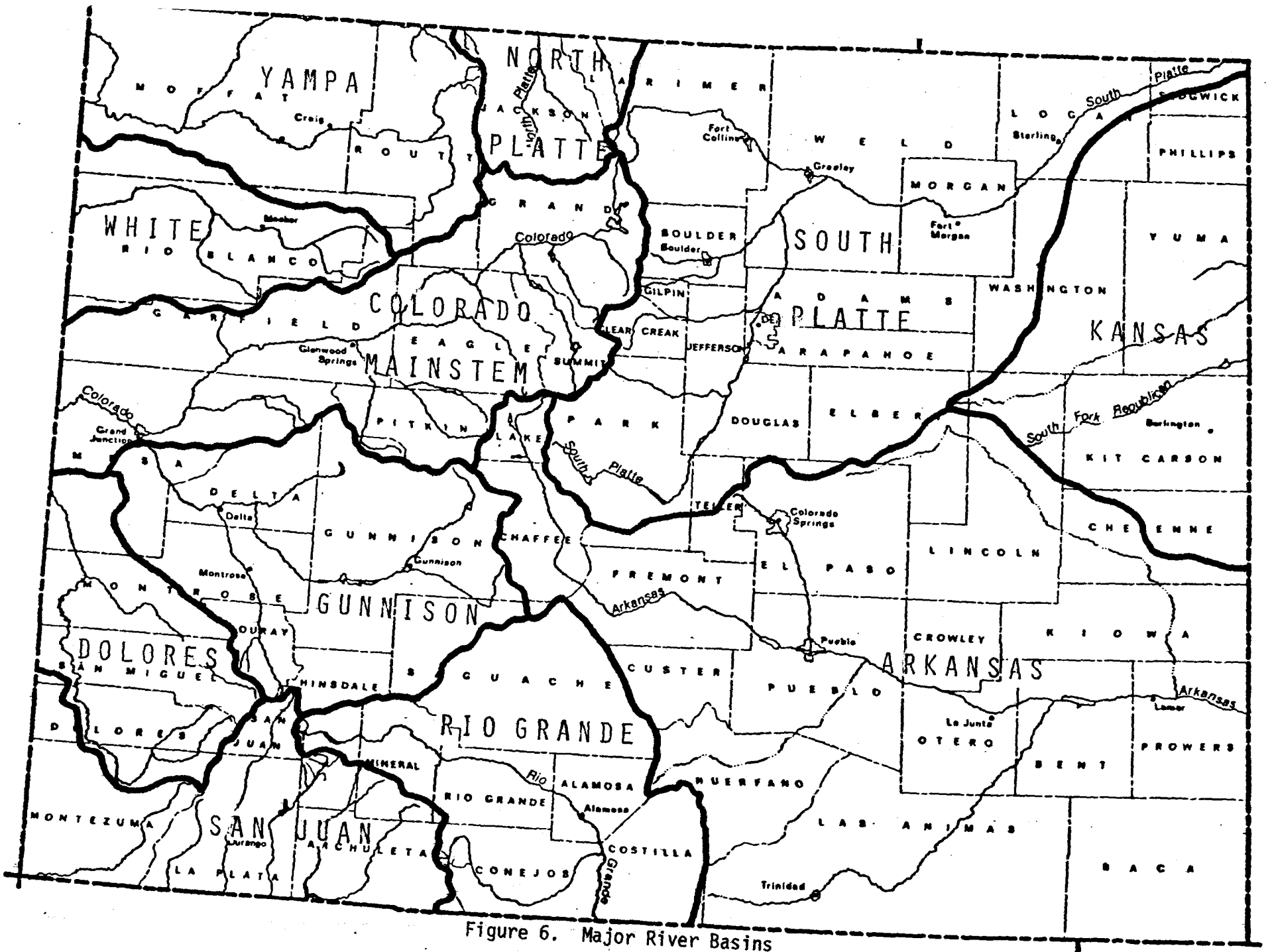


Figure 6. Major River Basins

Table 14. Population and Water Budget of Major River Basins

Basin and Subbasin	Population ^a			Water Budget (1,000 acre-feet) ^b				
	Number 1980	% of State	% Change 1970-1980	Water Supply ^c		Consumptive Used ^d		
				Native Runoff	Net Supply	Irrigation	M&I	Total
<u>Missouri River</u>								
North Platte	1,863	0.1	2.9	505	483	96	1	98
South Platte	1,961,383	67.9	33.3	1,441	1,899	1,259	227	1,527
Kansas	30,861	1.1	5.2	121	121	37	3	48
Subtotal	<u>1,994,107</u>	<u>69.1</u>	<u>32.7</u>	<u>2,067</u>	<u>2,503</u>	<u>1,392</u>	<u>231</u>	<u>1,673</u>
<u>Arkansas River</u>	568,265	19.7	18.6	884	985	824	66	913
<u>Rio Grande</u>	37,826	1.3	1.3	1,646	1,649	717	4	1,400
<u>Colorado River</u>								
San Juan	48,131	1.7	36.2	{ 1,685	{ 1,715	{ 180	{ 6	{ 188
Dolores	9,102	0.3	15.0					
Mainstem	142,693	4.9	60.2	{ 6,232	{ 5,578	{ 919	{ 29	{ 973
Gunnison	55,918	1.9	40.2					
Yampa	26,127	0.9	104.1	{ 2,212	{ 2,212	{ 93	{ 22	{ 122
White	6,665	0.2	28.1					
Subtotal	<u>288,636</u>	<u>10.0</u>	<u>51.1</u>	<u>10,129</u>	<u>9,505</u>	<u>1,192</u>	<u>57</u>	<u>1,283</u>
State Total	2,888,834	100.0	30.7	14,726	14,642	4,125	358	5,269

^aPopulation allocated by county and county census division; U.S. Bur. Census (1981).

^bColorado Water Conservation Board (1981).

^cEstimated average annual native runoff, including 76,000 acre-feet inflow from New Mexico in the Rio San Antonio (Rio Grande Basin) and 205,000 acre-feet inflow from Wyoming in the Little Snake and Vermillion Rivers (Yampa River Basin). Net supply is the native runoff + net imports for the 1976-1979 period; the amount actually available for Colorado's exclusive use is limited in each basin by interstate compacts or litigation.

^dData for the Kansas River Basin exclude pumpage of nontributary groundwater. "Municipal-industrial" includes rural domestic and steam-electric power generation. "Total" includes irrigation, M&I, recreation, fish and wildlife, phreatophytic consumption (Rio Grande Basin), and some reservoir evaporation.

8.5 percent by the year 2000 and 31.4 percent by the year 2020 (Young, et al., 1982, Tables A3-A7).

Trans-County Project

The Kansas River Basin itself does not contain any wilderness areas, wild and scenic study rivers, or critical habitat for endangered or threatened species. However, the proposed Trans-County Project, which envisions importing water from the South Platte mainstem to replace the region's diminishing groundwater supplies, could be adversely affected by preservation of the whooping crane habitat along the Platte River in central Nebraska. The quantity of diversions is assumed to average 200,000 acre-feet annually (Woodward-Clyde Consultants, 1982, p. 105). Depletions of this magnitude far exceed those associated with the Grayrocks, Wildcat, or Narrows projects and would thus likely be opposed by the Fish and Wildlife Service. Whether the Trans-County Project will ever be constructed is problematical. An economic evaluation by Woodward-Clyde Consultants (1982, Table C-5) shows a negative benefit-cost ratio of 0.38:1.

Arkansas River Basin

Consumptive water use in the Arkansas River Basin already equals the state's legal entitlement under terms of the Arkansas River Compact of 1948 (Colo. Energy Research Inst., 1981, table 4, p. 58; Witmer, 1968, p. 3-11). Trans-mountain diversions from the Colorado River Basin have long been used to supplement the basin's native streamflow. Although these imports are expected to help meet the growing demands of Pueblo and Colorado Springs until shortly after the turn of the century (Colo. Front Range Project, 1981, p. 33), they are inadequate to supply all of the basin's demand potential. Any constraints imposed by wilderness issues on development opportunities would reduce the already limited choice of alternatives in meeting the basin's future water demands.

Table 15. Wilderness Components in the Arkansas River Basin

WILDERNESS AREAS			
Agency and Area	Designated	Acres	
		Endorsed	Total
Forest Service			
Collegiate Peaks	81,450		81,450
Greenhorn Mountain		22,330	22,330
Holy Cross	9,020		9,020
Mount Massive	26,000		26,000
Sangre de Cristo		62,800	62,800
Subtotal	116,470	85,130	201,600
Bureau of Land Management			
Beaver Creek		17,000	17,000
Browns Canyon		6,614	6,614
Subtotal		23,614	23,614
Total	116,470	108,744	225,214

ENDANGERED AND THREATENED SPECIES

Black-footed ferret	Probable sightings reported in Baca, Las Animas, and Otero Counties during 1970-1982 period (Jobman and Anderson, 1981, 1983).
American peregrine falcon	Breeding and migrant populations (Colo. Field Ornithologists, 1978, p. 11).
Arctic peregrine falcon	Infrequent migration in foothills zone and eastern plains (Craig, telephone comm., 1983).
Bald eagle	Fairly common winter visitor in plains riparian zone; 50 birds, or 9% of state-wide total, counted during 1982 midwinter inventory (Colo. Field Ornithologists, 1978, p. 10; Goodman, 1982).
Greenback cutthroat trout	Resident in Cascade Creek and South Fork of Huerfano Creek in Huerfano County (Langlois, 1978).
Colorado squawfish and humpback chub	Could affect imports from the Colorado River Basin.

Fortunately, there are no wild and scenic study rivers in the basin (Table 15), nor do the listed wildlife species pose any known limitations to project development. Statutory exemptions have been granted to two transmountain diversions that might otherwise be affected by wilderness land withdrawals. In 1978 Congress exempted the Fryingpan-Arkansas Project, located partially within the Hunter-Fryingpan Wilderness (P.L. 95-237), and in 1980 similar provisions were made for operation and enlargement of the Homestake Project in the Holy Cross Wilderness (P.L. 96-487).

Some conflict potential is created by the presence of wilderness areas, both within the basin and on the adjoining west slope of the Continental Divide, and by the dependence on water imports from headwater drainages of the Colorado River system that support downstream endangered fishes. Wilderness withdrawals occupy much of the watershed area best suited to streamflow augmentation opportunities. Prohibition of cloud-seeding over wilderness areas within the basin would limit the region's small cloud-seeding potential of 25,000 acre-feet annually (Table 12). Minimum flow requirements for the endangered Colorado River fishes could adversely affect transmountain imports over the long term, either by prohibiting operational changes of existing projects or by limiting the potential for new diversions.

Rio Grande Basin

Table 16 identifies the wilderness components in the Rio Grande Basin. Although none are known to jeopardize project development, any potential constraints must be viewed with concern because of the basin's already scarce water-supply situation. Consumptive diversions in the Rio Grande and Conejos River Subbasins are limited by the Rio Grande Compact of 1938 to the historic levels that prevailed during the ten-year period 1928-1937 (Colo. District Court, 1980, p. 12; Witmer, 1968, p. 272-291). Further development of the

Table 16. Wilderness Components in the Rio Grande Basin

WILDERNESS AREAS			
Agency and Area	Acres		Total
	Designated	Endorsed	
Forest Service			
La Garita	24,146		24,164
Sangre de Cristo		125,600	125,600
South San Juan	87,847		87,847
Weminuche	<u>167,715</u>		<u>167,715</u>
Subtotal	279,726	125,600	405,326
National Park Service			
Great Sand Dunes National Monument	33,490	2,530	36,020
Total	<u>313,216</u>	<u>128,130</u>	<u>441,346</u>
WILD AND SCENIC STUDY RIVERS			
Stream	River Miles		Total
	Wild	Recreational	
Conejos River			
North Fork, Middle Fork, El Rito Azul, and South Fork	25.6		25.6
Conejos mainstem from Platoro Reservoir downstream to confluence with South Fork		13.2	13.2
Total	25.6	13.2	38.8
Rio Grande	Segment located in New Mexico between the Colorado-New Mexico state line and New Mexico Highway 96.		
ENDANGERED AND THREATENED SPECIES			
Black-footed ferret	San Luis Valley contains favorable habitat (Bissell, 1978), but no sightings reported during 1970-1982 period (Jobman and Anderson, 1981, 1983).		
American peregrine falcon	Year-round residents at Alamosa NWR, Monte Vista NWR, and Blanca Wildlife Habitat Area; one nesting site located west of Del Norte and another at the junction of Alamosa, Custer, Saguache, and Huerfano Counties (U.S. Bur. Reclamation, 1979a, p. B-59).		
Bald eagle	Fairly common winter visitor in San Luis Valley; 102 birds, or 18% of statewide total, counted during 1982 midwinter inventory (Colo. Field Ornithologists, 1978, p. 10; Goodman, 1982).		
Whooping crane	Alamosa and Monte Vista National Wildlife Refuges are designated critical habitat (U.S. Fish and Wildlife Service, 1978a).		

basin's water supply is restricted to improved groundwater management, including salvage of groundwaters now being lost through phreatophytic transpiration; conservation of existing water uses; construction of reservoirs to store pre-Compact direct flow rights; and initiation of cloud-seeding or other stream-flow augmentation programs in the mountain watersheds.

Wilderness Areas

Large portions of the basin's high-yielding watersheds are located within designated or administratively-endorsed wilderness areas. Although the full impact of these withdrawals on development opportunities is unknown, it is clear that the withdrawals would seriously impede future streamflow augmentation programs, especially if the Forest Service should prohibit or limit cloud seeding over its wilderness lands. Much of the basin's cloud-seeding potential of 116,000 acre-feet annually (Table 12) is dependent on seeding opportunities over wilderness areas.

Conejos Study River

A recommendation to add 38.8 miles of the Conejos River to the national wild and scenic rivers system was submitted to Congress on September 13, 1982 (Interagency Task Force, 1982; U.S. Forest Service, 1979a). Designation of the proposed river corridor would not jeopardize any major development opportunities. The corridor segments eligible for wild river status are already protected because of their location in the South San Juan Wilderness. Water appropriations in the affected area are limited to the operation of Platoro Reservoir and to the preservation of numerous small lakes by the Colorado Water Conservation Board. Concern that designation would interfere with the operation of Platoro Reservoir (Sowards, 1979) is unfounded, since any in-stream flow rights sought by the Forest Service would be junior to existing

water decrees. A small hydroelectric plant of 0.68 MW capacity could be installed in Platoro Dam, but no plans exist for its development.

The Rio Grande wild and scenic river segment, which is located in New Mexico immediately below the Colorado-New Mexico state line, should not jeopardize project development in Colorado because major streamflow depletions would be prohibited in any event by the Rio Grande Compact. The proposed Closed Basin Project northeast of Alamosa is expected to benefit rather than degrade the river corridor (U.S. Bur. Reclamation, 1979a).

Endangered and Threatened Species

Portions of the Rio Grande Basin provide habitat for the American peregrine falcon, bald eagle, and whooping crane. Both the Alamosa and Monte Vista Wildlife Refuges have been designated as critical habitat for the Grays Lake whooping crane flock, which migrates annually between southeastern Idaho and southcentral New Mexico (U.S. Fish and Wildlife Service, 1978a). Use is presently confined to the Monte Vista refuge and to the wet meadows along the Rio Grande downstream to the town of Lasasues during late January-early May and late August-early November (U.S. Bur. Reclamation, 1979a, p. B61-B62). No critical habitat has been designated for the peregrine falcon or bald eagle.

The biological opinion for the Closed Basin Project concluded that the project will not jeopardize any federally listed species (U.S. Fish and Wildlife Service, 1979d). No constraints are known to exist on other development opportunities in the basin.

North Platte River Basin

The North Platte Basin is one of the more isolated and sparsely populated areas in the state. Intrabasin water demand, which consists mainly of irrigating high-altitude hay meadows, is appreciably less than the available supply (Table 14), and this favorable situation is likely to continue indefinitely. Utilization of surplus flows by transferring water outside the basin is limited by the North Platte and Laramie River litigations to an aggregate of 25,875 acre-feet annually (Witmer, 1969, p. 665-702, 724-777), or approximately 5 percent of the basin's virgin water yield. Most of this amount is already being exported to users in the South Platte Basin.

Wilderness Areas

Forest Service wilderness areas comprise a major portion of the basin's high-yielding watersheds (Table 17). Project construction in these areas requires a Presidential exemption. Severe restrictions could also be imposed on streamflow augmentation opportunities, including the estimated cloud-seeding potential of 66,000 acre-feet annually within the Colorado and adjoining Wyoming portions of the Park Range (Table 12).

Encampment Study River

A recommendation to add 19.5 miles of the Encampment River to the national wild and scenic rivers system was submitted to Congress on October 2, 1979 (U.S. Forest Service, 1980b). All but about 2.5 miles of the river corridor lies within the Mount Zirkel Wilderness or Davis Peak further planning area. The Encampment River is genuinely "freeflowing" in the sense that there are no diversions anywhere in the basin. Several potential hydroelectric dam sites exist below the Colorado-Wyoming state line (Raybourn, 1979). Development at one of the sites would inundate the lower 1 mile of

Table 17. Wilderness Components in the North Platte River Basin

WILDERNESS AREAS			
Agency and Area	Acres		Total
	Designated	Endorsed	
Forest Service			
Davis Peak		8,100	8,100
Mount Zirkel	71,150		71,150
Neota	220		220
Never Summer	6,659		6,659
Rawah	67,899		67,899
Total	145,928	8,100	154,028
WILD AND SCENIC STUDY RIVERS			
River			Wild River (Miles)
Encampment River			
Mainstem from headwaters to Colorado-Wyoming state line			12.5
West Fork from headwaters to confluence with mainstem			7.0
Total			19.5
ENDANGERED AND THREATENED SPECIES			
Black-footed ferret	Three probable sightings reported in Jackson County during 1970-1982 period (Jobman and Anderson, 1981, 1983).		
American peregrine falcon	Resident nonbreeding population (Colo. Field Ornithologists, 1978, p. 11).		
Bald eagle	Winter visitor, but none counted during 1982 midwinter inventory (Goodman, 1982).		
Whooping crane	Basin located upstream from critical habitat along the Platte River in Nebraska (U.S. Fish and Wildlife Service, 1978a).		
Northpark phacelia	Only known world occurrence limited to sandstone exposures and adjacent areas of the Coalmont Formation along the Michigan and North Platte Rivers (Peterson, 1982).		

eligible river corridor. Maximum power development, excluding imported flows from the Little Snake River in connection with Cheyenne's municipal supply project, is estimated to be 10,800 KW or 94,600 MWh annually. No plans exist for development of this hydroelectric potential.

Endangered and Threatened Species

Project development in the North Platte Basin could adversely affect the critical habitat of the whooping crane in central Nebraska. In 1978 the Fish and Wildlife Service opposed construction of the Grayrocks Reservoir, located on the Laramie River about 115 miles downstream from the Colorado-Wyoming state line (U.S. Fish and Wildlife Service, 1978b). The multi-purpose reservoir was designed to store cooling water for the Laramie River station, a 1,500 megawatt coal-fired electric generating plant owned by the Missouri Basin Power Project, and provide irrigation water for the Corn Creek Irrigation District.

The Grayrocks Reservoir ultimately received an exemption under Section 7 of the Endangered Species Act following resolution of a court suit brought against the Army Corps of Engineers, which had authorized project construction by issuing a Section 404 dredge-and-fill permit, and the Rural Electrification Administration, which had guaranteed a portion of project construction costs (Endangered Species Comm., 1979). The three plaintiffs--National Wildlife Federation, National Audubon Society, and the State of Nebraska--agreed to a compromise stipulation that project owners (1) limit maximum annual water use to 23,250 acre-feet, (2) make releases of water during various periods of the year, (3) replace up to 11,250 acre-feet of water withdrawn by Corn Creek Irrigation District, (4) establish a trust fund of \$7.5 million for maintenance

and enhancement of the Platte River critical habitat, and (5) otherwise restrict operations of the project.

South Platte River Basin

The South Platte Basin contains about two-thirds of the state's population (Table 14). Absolute growth during the last census decade totaled nearly 490,000 persons, which is approximately equivalent to the present population size of the City of Denver. Continuation of this rapid rate of urbanization would impose an increasingly competitive demand on the basin's water supply which consists of native streamflow, groundwater, and transmountain imports. Expansion of transmountain imports and full development of the basin's native streamflow could be impeded by several wilderness issues.

Wilderness Areas

Wilderness areas comprise large acreages of mountain watershed on both sides of the Continental Divide (Table 18). These withdrawals foreclose some streamflow augmentation opportunities, including, possibly, a portion of the basin's orographic cloud-seeding potential of 115,000 acre-feet annually (Table 12). The withdrawals could also limit further development of the basin's natural streamflow. At least three potential reservoir sites in the Cache la Poudre River system overlap to some degree with designated wilderness areas (Table 19).

The Eagles Nest Wilderness, located on the West Slope in the Colorado Mainstem Basin, could affect three of the Denver Water Department's proposed transmountain diversions, namely, the East Gore, Eagle-Piney, and Eagle-Colorado units. An engineering study conducted in 1976 concluded that re-designing the East Gore and Eagle-Piney units to locate all facilities outside the wilderness boundaries would increase construction costs by nearly two-thirds

Table 18. Wilderness Components in the South Platte River Basin

Agency and Area	WILDERNESS AREAS		Total
	Designated	Acres Endorsed	
Forest Service			
Cache la Poudre	9,400		9,400
Comanche Peak	67,500		67,500
Indian Peaks	30,714		30,714
Lost Creek	106,000		106,000
Mount Evans	73,000		73,000
Neota	10,000		10,000
Rawah	6,000		6,000
Subtotal	302,614		302,614
National Park Service			
Rocky Mountain National Park	2,400	148,668	151,068
Total	305,104	148,668	453,682
WILD AND SCENIC STUDY RIVERS			
River	River Miles		
	Wild	Recreational	Total
Cache la Poudre River			
Mainstem from:			
Source of Poudre Lake to confluence with Joe Wright Creek	18		18
Joe Wright Creek to Indian Meadows		16	16
Indian Meadows to confluence with South Fork		7	7
Confluence with South Fork to Poudre Park		10	10
South Fork of Cache la Poudre:			
Source near Icefield Pass and Flint Pass to Little Beaver Creek		11	11
Little Beaver Creek to confluence with mainstem	7		7
Total	25	44	69
ENDANGERED AND THREATENED SPECIES			
Black-footed ferret	Last confirmed sightings near Dearfield in Weld County in 1952 and near Denver in 1953 (Fisher, 1980); two probable sightings in Weld County during 1970-1982 period (Jobman and Anderson, 1981, 1983).		
American peregrine falcon	One nesting pair near Estes Park (Goodman, personal comm., 1983); unusual migrant elsewhere in basin (Colo. Field Ornithologists, 1978, p. 11).		
Arctic peregrine falcon	Infrequent migrant in foothills zone and eastern plains (Craig, telephone comm., 1983).		
Bald eagle	Fairly common winter visitor in plains riparian zones; 115 birds, or 21% of statewide total, counted during 1982 mid-winter inventory (Goodman, 1982).		
Eskimo curlew	Last reported sighting near Denver in 1882 (Bailey and Niedrach, 1965, p. 335).		
Whooping crane	Accidental migrant (Colo. Field Ornithologists, 1978, p. 13); Platte River critical habitat in Nebraska located about 125 miles downstream from South Platte River at Julesburg (U.S. Fish and Wildlife Service, 1978a).		
Greenback cutthroat trout	Occurs in Black Hollow Creek, Hourglass Creek, and South Fork of Cache la Poudre River in Larimer County; Como Creek in Boulder County; and Bear Lake, Caddis Lake, Big Thompson River and Hidden Valley Creek in Rocky Mountain National Park (Langlois, 1978).		
Colorado squawfish and humpback chub	Will affect imports from the Colorado River Basin.		

and would add another \$2 million annually for power costs to lift water that otherwise would be delivered by gravity flow (Parsons, Brinckerhoff, Quade & Douglas, 1976). Substantial pumping costs would also be added to the Eagle-Colorado unit if the Eagle-Piney gravity system cannot be built through the wilderness area (Denver Board Water Comm., 1981).

The extent to which these potential costs might accrue is problematical. Figure 7 compares three scenarios of future water demand in the metropolitan Denver area, as projected by the Denver Board of Water Commissioners (1981), with a hypothetical staging of the Board's proposed supply projects. The "conservation" demand curve incorporates the demand-reduction goals which Denver agreed to institutionalize under the Foothills Consent Decree (U.S. District Court, 1979). Under the development conditions assumed in Figure 7, and assuming that Denver successfully implements the Foothills stipulation, only the East Gore unit would be needed to meet the demands of an expanded service area through the year 2020. Even this need could possibly be eliminated by pursuing other supply options. Such options might include adoption of a more ambitious conservation program, as suggested by Morris and Jones (1980); acceptance of a lower firm water yield, which could be offset by a more stringent demand reduction during severe drought; development of local groundwater supplies; purchase of East Slope agricultural water rights; or negotiations of an exchange agreement involving West Slope rights to Green Mountain Reservoir. As noted in a later discussion, however, the Eagle-Piney and Eagle-Colorado units might be indispensable if preservation of the whooping crane prohibits or severely limits capture of South Platte flows in Two Forks Reservoir.

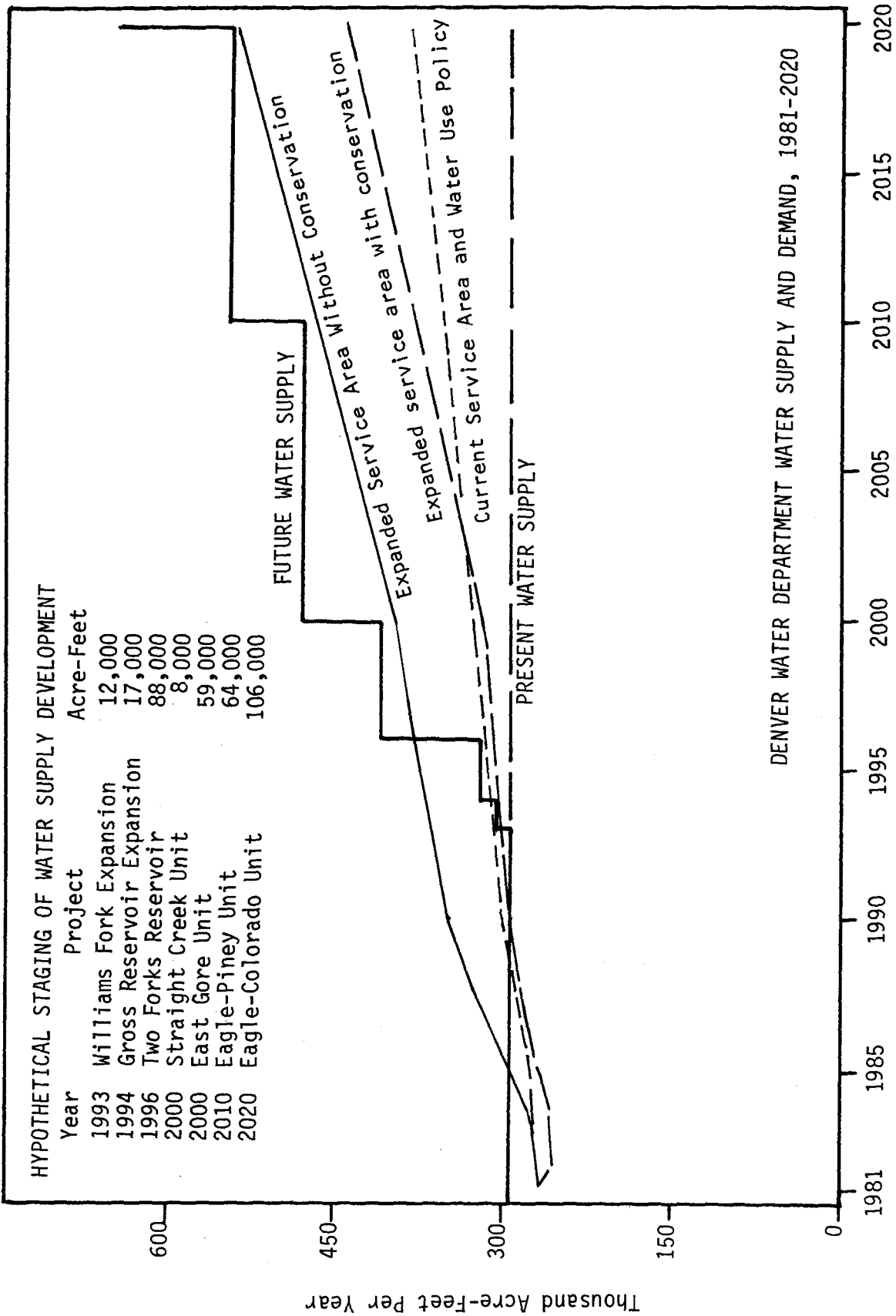


Figure 7

Aurora's Homestake Project, which imports water from the Holy Cross Wilderness, can be expanded under the exemption provision granted by the Colorado Wilderness Act of 1980.

Cache la Poudre Study River

The Forest Service has provisionally recommended that 69 miles of the Cache la Poudre River be added to the national wild and scenic rivers system (U.S. Forest Service, 1980a). Approximately two-thirds of the eligible corridor is located at least partly within the Cache la Poudre and Comanche Peak Wilderness areas. Shortly after the Forest Service released its recommendations, the General Assembly authorized the Colorado Water Conservation Board to fund a reconnaissance level study of the engineering and economic feasibility of alternative projects that could develop new water supplies, improve the management of already developed supplies, and generate hydro-electrical power. Table 19 summarizes the results of the reconnaissance study. As noted, all but the Grey Mountain Project would affect portions of the eligible river corridor, and all but the Grey Mountain-Idlywilde Project would require a Presidential exemption because of their location or partial location within designated wilderness areas. None of the project configurations can be economically justified on the basis of conservation storage only. Economic feasibility of the multi-reservoir alternatives is conditional upon the uncertain future demand for and price of hydroelectric peaking power. At the time of this writing, the General Assembly is considering a recommendation by the Water Conservation Board to fund additional studies.

Designation of the Cache la Poudre as a wild and scenic river would likely affect only the Grey Mountain-Idlywilde Project. All of the other project facilities lying within the eligible corridor could not be built without a Presidential exemption or special act of Congress. Prospects for obtaining

Table 19. Summary of Cache la Poudre Project Alternatives

Alternative	Miles of Eligible River Corridor Affected by		Designated Wilderness Inundated (Acres)	Benefit-Cost Ratio ^a	Yield of New Water (Afy)	Hydroelectric Capacity (MW)
	Inundation	Altered Flows				
PHASE I EVALUATION						
1 Grey Mountain Reservoir	0	0	0	0.58	16,300	12.0
2 Grey Mountain and Idylwilde Reservoirs	8.3	22.0	0	1.21	14,300	118.0
3 Grey Mountain and Elkhorn Reservoirs	7.0	8.0	213	1.14	14,000	104.3
4 New Seaman, Indian Meadows, and Rockwell Reservoirs	8.2	37.0	50	1.08	12,800	109.0
5 New Seaman, Indian Meadows, and Rockwell Reservoirs	7.1	37.0	122	1.14	11,300	124.7
6 Grey Mountain, Indian Meadows, Upper Poudre, and Rockwell Reservoirs	10.6	57.0	730	1.08	13,000	178.7
7 New Seaman and Elkhorn Reservoirs	7.0	8.0	213	1.10	13,100	88.3
8 Elkhorn Reservoir	7.0	8.0	213	0.80	14,400	14.0
PHASE II EVALUATION						
1 Grey Mountain Reservoir Conservation only	0	0	0	0.36	16,300	0
Conservation with hydro	0	0	0	0.59	16,300	12.0
2 Grey Mountain and Idylwilde Reservoirs	8.3	22.0	0	(135) ^b	14,300	118.0
7 New Seaman and Elkhorn Reservoirs	7.0	8.0	213	(135) ^b	13,100	88.0
8 Elkhorn Reservoir Conservation only	7.0	8.0	213	0.44	14,400	0
Conservation with hydro	7.0	8.0	213	0.73	14,400	14.0

88

^aDirect costs and direct benefits valued at January 1982 prices and discounted at 7.5 percent interest over 100 years. Direct benefits include (1) new storage for M&I use, (2) new storage for supplemental irrigation, (3) new storage space for improved management of waters already developed and used for irrigation, and (4) the value of peaking and run-of-the-river hydroelectric power.

^bInstead of computing a benefit-cost ratio for the multi-reservoir alternatives, Phase II computed a "breakeven value," or the minimum peaking power value in mills per kilowatt hour that would be required to make the power benefits just equal to the separable costs for peaking hydro-power.

Source: Tudor Engineering (1982a, 1982b, 1983).

an exemption are remote. None of the affected projects has a definite sponsor, none would supply water that is critically needed at this time, and the peak-load electricity, which is the major benefit of five of the projects, could be supplied by other means.

Endangered and Threatened Species

Table 18 identifies the endangered and threatened species which could affect project development within the basin. Reservoir construction in the plains riparian zone may have to adopt some conservation measures to protect wintering bald eagles. The biological opinion for the Narrows Unit, for example, stipulated that cottonwood roost and perch sites should be preserved and that operation of the reservoir should optimize bald eagle use and habitat (U.S. Fish and Wildlife Service, 1982g). The most serious constraints to project development are likely to be imposed by the Colorado River fishes, which will affect transmountain imports, and the whooping crane habitat in central Nebraska, which could limit full development of South Platte River flows.

The Fish and Wildlife Service has issued biological opinions for two transmountain imports. The opinion for the existing Colorado-Big Thompson Project concluded that continued operation at historical levels of diversion would not adversely affect the endemic fishes (U.S. Fish and Wildlife Service, 1981e). The opinion for the Windy Gap Project concluded that new diversions from the Colorado River Mainstem would not appreciably affect survival of the Colorado squawfish and humpback chub, but could reasonably be expected to appreciably reduce the likelihood of recovery of the two species (U.S. Fish and Wildlife Service, 1981c). As currently designed, Windy Gap will divert an average of 57,300 acre-feet of water annually and a maximum of 93,000 acre-feet in any one year. To mitigate the effects of these diversions,

the project operator has agreed to bypass minimum streamflows during critical periods, fund the creation of squawfish backwater habitat areas along the Colorado River Mainstem below the head of DeBeque Canyon, and fund a three-year field program of habitat evaluation. The minimum flow delivery, negotiated with the Colorado Division of Wildlife, is primarily intended to protect trout habitat between Windy Gap Diversion Dam and the mouth of the Blue River, but will also benefit the downstream endangered fishes. The project operator has committed \$425,000 to fund the two mitigation measures that will exclusively benefit the endangered fishes (Simpson, telephone comm., 1982).

Biological assessments have yet to be made for other transmountain imports, notably the proposed expansion of Aurora's Homestake Project and the West Slope collection systems of the Denver Water Department. Since the aggregate diversions of these expansions will appreciably exceed that of the Windy Gap Project, some conservation measures will likely be required by the Fish and Wildlife Service to protect the Colorado River fishes.

According to Woodward-Clyde Consultants (1982, p. 54-59), Colorado's unused entitlement to South Platte River flows under provisions of the South Platte Compact of 1923 presently averages as much as 317,000 acre-feet annually at the Julesburg gaging station. The extent to which preservation of the whooping crane habitat in central Nebraska may limit development of this remaining entitlement appears to be dependent upon at least three factors: (1) the degree to which the Fish and Wildlife Service might allow substitution of artificial clearing of woody vegetation or acquisition of additional habitat land for channel scouring flows, (2) the ability of projects to provide storage releases or replacement flows during spring and fall, and (3) the readiness of a project to proceed before other project developments consume all available offsetting measures.

As explained in Chapter 3, the Fish and Wildlife Service proposed to issue a nonjeopardy opinion for Wildcat Reservoir if sponsors would agree to offset the project's streamflow depletion effects by funding artificial control of vegetation encroachment along 1.7 miles of the Platte River (U.S. Fish and Wildlife Service, 1982a). This same alternative was not extended to the Narrows Project. Instead, Narrows will have to allocate part of its storage releases to the provision of scouring flows and to the maintenance of habitat flows during the fall and spring migration periods (U.S. Fish and Wildlife Service, 1983).

One possible means of protecting the whooping crane habitat is to replace any new depletions of South Platte water with the return flows associated with future transmountain imports. The Windy Gap Project, for example, which is presently under construction, will generate a return flow of approximately 24,000 acre-feet per year (Woodward-Clyde Consultants, 1982, p. 58). A flow of this magnitude, if suitably available, would be more than adequate to offset the depletion effect of Wildcat Reservoir or any similar small projects. Future imports by Denver and Aurora will create even more return flows. Further study is needed to determine what portion of the urban return flows might be recycled by the cities themselves and what portion might be available for offsetting harm to the whooping crane habitat.

Projects that can meet the required flow regime, or can offset depletion impacts by habitat manipulation or land acquisition, will be approved on a first-come, first-served basis under the cumulative effects policy described in Chapter 2. In this connection, it should be noted that the Denver Water Department has begun a detailed evaluation of its proposed Two Forks Project. Early Section 7 consultation and readiness to proceed could be crucial if the project is to receive a favorable biological opinion. The project will

develop 88,000 acre-feet of firm water from the South Platte River and will also be designed to provide regulatory storage for up to 57,000 acre-feet of imported water developed by the Straight Creek, East Gore, and Eagle-Piney Units (Denver Board Water Comm., 1981). The depletion effect of Two Forks, neglecting return flows from the imported water, would be approximately 29,000 acre-feet per year, or one-half that estimated for the Narrows Project. Two Forks or an alternative East Slope storage facility appears to be crucial to the future water supply of metropolitan Denver. Without additional East Slope storage, greater reliance would have to be placed on West Slope imports which, in turn, could jeopardize the Eagles Nest Wilderness and the endangered Colorado River fishes.

Finally, it should be emphasized that development of Colorado's remaining South Platte entitlement faces economic as well as ecological challenges. A reconnaissance-level assessment conducted recently for the Colorado Water Conservation Board concluded that 12 of the 13 project alternatives studied would produce negative economic benefits (Table 20). The only project having a prospective net benefit involves reallocating the existing flood-control storage of Chatfield Reservoir to conservation storage. Even this project might be inefficient if the foregone flood-control benefits were calculated and if the new beneficiaries were required to reimburse the federal government for conservation storage. Although the reconnaissance study is based on broad generalizations and assumptions, and therefore cannot be used to judge the ultimate feasibility of any particular project, it does provide a relatively accurate comparison among project alternatives. Particularly noteworthy is the low benefit-cost ratio of Narrows Reservoir. Narrows has long been one of the projects favored for early construction by the Colorado Water Conservation Board and other pro-development interests.

Table 20. Summary of Project Alternatives in the South Platte River Basin

Project Alternative	Consumptive Water Use (Ac-Ft/Yr)	Benefit-Cost Ratio ^a	Project Outputs ^b
Two Forks Reservoir ^c	15,300	0.17	M,A
West Plum Creek Reservoir	15,300	0.05	M,A
Chatfield Reservoir	3,000	d	M,A
Chatfield Reservoir expansion	15,300	0.44	M,A
Geer Canyon, Coffintop, and Grey Mountain Reservoir	19,400	0.48	M,A,H
Cactus Hill Reservoir	11,900	0.06	A
Carter Lake and Horsetooth Reservoir expansion	5,800	0.43	M,A
Narrows Reservoir	58,900	0.10	A,F
Hudson and Wildcat Reservoirs	43,900	0.15	A
Prewitt Reservoir expansion	2,500	0.06	A
Trans-County Project	120,000	0.38	A
Conjunctive use plan	94,500	0.29	A
East Bijou, West Bijou, and Muddy Creek Reservoirs	1,440	0.03	A

^aDirect costs and benefits valued at 1982 prices and discounted at 7.5% interest over 100 years.

^bEvaluated project outputs: M = municipal water, A = irrigation water, including use of municipal return flows, H = hydroelectric power, F = flood control.

^cThis is a smaller project than that currently envisioned by the Denver Water Department and does not include storage of any water imported from the Colorado River system.

^dNo benefit-cost ratio because project involves reallocation of existing flood-control storage to conservation storage; no assumed costs.

Source: Woodward-Clyde Consultants (1982).

San Juan River Basin

Although the Colorado River system drains only one-third of the state's land area, it yields roughly two-thirds of the state's virgin annual runoff and contains most of the undeveloped streamflow still legally available for instate consumption (Table 14). Nearly all portions of the basin experienced rapid population growth over the last census decade. The overall rate of growth, 51 percent, was substantially higher than that recorded in any of the East Slope river basins, and the potential for additional growth is very large. Especially relevant is the possibility that commercialization of oil shale, and possibly coal gasification, will greatly accelerate municipal-industrial water demands by the end of the century (Colo. Dept. Natural Resources, 1979; Colo. Energy Research Inst., 1981; U.S. Dept. Interior, 1974). This changing structure of inbasin water use would place irrigated agriculture at a disadvantage and would also heighten the competition between East Slope and West Slope water interests. Existing transmountain diversions represent about one-third of all water depletions, and several major enlargements of these exports are either proposed or underway (U.S. Dept. of Interior, 1974).

For purposes of this assessment, the Colorado River system is disaggregated into the San Juan, Dolores, Gunnison, Colorado Mainstem, White, and Yampa River Basins. The San Juan Basin generates approximately 15 percent of the Colorado system's virgin water yield. Most of the streamflow heads in the mountainous eastern part of the basin, which imports most of its supply from the Dolores River (U.S. Bur. Reclamation, 1977a). Irrigated agriculture presently accounts for well over 90 percent of streamflow depletions. This dominance is expected to continue, although municipal-industrial demands could increase substantially before the end of the century because of coal-related energy growth (Colo. Dept. Natural Resources, 1979; Colo. Energy Research Inst., 1981). Part of the runoff

originating in the basin must be shared with New Mexico under terms of the La Plata River Compact of 1922 and the Upper Colorado River Basin Compact of 1948 (Witmer, 1968, p. 198-201, 339-353).

Wilderness Areas

Future project development could be constrained by wilderness withdrawals, especially those located within the high-yielding national forest watersheds along the Continental Divide (Table 21). Prohibition of cloud seeding over wilderness areas could seriously reduce the region's cloud-seeding potential of some 400,000 acre-feet of incremental runoff (Table 12). Most of the stream mileage recommended for wild and scenic river status is located within wilderness boundaries, which means that project development on the affected river segments could be precluded even if they are not added to the national wild and scenic rivers system.

Los Pinos Study River

A recommendation to add portions of the Piedra and Los Pinos Rivers to the national wild and scenic rivers system was submitted to Congress on September 13, 1982 (Interagency Task Force, 1982). The eligible segment of Los Pinos River extends along the mainstem upstream from the Weminuche Wilderness boundary and includes Lake Creek, Flint Creek, Rinco La Osa, Rincon La Vaca, Snowslide Canyon, and Sierra Vandera tributaries (U.S. Forest Service, 1979b, 1982b). All 54 miles of river corridor qualify for wild river designation. Two existing ditches divert some headwaters into the Rio Grande Basin. Several potential hydroelectric sites have been identified, but no plans exist for their development. The Pine River Irrigation District holds a decree for storage of 7,708 acre-feet of water on Lake Creek, but no specific development plans have been presented for exercising the decree. Since the eligible corridor is already

Table 21. Wilderness Components in the San Juan River Basin

Agency and Area	WILDERNESS AREAS			Total
	Designated	Endorsed	Further-Study	
				Acres
Forest Service				
Piedra		41,500		41,500
South San Juan	39,874			39,874
Weminuche	297,975			297,975
West Needle		15,800		15,800
Subtotal	<u>337,849</u>	<u>57,300</u>		<u>395,149</u>
Bureau of Land Management				
Cahone Canyon			8,385	8,385
Cross Canyon			8,440	8,440
Menefee Mountain			7,360	7,360
Weber Mountain			6,320	6,320
West Needles Creek Contiguous		5,780		5,780
Whitehead Gulch		1,770		1,770
Subtotal		<u>7,550</u>	<u>30,505</u>	<u>38,055</u>
National Park Service				
Mesa Verde National	8,100			8,100
Total	<u>345,949</u>	<u>64,850</u>	<u>30,505</u>	<u>441,304</u>

River	WILD AND SCENIC STUDY RIVERS		Total
	Wild	River Miles Scenic	
Los Pinos River			
Mainstem from confluence with North Fork and Rincon La Vaca downstream to Weminuche Wilderness boundary.	20.0		20.0
Tributaries:			
Lake Creek	8.0		8.0
Flint Creek	8.0		8.0
Rincon La Osa	6.0		6.0
Rincon La Vaca	5.0		5.0
Snowslide Canyon Creek	3.0		3.0
Sierra Vandera	4.0		4.0
Subtotal	<u>54.0</u>		<u>54.0</u>
Piedra River			
Mainstem, confluence with Indian Creek upstream to boundary between Sections 8 and 9, Township 36 North, Range 3 West, New Mexico PM.	12.2		12.2
Middle Fork, from boundary between Sections 10 and 15, Township 37 North, Range 3 West, New Mexico PM, upstream to boundary of Weminuche Wilderness		7.9	7.9
Middle Fork, from boundary of Weminuche Wilderness to headwaters	9.3		9.3
Subtotal	<u>21.5</u>	<u>7.9</u>	<u>29.4</u>
Total	<u>75.5</u>	<u>7.9</u>	<u>83.4</u>

ENDANGERED AND THREATENED SPECIES

Black-footed ferret	Last confirmed sighting near Mancos in 1953 (Fisher, 1980); no reported sightings during 1970-1982 period (Jobman and Anderson, 1981, 1983).
American peregrine falcon	Breeding population (Colo. Field Ornithologists, 1978, p. 11).
Bald eagle	Breeding population and fairly common winter visitor (Colo. Field Ornithologists, 1978, p. 10); 20 birds or nearly 4% of state-wide total, counted during 1982 midwinter inventory (Goodman, 1982).

(Continued)

Table 21. (continued)

Knowltons miniature cactus	Occurs on gravelly soils in the vicinity of Navajo Reservoir near the Los Pinos River (Peterson, 1982).
Mesa Verde cactus	Occupies adobe hills and dry clay soils in southern portion of Mesa Verde National Park and adjoining Ute Indian Reservation in Montezuma County (Ecology Consultants, 1978, p. 49-50; Peterson, 1982).
Colorado squawfish	Former habitat included the lower Piedra, Los Pinos, and San Juan Rivers (Ecology Consultants, 1978b, p. 16, 40); most recent collection occurred in the San Juan River in New Mexico in 1965 (Joseph, et al., 1977, p. 55).

being managed under the Wilderness Act, all new water developments, including the Lake Creek storage facility, would require a Presidential exemption even if the corridor is not designated under the Wild and Scenic Rivers Act.

Piedra Study River

Eligible segments of the Piedra River include 12.2 miles of the mainstem and 17.2 miles of Middle Fork (Interagency Task Force, 1982; U.S. Forest Service, 1979c). About half of the Middle Fork segment (9.3 miles) is located within Weminuche Wilderness, and about 40 percent of the mainstem segment (5 miles) is located within the Piedra further-study area, which has been administratively endorsed for wilderness inclusion. Designation under the Wild and Scenic Rivers Act would extend protection to the entire river corridor. The only known opportunity cost of designation would be exclusion of the O'Neal Park hydroelectric potential. A reconnaissance study of the O'Neal Park site in the early 1950s indicated a potential generating capacity of 40 million MWh annually, but no plans currently exist for its development. Utilization of the O'Neal Park site would also be excluded by designation of the Piedra wilderness study area (U.S. Forest Service, 1982c, p. III-11).

Endangered and Threatened Species

None of the listed species occurring in the basin are known to jeopardize project development. Colorado squawfish formerly inhabited the San Juan mainstem and lower portions of Los Pinos and Piedra Rivers, but no specimens have been captured in these locations for many years (Ecology Consultants, 1978b, p. 40). Protection of Colorado squawfish could affect water imports from the Dolores River, however, as noted in the next section.

Dolores River Basin

The Dolores River Basin discharges less than 10 percent of the Colorado River's virgin water yield. Existing water developments reduce the basin's natural outflow by about 25 percent, with approximately one-third of this occurring as exports to the San Juan Basin (U.S. National Park Service, 1979a, p. 43). Inbasin water use is devoted mainly to irrigating hay and pasturelands. Population size is very small, numbering only 9,000 persons in 1980 (Table 14). Most of the population growth over the last census decade was associated with ski-area development in the Telluride area. Most of the basin's conditionally decreed water is held by two federal projects; the Dolores Project, currently under construction, and the San Miguel Project, which has been found economically unjustified at this time. A third federal project, the Paradox Valley Salinity Control Unit, is currently under development to improve water quality.

Wilderness Areas

The BLM wilderness study areas (Table 22) are not known to pose any constraints to project development. One of the units, Dolores River Canyon, overlaps with a portion of the Dolores study river. The Forest Service wilderness areas could limit local development in the mountain

Table 22. Wilderness Components in the Dolores River Basin

WILDERNESS AREAS				
Agency and Area	Acres		Total	
	Designated	Further-Study		
Forest Service				
Lizard Head	41,496		41,496	
Mount Sneffels	11,100		11,100	
Subtotal	52,596		52,596	
Bureau of Land Management				
Dolores River Canyon/Coyote Wash		25,550	25,550	
McKenna Peak		21,900	21,900	
Sewemup Mesa		19,140	19,140	
Tabeguache Creek		7,270	7,270	
The Palisades		26,050	26,050	
Subtotal		99,910	99,910	
Total	52,596	99,910	152,506	
WILD AND SCENIC STUDY RIVERS				
River	River Miles			Total
	Wild	Scenic	Recreational	
Dolores River				
West Dolores from its source to confluence with mainstem ^a			(35.0)	(35.0)
Mainstem from 1.3 miles below McPhee Dam site to Bradfield Ranch bridge			11.0	11.0
Mainstem from Bradfield Ranch bridge to Disappointment Creek		41.0		41.0
Mainstem from Disappointment Creek to Little Gypsum Valley bridge			20.0	20.0
Mainstem from Little Gypsum Valley bridge to 1 mile above Highway 90 bridge near Bedrock	33.0			33.0
Subtotal	33.0	41.0	31.0	105.0
Lower Dolores River				
Mainstem from Gateway to Fisher Creek		8.5 (5.5 in Utah)		8.5
Mainstem from Fisher Creek to Bridge Canyon	(6.0 in Utah)			
Subtotal		8.5		
Total	33.0	49.5	31.0	113.5
ENDANGERED AND THREATENED SPECIES				
Black-footed ferret	No sightings reported during the 1970-1982 period (Jobman and Anderson, 1981, 1983).			
Spineless hedgehog cactus	Occurs in Paradox Valley (Ecology Consultants, 1978a, p. 43).			
American peregrine falcon	Breeding population and excellent potential habitat (Colo. Field Ornithologists, 1978, p. 11; U.S. Natl. Park Service, 1979a, p. 104).			
Bald eagle	Fairly common winter visitor; 24 birds, or 4% of state-wide total, counted during 1982 midwinter inventory (Goodman, 1982).			
Colorado squawfish	No specimens captured in lower 68 miles during April-October 1981 sampling (Valdez, et al., 1982b); basin does contribute flow to reaches of the Colorado River that have been provisionally recommended as critical habitat.			

^aRecommended by the State of Colorado but not by the Federal Study Team.

watersheds, including cloud-seeding opportunities totaling an estimated 82,000 acre-feet annually (U.S. Bur. Reclamation, 1979b).

Dolores and Lower Dolores Study Rivers

The Dolores study river consists of two components: the upper mainstem, extending from 1.3 miles below McPhee Dam to 1 mile above Colorado Highway 90 bridge near the community of Bedrock (U.S. Forest Service and U.S. Bur. Outdoor Recreation, 1976a, 1976b), and the lower mainstem, extending from near the community of Gateway, Colorado, to Bridge Canyon, Utah (U.S. National Park Service, 1979a). The two segments were studied separately because the lower eligible segment in Colorado is too short to qualify for designation by itself. The President's report recommending addition of the upper mainstem to the national wild and scenic rivers system was submitted to Congress on May 23, 1977, but no legislative action was ever taken. The report for the lower mainstem is still under review by the Secretary of the Interior.

Legislation authorizing study of the Dolores for wild and scenic river values explicitly excluded those segments of the river corridor needed for construction of the Dolores and Paradox Valley Projects (U.S. Senate-House Conf. Comm., 1974). The Dolores Project, currently under construction, will augment exports to the San Juan Basin and will deplete the average virgin flow of the Dolores River at the Colorado-Utah state line by an additional 19 percent (U.S. Bur. Reclamation, 1977a). The effect of storage behind McPhee Dam will be to reduce rafting opportunities during dry years and increase them during wet years (U.S. Forest Service and U.S. Bur. Outdoor Recreation, 1976b, p. 43-44). Operation of McPhee Dam during a period of streamflow similar to 1928-1973 would reduce the number of years suitable for rafting by about one-third. On the other hand, operational releases

during wet years would enable better prediction, scheduling, and grouping of rafting opportunities. The Paradox Valley unit will greatly reduce natural salt loading of the Lower Dolores and will deplete the virgin annual river flow by less than 1 percent (U.S. Bur. Reclamation, 1979c).

Various conditional water decrees involving small quantities of water are held within the proposed river corridor and elsewhere within the basin. Designation might prohibit development of some of these rights. Since the total quantity of final and conditional decrees already far exceeds the physical supply, it is also true that not all water rights could be developed in any case (U.S. Forest Service and U.S. Bur. Outdoor Recreation, 1976a, p. III-5).

Designation of the upper mainstem would preclude use of a potential pumped storage hydroelectric site located in Dolores Canyon near the Dove Creek Pumping Plant (U.S. Forest Service and U.S. Bur. Outdoor Recreation, 1976a, p. II-80), and designation of the lower mainstem would preclude development of the Dewey hydroelectric site located in Utah (U.S. National Park Service, 1979a, p. 112). No plans exist for development of either of the two sites.

Designation of the lower mainstem could also affect the proposed San Miguel Project, which would be located on the San Miguel River upstream from the eligible study corridor. Many alternative plans have been formulated for the San Miguel Project since it was authorized for construction in 1968, but none have met the national economic efficiency criterion. The most recent plan formulation has a benefit-cost ratio of only 0.79:1 even when discounted at the grandfathered interest rate of $3\frac{1}{2}$ percent (Table 23). Further planning for the project was discontinued in 1982.

Table 23. Annualized Costs and Benefits of Eight Bureau of Reclamation West Slope Water Projects

	Animas-La Plata ^a		Fruitland Mesa		Savory-Pot Hook		San Miguel ^b	
	Current	Modified	Current	Modified	Current	Modified	Current	Modified
Costs (10 ³ \$)	17,633		4,166	4,131	3,795	1,401		4,143
Benefits (10 ³ \$)								
Direct	20,424		2,304	2,328	2,660	3,231		2,838
Total	22,400		3,620	3,668	3,603	3,412		3,275
Benefit-Cost Ratio								
Direct	1.16:1		0.52:1	0.56:1	0.70:1	2.31:1		0.69:1
Total	1.27:1		0.87:1	0.89:1	0.95:1	2.44:1		0.79:1
Discount Rate	3.25%		3.125%	3.125%	3.33%	3.33%		3.25%
	West Divide		Dominguez Reservoir		Grand Mesa		Yellow Jacket	
	Current	Modified	Current	Modified	Current	Modified	Current	Modified
Costs (10 ³ \$)	7,878	15,636	48,830	49,250	5,023	6,015	9,761	10,069
Benefits (10 ³ \$)								
Direct	4,876	23,572	49,670	50,870	2,752	3,356	12,211	12,857
Total	6,509	25,202						
Benefit-Cost Ratio								
Direct	0.62:1	1.51:1	1.02:1	1.03:1	0.55:1	0.56:1	1.25:1	1.28:1
Total	0.83:1	1.61:1						
Discount Rate	3.25%	3.25%	7.125%	7.125%	7.125%	7.125%	7.125%	7.125%

Explanation: "Current" plans are evaluated on the basis of multipurpose outputs, including, in some cases, provision of water supply for confirmed energy developments within the original project area. "Modified" plans include potential end-of-century water demands for oil shale, coal-fired electric power plants, coal gasification, or slurry pipelines. "Total" benefits include the secondary, or indirect, effects of the project. Costs and benefits are expressed in January 1980 dollars, increased 10 percent annually to allow for inflation. Interest rates used in time discounting vary by project, depending on when it was authorized by Congress. Source: U.S. Water and Power Resources Service (1980).

^aNo additional energy demands could be met by the project.

^bVarious current alternatives have been considered, but none is economically justified.

Endangered and Threatened Species

The Dolores River formerly supported Colorado squawfish and bonytail chub as far upstream as the confluence with San Miguel River (Ecology Consultants, 1978b, p. 8, 15). The bonytail chub has apparently disappeared completely, and the river in its present state probably cannot support any significant numbers of squawfish except possibly in the reach near the Colorado River (Valdez, et al., 1982b). Project development could nonetheless be affected because the basin outflow is tributary to downstream segments of the Colorado Mainstem that are critical to squawfish spawning and rearing (Table 9). The preliminary biological opinion issued for the Dolores Project conditioned development on preserving the Colorado Mainstem's seasonal flow regime, either by releasing water from the Dolores Project itself or by releasing water from other Bureau of Reclamation projects (U.S. Fish and Wildlife Service, 1980b). The specific flow amount needed to sustain squawfish habitat has not yet been determined.

None of the other species listed in Table 22 pose any known threat to project development at this time.

Gunnison River Basin

The Gunnison River discharges roughly one-fifth of the Colorado River system's virgin water yield. Offchannel consumptive uses currently deplete the basin's outflow by about 20 percent, and new depletions through the year 2000 are projected to increase only modestly (Colo. Dept. Natural Resources, 1979; Colo. Energy Research Inst., 1981).

Wilderness Areas

Designated and potential wilderness units comprise about 13 percent of the basin's total drainage area and an even larger proportion of the

high-yielding mountain watersheds (Table 24). Restrictions on cloud-seeding over wilderness lands would severely reduce the potential for augmenting natural water yield, which is estimated to be at least 191,000 acre-feet per year (Table 12). Two BLM study units could affect proposed water projects. The Dominguez Canyon unit lies adjacent to the Bureau of Reclamation's Dominguez Reservoir site, but is not expected to prevent its development. The Gunnison Gorge unit contains two proposed reservoir sites that are also affected by the Gunnison study river.

Gunnison Study River

A recommendation to designate 26 miles of the Gunnison River as a component of the national wild and scenic rivers system was submitted to Congress on October 2, 1979, but the absence of subsequent legislative action means that formal study status expired on October 2, 1982. The proposed corridor consists of two segments, one located in the wilderness portion of Black Canyon of the Gunnison National Monument, and the other located in the Gunnison Gorge study area, which is currently being evaluated by the Bureau of Land Management for its wilderness suitability (U.S. Bur. Land Mgmt., 1980a; U.S. National Park Service, 1979b). Project construction within the monument segment is already prohibited by provisions of the Wilderness Act. Designation of Gunnison Gorge under the Wilderness or Wild and Scenic Rivers Act would extend similar protection to the entire river corridor.

The Gunnison River can be described as "free-flowing" only in the most generous sense of the term. Discharge through the study corridor is regulated by three dams--Crystal, Morrow Point, and Blue Mesa--which generate hydroelectricity, provide carryover storage for the Upper Colorado River Basin, and inundate nearly 35 miles of channel just upstream from the monument segment. Water is exported from headwater tributaries to the Arkansas and Rio Grande

Table 24. Wilderness Components in the Gunnison River Basin

Agency and Area	WILDERNESS AREAS			Total
	Designated	Endorsed	Further-Study	
Acres				
Forest Service				
Big Blue	97,700			97,700
Cannibal Plateau		14,150		14,150
Collegiate Peaks	48,000			48,000
La Garita	77,122			77,122
Maroon Bells-Snowmass	19,850			19,850
Mount Sneffels	5,100			5,100
Raggeds	42,200			42,200
West Elk	176,412			176,412
Subtotal	466,384	14,150		480,534
Bureau of Land Management				
Adobe Badlands			10,560	10,560
Camel Back			10,900	10,900
Dominguez Canyons			75,800	75,800
Gunnison Gorge			19,560	19,560
Handies Peak		7,120		7,120
Powderhorn Instant		44,951		44,951
Red Cloud Peak		11,140		11,140
Subtotal		63,211	116,820	180,031
National Park Service				
Black Canyon of the Gunnison National Monument	11,180			11,180
Total	<u>477,564</u>	<u>77,361</u>	<u>116,820</u>	<u>671,745</u>

WILD AND SCENIC STUDY RIVERS

	Wild River (miles)
Gunnison River Southern (upstream) boundary of Black Canyon of the Gunnison National Monument to 1 mile below the confluence with Smith Fork	26

ENDANGERED AND THREATENED SPECIES

Black-footed ferret	Four probable sightings near Hotchkiss reported during 1970-1982 period (Jobman and Anderson, 1981, 1983).
American peregrine falcon	Breeding and migrant populations (Colo. Field Ornithologists, 1978, p. 11).
Bald eagle	Fairly common winter visitor; 48 birds, or 9% of statewide total, counted during 1982 mid-winter inventory (Goodman, 1982).
Whooping crane	Basin lies within flyway of the experimental Grays Lake flock (Graul, 1978, p. 59).
Mesa Verde cactus	Occurs in the Uncompahgre Plateau in Montrose County (Ecology Consultants, 1978a, p. 50).
Spineless hedgehog cactus	Occurs in Montrose, Ouray, and Delta Counties (Ecology Consultants, 1978a, p. 44; U.S. Fish and Wildlife Service, 1982a, p. 2).
Uinta Basin hookless cactus	Occurs along lower Gunnison River and east of Delta (Ecology Consultants, 1978a, p. 48; U.S. Fish and Wildlife Service, 1981a, p. 3).
Colorado squawfish	Occurs in lower 40 miles of Gunnison mainstem and in the Colorado mainstem below its confluence with the Gunnison (U.S. Fish and Wildlife Service, 1982e, p. 5; Valdez, et al., 1982a).
Humpback chub	Occurs in Ruby and Westwater Canyons on the Colorado Mainstem below its confluence with the Gunnison (Valdez, et al., 1982b).

Basins, and the Gunnison Tunnel, located near the upstream boundary of the study segment, diverts large quantities of irrigation water to the nearby Uncompahgre Valley during April through October. The Gunnison Tunnel has also been enlarged to accommodate Project 7, which is a regional municipal-industrial project that will serve the communities of Delta, Montrose, and Olathe, the Tri-County Water Conservancy District, and two private water companies.

The Gunnison River study team identified four project proposals that would be jeopardized by designation of the Gunnison Gorge segment (U.S. National Park Service, 1979b, p. II-69-II-74). Further investigation reveals that two of the proposals, Colorado-Ute Electric Association's Tri-County Project and the City of Delta's municipal diversion, would not be affected. The City of Delta holds a water decree of 50 cfs having an alternative diversion point located near the downstream end of the river corridor. Precluding use of this diversion point would not prevent development of the decree, since the city is currently using the water by diverting it through the Gunnison Tunnel and Uncompahgre Project facilities (Brand, telephone comm., 1983). Reevaluation of Colorado Ute's Tri-County hydroelectric and water-storage project shows that its reservoir tailwaters would not invade the lower 1 mile of eligible river corridor as originally thought (Colo.-Ute Electric Assoc., telephone comm., 1983). In any event, plans to develop the project have been delayed indefinitely because of unfavorable economic conditions.

The two potential projects that would be affected are actually mutually exclusive because of overlapping reservoir tailwaters. Either project would inundate most of the river corridor below the monument segment (U.S. National Park Service, 1979b, Fig. 2-13). Pittsburgh and Midway Coal Company's proposed Cedar Flats Project would generate 60 MW of hydroelectricity and store 100,000

acre-feet of water for coal-fired electric power generation and, possibly, coal gasification plants. The City of Delta's proposed Smith Fork Project, which received a preliminary permit for feasibility investigation from the Federal Energy Regulatory Commission in December 1981, would produce 35.5 MW of hydroelectricity. The opportunity costs of foreclosing either proposal might be offset, at least in part, by constructing an alternative facility outside the river corridor. One possibility is the Sulphur Gulch Project, which calls for a dam and reservoir at Sulphur Gulch, with water being pumped from a small impoundment on the Gunnison mainstem below its confluence with the North Fork (U.S. National Park Service, 1979b, p. II-72-II-73). The project would yield about 100,000 acre-feet of water for coal-based energy development and could also generate pumped-storage hydroelectricity.

Designation of the Gunnison Gorge as a wilderness area or wild river corridor is not expected to interfere with the Fruitland Mesa Project (U.S. Bur. Reclamation, 1977b). If developed, the project would irrigate lands east of the river corridor and would contribute salt-laden return flows to the lower eligible section via Smith Fork and Crystal Creek. Dilution of the small return flows would prevent significant water quality deterioration. The project was authorized by Congress in 1964 as part of the Colorado River Storage Project. No construction funds have ever been appropriated, and planning was discontinued several years ago.

Endangered and Threatened Species

Some project developments will be affected by the presence of adult Colorado squawfish in the lower 40 miles of the Gunnison River (Valdez, et al., 1982b) and by the presence of critical habitat for both squawfish and humpback chub in the Colorado Mainstem downstream from its confluence with the Gunnison (Table 9, Fig. 5). Management of river flows in the Gunnison Basin appears to

be indispensable to conservation of the endangered fishes because the Gunnison contributes up to 41 percent of the flow of the Colorado Mainstem at the Colorado-Utah state line in a high-water year and 53 percent in a low-water year (U.S. Fish and Wildlife Service, 1979c, p. 2). Even small depletions during the critical spawning and rearing months of April-September could be detrimental to survival and recovery of the fishes.

The Fish and Wildlife Service has issued biological opinions for four project developments in the basin (Table 10). Two of the projects were found not to affect the endangered fishes. Nonjeopardy opinions for the other two, Dallas Creek and Dominguez Reservoir, are conditional upon adoption of conservation measures (U.S. Fish and Wildlife Service, 1969c, 1982e). The preliminary opinion for Dallas Creek indicated that minimum flows would have to be provided, either from Dallas Creek itself or from other storage facilities in the basin. Construction is proceeding while final determination of necessary flow amounts is being made. Construction of the proposed Dominguez Project would inundate about 26 miles of occupied squawfish habitat in the lower Gunnison. Conservation measures required to offset this loss, as well as protect critical squawfish habitat in downstream reaches of the Colorado Mainstem, are summarized in Table 10.

As noted in Table 24, the Gunnison Basin contains occupied or potential habitat for the black-footed ferret, American peregrine falcon, bald eagle, whooping crane, and three species of endangered plants. The Fish and Wildlife Service (1981f, p. 2) has expressed concern that loss of wetlands in the basin could affect the Grays Lake whooping crane flock, which is expected to increase its use of the area as the flock grows in size. Irrigation or other developments that reduce wetland acreage may have to provide compensating habitat.

Some project developments within the Gunnison Basin will be constrained by economic rather than ecological considerations. Dominguez Reservoir, Fruitland Mesa, and Grand Mesa provide three examples. According to a recent evaluation published by the Bureau of Reclamation, the projects have benefit-cost ratios of only 1.03:1, 0.89:1, and 0.56:1, respectively, even when re-designed to supply water for potential coal or oil-shale developments (Table 23).

Colorado Mainstem Basin

The Colorado Mainstem Basin contributes approximately one-third of the West Slope's virgin water yield. Current depletions, including exports to the South Platte and Arkansas River Basins, reduce the natural outflow at the Colorado-Utah state line by nearly 30 percent. The Colorado Department of Natural Resources (1979) forecasts that consumptive demand through the year 2000 could increase by up to 41 percent, with two-thirds of the incremental demand being transmountain diversions to the East Slope.

Wilderness Areas

Wilderness areas comprise a major share of the basin's high-yielding watersheds (Table 25). As noted in the discussion of the South Platte Basin, two of the units--Eagles Nest and Holy Cross--contain lands that would be affected by proposed East Slope diversions. Withdrawal of the high-yielding watersheds could affect both East Slope and West Slope interests by limiting streamflow augmentation opportunities, including much of the basin's cloud-seeding potential of approximately 300,000 acre-feet annually (Table 12).

Colorado Study River

The Department of the Interior has provisionally recommended that 56 miles of the Colorado River be added to the national wild and scenic rivers

Table 25. (continued)

Bonytail chub	No specimens captured during sampling from July 1979 to July 1981 (Valdez, et al., 1982a).
Spineless hedgehog cactus	Occurs near the Colorado River in Mesa County (Ecology Consultants, 1978a, p. 44).
Uinta Basin hookless cactus	Occurs in Mesa and Rio Blanco Counties (Ecology Consultants, 1978a, p. 48).

system (U.S. National Park Service, 1979a). The eligible segment of the river extends from the Loma boat launching site, about 4 miles west of Fruita, Colorado, downstream through Horsethief, Ruby, and Westwater Canyons to the confluence with the Dolores River in Utah. Most of the corridor contains critical habitat for the endangered humpback chub or Colorado squawfish (Table 9, Fig. 5). The 20.7-mile segment lying within the State of Colorado has been recommended for scenic river status. Existing water developments within the corridor are limited to small irrigation works, usually pumps which divert waters onto adjoining meadowlands.

Two potential water projects have been identified within the river corridor (U.S. National Park Service, 1979a, p. 193-195). One is the Dewey hydroelectric dam site, located approximately 2 miles below the confluence with the Dolores River in Utah, that would inundate the entire corridor if developed. No proposals currently exist for licensing the site. The other potential development is a conditional decree held by Industrial Resources, Inc., for a storage reservoir of 38,000 acre-feet capacity that would back water through Horsethief Canyon in the Colorado portion of the corridor. Water withdrawn from the reservoir would be used for irrigation, municipal, and industrial purposes, including steam-electric power generation. Preservation of the endangered fish species would likely preclude construction of both projects even if the corridor is not designated under the Wild and Scenic Rivers Act.

Endangered and Threatened Species

Preservation of the Colorado squawfish and humpback chub pose a significant constraint to future project development. Squawfish range throughout the length of the Colorado Mainstem from DeBeque Canyon to Lake Powell (Valdez, et al., 1982a), and much of the reach between Grand Junction and Cataract Canyon, Utah, has been provisionally recommended as critical habitat for squawfish spawning or rearing (Table 9, Fig. 5). The only major populations of humpback chub known to still exist in the Upper Colorado River Basin are located in Ruby and Westwater Canyons near the Colorado-Utah state line. Both sites are regarded as critical habitat.

The Fish and Wildlife Service will undoubtedly oppose construction of projects near or below Grand Junction that would inundate critical habitat, block fish passage, adversely alter water temperature, or otherwise jeopardize continued existence of squawfish and humpback chub. Judging from the biological opinions issued to date, it appears that projects depleting streamflow anywhere in the basin may be required to provide minimum flows or fund mitigating conservation measures (Table 10). Whether cumulative water depletions may reach a stage, such that no new projects would be allowed, cannot be determined from the available information. An assessment of cumulative depletions would have to consider both the Colorado Mainstem and Gunnison Basins, including proposed diversions to the East Slope.

Other endangered species located in the basin (Table 25) do not constitute any known constraints to project development at this time.

White River Basin

The White River Basin discharges about 5 percent of the Colorado system's total water yield. Consumptive demand is very small at the present time, but could increase dramatically over the next two decades with commercialization

of oil shale deposits in the Piceance and Yellow Creek drainages (Colo. Dept. Natural Resources, 1979; Colo. Energy Research Inst., 1981). Growth of an oil shale industry is equally likely within the Utah portion of the basin, which means that competitive demands on the available supply could limit Colorado's upstream use. Utah has already initiated steps to build a storage reservoir on the White River to supply anticipated oil shale demands in that state (U.S. Fish and Wildlife Service, 1982b).

Wilderness Areas

Potential constraints on water-project development include the Flat Tops Wilderness area and habitat for several endangered or threatened species (Table 26). The Flat Tops Wilderness, created in 1976, occupies the higher elevation portions of the White River Plateau. Together with adjoining national forest watersheds, it generates approximately 75 percent of the basin's annual water yield (U.S. Forest Service, 1972). Designation of the wilderness area precluded development opportunities proposed by the Rocky Mountain Power Company and the Colorado River Water Conservation District (McAda, 1978, p. 54-55, 67). Whether either of the proposals could have been economically justified is not known. The Rocky Mountain Power Company's proposal involved constructing a hydroelectric facility or, alternatively, exporting water to the Colorado Mainstem Basin as exchange water for additional East Slope diversions (U.S. Senate, 1975, p. 18). The Water District's proposal involved developing 13,500 KW of hydroelectric base load power, 525,000 KW of pump storage, and storing approximately 85,000 acre-feet of industrial water for oil-shale use. The wilderness withdrawal also jeopardizes much of the basin's streamflow augmentation potential, including cloud-seeding opportunities of 130,000 acre-feet annually (Table 12).

Table 26. Wilderness Components in the White River Basin

WILDERNESS AREAS	
Agency and Area	Designated (Acres)
Forest Service Flat Tops	138,380
ENDANGERED AND THREATENED SPECIES	
Black-footed ferret	Three probable sightings reported during 1970-1982 period (1976, near Rangely; 1977, near Massadona; 1977, near Douglas Pass; Jobman and Anderson, 1981, 1983).
American peregrine falcon	Limited use of area because of poor nesting and hunting habitat (Craig, 1978a, p. 45; U.S. Fish and Wildlife Service, 1982c, p. 9).
Bald eagle	Resident breeder and fairly common winter visitor (Goodman, personal comm., 1983); 78 birds, or 14% of statewide total, counted during 1982 midwinter inventory (Goodman, 1982).
Whooping crane	Basin lies along the flyway of the experimental Grays Lake flock (Colo. Field Ornithologists, 1978, p. 13; Graul, 1978, p. 59).
Bonytail chub	No specimens collected during April-November 1981 sampling; habitat does not appear suitable (Miller, et al., 1982b, p. 56).
Humpback chub	Only one suspected specimen collected during April-November 1982 sampling; habitat does not appear suitable (Miller, et al., 1982b, p. 56).
Colorado squawfish	Occupies lower 150 miles of mainstem (Miller, et al., 1982b); basin contributes flow to critical spawning and rearing habitat in the Green River (Table 9, Fig. 5).

Endangered and Threatened Species

Project development will affect the Colorado squawfish, but is unlikely to jeopardize the humpback or bonytail chub. Squawfish have been collected at several locations on the mainstem as far upstream as the confluence with Piceance Creek (Miller, et al., 1982b; U.S. Fish and Wildlife Service, 1982b, 1982c). Fish movement appears to occur between the White and Green Rivers with a general migration of larger squawfish from the Green into the White, presumably to seek preferred food or to reduce competition. Although no

spawning has been documented in the White River, there is evidence that it occurs or historically occurred in the lower 50 miles. In 1980, apparent spawning behavior was observed at a site on the lower White which displays habitat characteristics similar to the site on the Yampa River that is currently the only documented spawning habitat in the entire Upper Colorado River Basin.

The Fish and Wildlife Service (1982b, 1982c) has issued biological opinions for the White River Dam Project, which involves construction of a storage reservoir and small hydroelectric dam on the mainstem near Bonanza, Utah, and the Taylor Draw Project, which involves construction of a storage reservoir and direct-flow diversion structure near Rangely, Colorado. Although both projects will inundate occupied squawfish habitat, they were allowed to proceed subject to various conservation measures (Table 10). Very importantly, the two opinions concluded that loss of the squawfish population upstream from the project sites "will not result in the likelihood of jeopardy of the species." This decision removes most of the impediment that would otherwise confront development in the Colorado portion of the basin. The remaining concern involves future streamflow depletions that might adversely affect downstream critical habitat in the Green River (Table 9, Fig. 5).

Consumptive water use in the basin might be ultimately constrained, not by the Endangered Species Act, but by the obligation of Colorado to deliver water downstream to the Utah state line. Although interstate flows in the White River are not apportioned by the Upper Colorado River Basin Compact of 1948 (Witmer, 1968, p. 339-353), there are competing demands on the supply. Specifically, the Ute Indian Tribe in Utah claims a right to use of water in the White River under the Winters Doctrine (U.S. Bur. Land Mgnt. and Rural Electrification Admin., 1981, p. 13). The amount of water has not yet been

agreed upon by the Ute Tribe and the priority date has not been firmly established, but will most likely be either 1882 or 1948. Whether Colorado would be required to honor the Ute claim is problematical.

Yampa River Basin

Virgin annual runoff in the Colorado portion of the Yampa River Basin averages about 1.4 million acre-feet (U.S. Dept. Agr., 1969), or approximately 15 percent of the West Slope's native water yield. Under terms of the Upper Colorado River Basin Compact of 1948 (Witmer, 1968, p. 339-353), Colorado and Wyoming are apportioned flows originating in the Little Snake drainages, and Colorado must deliver water to Utah by not depleting the flow of the Yampa mainstem at the Maybell Gaging Station below an average of 0.5 million acre-feet per year. The residual supply available for Colorado's exclusive use is large relative to the present consumptive demand (Table 14). Demand is projected to increase substantially over the next two decades, however, because of irrigation and coal-related energy growth (Colo. Dept. Natural Resources, 1979; Colo. Energy Research Inst., 1981).

Wilderness Areas

Designated and potential wilderness areas comprise about 9 percent of the basin's total drainage area (Table 27). Watersheds located within the national forest units contain most of the basin's streamflow augmentation potential, including cloud-seeding opportunities of approximately 135,000 acre-feet of water per year (Table 12). The BLM Cross Mountain study area contains lands that would be inundated by the lower reservoir unit of the proposed Juniper-Cross Mountain Project (U.S. Natl. Park Service, 1979c, p. 49). Colorado-Ute Electric Association, one of the project sponsors,

Table 27. Wilderness Components in the Yampa River Basin

WILDERNESS AREAS				
Agency and Area	Acres			Total
	Designated	Endorsed	Further-Study	
Forest Service				
Flat Tops	38,870			38,870
Mount Zirkel	68,748			68,748
Service Creek		39,860		39,860
Subtotal	107,618	39,860		147,478
Bureau of Land Management				
Cross Mountain			14,081	14,081
Diamond Breaks			31,480	31,480
Dinosaur National Monument				
Adjacent-North			12,100	12,100
West Cold Springs			14,352	14,352
Subtotal			72,013	72,013
National Park Service				
Dinosaur National Monument		165,988	3,202	169,290
Total	107,618	205,848	75,215	388,781
WILD AND SCENIC STUDY RIVERS				
River	River Miles			Total
	Wild	Scenic	Recreational	
Elk River				
North Fork from unnamed lake on Big Agnes Mountain to Mt. Zirkel Wilderness boundary	5.9			5.9
North Fork from Mt. Zirkel Wilderness boundary to confluence with Middle Fork		6.9		6.9
South Fork from Dome Lake to confluence with mainstem	10.8			10.8
Middle Fork and mainstem from confluence of Gold and Gilpin Creeks (Slavonia) to confluence with South Fork		5.5		5.5
Subtotal	16.7	12.4		29.1
Green River				
Flaming Gorge Dam to Indian Crossing, Utah		(15.0, Utah)		(15.0)
Indian Crossing to Gates of Lodore			18.0 (14.0, Utah)	18.0 (14.0)
Gates of Lodore to Split Mountain, Utah	22.0 (22.0, Utah)			22.0 (22.0)
Subtotal, Colorado	22.0		18.0	40.0
Subtotal, Utah	(22.0)	(15.0)	(14.0)	(51.0)
Yampa River				
Eastern boundary of Dinosaur National Monument to confluence with Green River	47.0			47.0
Total, Colorado	85.7	12.4	24.2	122.3
Total, Utah	(22.0)	(15.0)	(14.0)	(51.0)

ENDANGERED AND THREATENED SPECIES

Black-footed ferret	Four probable sightings reported during 1970-1982 period (1977, near entrance to Nine Mile Gap; 1978, 1979, Ices Grove between Craig and Meeker; 1982, near Dinosaur Road; Jobman and Anderson, 1981, 1983).
American peregrine falcon	Breeding population along lower Yampa (Goodman, personal comm., 1983).

Table 27. (continued)

Bald eagle	Resident breeder and fairly common winter visitor (Goodman, personal comm., 1983); 52 birds, or 9% of statewide total, counted during 1982 midwinter inventory (Goodman, 1982).
Whooping crane	Basin lies along the flyway of the experimental Grays Lake flock (Graul, 1978, p. 59).
Bonytail chub	No specimens collected during 1981 sampling, and the species appears to be absent from the river (Miller, et al., 1982c, p. 66).
Colorado squawfish	Occurs as far upstream as Juniper Canyon; lower Yampa contains the only documented spawning site in the Upper Colorado River Basin (Miller, et al., 1982c). Basin contributes flow to downstream critical habitat in the Green River (Table 9, Fig. 5).
Humpback chub	Four specimens collected on the Yampa during 1981 sampling (Miller, et al., 1982c, p. 69).

recently withdrew its participation because of unfavorable economic conditions (Colo.-Ute Electric Assoc., telephone comm., 1983).

Elk Study River

A recommendation to add about 29 miles of the Elk River to the national wild and scenic rivers system was submitted to Congress on September 13, 1982 (Interagency Task Force, 1982). The proposed river corridor includes the mainstem upstream from its confluence with the South Fork, the North and South Forks to their headwaters, and the Middle Fork to the confluence of Gilpin and Gold Creeks (U.S. Forest Service, 1979d). Nondesignation was recommended for the study segment located below the confluence with South Fork in order to avoid potential impacts on 545 acres of private land and to allow development of Public Service Company's proposed Hinman Park Reservoir.

The study corridor already enjoys some protection against water-resource development. About 11 miles of North and South Forks lie within the Mount Zirkel Wilderness, where development is precluded without a Presidential exemption. The Colorado Water Conservation Board has appropriated instream flow rights on all the forks of the Elk River, their major tributaries, and the mainstem itself. Opportunity costs of designating the recommended corridor appear to be minimal. No potential hydroelectric sites have been identified

in the area. The only known potential conflict involves the Colorado River Water Conservation District's proposed Grouse Mountain Reservoir. This 79,000 acre-foot reservoir would be located on Willow Creek, outside the river corridor, but would be filled by a feeder canal diverting water from Middle Fork. The Elk River Study Team (U.S. Forest Service, 1979d, p. 22) concluded that designation would not prevent construction of the project because compatible diversion structures could be built and adequate downstream river flows could be made available during the recreation season.

Green Study River

The 91-mile segment of the Green River studied for wild and scenic river status extends from the Forest Service boat ramp below Flaming Gorge Dam in Utah to the southwestern boundary of Dinosaur National Monument in Utah (U.S. National Park Service, 1979c). That portion of the corridor located in Colorado totals approximately 40 miles. The upper 16 miles lie within Browns Park National Wildlife Refuge and the lower 24 miles within Dinosaur National Monument.

Designation would have little effect on project development within the corridor itself. Two proposed federal projects, Echo Park and Split Mountain Dam, were strongly opposed by environmental interests in the 1950s; both projects are now considered dead, and powersite and reclamation withdrawals for both are being lifted (U.S. National Park Service, 1979c, p. 234). Plans for a pumped storage project in the upper Utah segment of the corridor have been postponed indefinitely because of high construction costs. Designation of the upper Utah segment might limit expansion of hydroelectric output at Flaming Gorge Dam. Designation of the segment below Echo Park might reinforce limitations on developing water supplies in the Yampa River Basin.

Yampa Study River

The segment of the Yampa River eligible for wild river status extends from Dearlodge Park, at the eastern boundary of Dinosaur National Monument, downstream 47 miles to the confluence with the Green River at Echo Park. The entire segment lies within the monument. Numerous water projects located upstream from the corridor are in various stages of planning or feasibility study (U.S. National Park Service, 1979c, Table II-4). Potential uses include irrigation, municipal, industrial, hydroelectric power, and export to the South Platte River Basin. Not all of the projects could be built, as some overlap at near-identical sites and the aggregate would develop more water than is physically available.

A draft report for both the Green and Yampa Rivers was completed in July 1979 (U.S. National Park Service, 1979c). Final recommendations were submitted to the Office of Management and Budget in 1980, but were subsequently returned to the Secretary of the Interior for further review. In any event, it appears that any constraints on project development imposed by wild and scenic river designation might be secondary to those created by preservation of the endangered Colorado squawfish.

Endangered and Threatened Species

The lower 20 miles of the Yampa River and five downstream segments of the Green River are considered critical habitat for squawfish spawning and rearing (Table 9, Fig. 5). Maintenance of suitable flows in the Yampa River is essential to all these sites, partly because outflow from the Yampa provides almost half of the water in the Green River in an average year, as measured at Jensen, Utah, and partly because the lower Yampa itself contains the only documented active squawfish spawning site located in the entire Upper Colorado River Basin (Miller, et al., 1982c; U.S. Fish and Wildlife Service, 1982f).

Biological opinions have been issued to date for Cheyenne's Stage II diversion from the Little Snake River in Wyoming (U.S. Fish and Wildlife Service, 1982f; U.S. Forest Service, 1981) and the Moon Lake Power Project diversion from the Green River near Jensen, Utah (U.S. Bur. Land Mgnt. and Rural Electrification Admin., 1981; U.S. Fish and Wildlife Service, 1981h). The Service concluded in both cases that flow depletions would not likely jeopardize survival of the endangered fishes, but could jeopardize recovery of the species unless conservation measures are taken (Table 10). The City of Cheyenne agreed to fund certain programs, at a cost not to exceed \$138,000, involving flow releases, habitat manipulation, monitoring and research, and fish stocking. Operators of the Moon Lake Project agreed to either purchase replacement water from Flaming Gorge Reservoir or to fund studies and/or programs designed by the Fish and Wildlife Service in an amount not to exceed \$500,000.

Specific constraints on project opportunities in Colorado are unclear at this time, but will become more evident with publication of the Fish and Wildlife Service's forthcoming conservation plan (Archer, 1982). Preliminary data suggest that minimum flow releases will be needed for the season extending from June 15 to October 15 (Miller, et al., 1982a, Table 5). Meeting this flow regime would have its greatest effect on new irrigation developments because irrigation demand peaks during the same time interval. On the other hand, a large increase in irrigation use appears unlikely unless irrigation benefits can be combined with hydroelectric power or municipal-industrial demand to improve project feasibility. The proposed Savory-Pot Hook Project, for example, when designed only for irrigation purposes, has a negative benefit-cost ratio of 0.95:1 even when discounted at the low grandfathered interest rate of 3 1/3 percent (Table 23). Additionally, it should be remembered that Colorado must

deliver an average of 500,000 acre-feet of water per year at the Maybell Gaging Station under terms of the Upper Colorado River Basin Compact of 1948 (Witmer, 1968, p. 349). Delivery of this legal obligation to Utah might possibly be scheduled to coincide with water needs of the endangered fishes.

Other endangered species occurring in the basin (Table 27) do not pose any known constraints to project development at this time.

CHAPTER 5
SUMMARY AND CONCLUSIONS

Wilderness Act

More than 2.6 million acres of land in Colorado have already been placed in the national wilderness preservation system, an additional 889,000 acres have been administratively endorsed for inclusion, and another 447,000 acres are currently being studied for their wilderness suitability (Tables 2-4). Nearly all of the designated acreage and more than one-third of the endorsed acreage is located on national forest lands, generally above 9,000 to 10,000 feet elevation in the alpine-subalpine watersheds. Runoff from the national forest wilderness equals roughly one-fifth of the state's renewable water supply. The same areas contain significant opportunities for enhancing natural runoff through vegetation-snowpack management and orographic cloud seeding. A small part of the designated acreage and about one-half of the endorsed acreage is located in national park units. These areas would be managed as de facto wilderness even without official Congressional action. The remaining potential wilderness acreage is generally located below 9,000 elevation and is administered by the Bureau of Land Management.

Unless otherwise provided for in the enabling legislation, wilderness designation automatically precludes any type of new construction works in the affected area, including enlargements of existing structures; modification of the plant, soil, or snow cover to increase or change the timing of natural runoff; and installation of hydrological measuring equipment, except on a temporary basis. Maintenance of existing structures is permitted, but owners are required to use primitive means of transportation and hand tools wherever and whenever feasible. Use of wilderness lands as target areas for cloud seeding is permitted only if proponents can provide reasonable, scientifically

supportable assurance that seeding will not create permanent, substantial changes in natural conditions.

Fortunately, much of the national forest wilderness acreage is unsuited to construction works because of its rugged terrain, remoteness, or compartmentalization into small watersheds. Reservoir construction within the small watersheds is generally inefficient because of the inability to collect and store large volumes of runoff at any one site. Reservoir storage on much of the BLM acreage is not feasible because of low unit water yield. These physical characteristics, together with the careful drawing of wilderness boundaries so as to exclude many developed sites, have helped to minimize development conflicts. Potential conflicts involving expansion of the Fryingpan-Arkansas and Homestake Projects were resolved by granting exemptions in the enabling legislation.

This study has identified only a few instances where new construction projects have been excluded or might be excluded. Creation of the Flat Tops Wilderness in 1975 excluded two project proposals of undetermined viability. The Cache la Poudre and Comanche Peak Wilderness areas contain several reservoir sites that were evaluated as part of the Cache la Poudre Project study. Development potential of the sites is contingent upon the future price of peaking hydroelectric power. Designation of BLM's Cross Mountain study area would prevent construction of the lower reservoir unit of the proposed Juniper-Cross Mountain Project. The opportunity cost of this potential conflict is moot at present because Colorado-Ute Electric Association, one of the project sponsors, has withdrawn its participation. Designation of BLM's Gunnison Gorge study area would exclude either the Cedar Flats or Smith Fork Project. The City of Delta is currently exploring the technical feasibility of its proposed Smith Fork hydroelectric project.

The Forest Service's Piedra study area contains a potential hydroelectric site, but no plans now exist for its development.

The other conflict involves the Eagles Nest Wilderness and the Denver Water Department's proposed expansion of its Roberts Tunnel collection system. Each of the three affected units, East Gore, Eagle-Piney, and Eagle-Colorado, could be built completely outside the wilderness boundaries, albeit at higher economic cost, or need for the projects might be obviated by pursuing other supply options, such as an exchange transfer of water rights in Green Mountain Reservoir. Need for the Eagle-Piney and Eagle-Colorado units, even to supply an expanded service area, could be deferred until after the year 2020 in any case, providing the Department successfully implements the Foothills Consent Decree and is able to build its other proposed facilities (Fig. 7).

Alternatively, the Denver Water Department, or any affected project sponsor, could apply for a Presidential exemption or seek Congressional support for legislative relief. Section 4 of the Wilderness Act authorizes the President to grant an exemption if such action "will better serve the interests of the United States and the people thereof than will its denial." No formal application has ever been made under the Section 4 provision for any wilderness area in the nation and, accordingly, no precedent has yet been established for the granting of a Presidential exemption.

Prohibition against modifying the plant, soil, or snow cover to enhance natural water yield may represent a significant opportunity cost to some local areas in the future. Any major limitations on cloud seeding over national forest wilderness areas would foreclose much of the state's cloud-seeding potential, estimated to total at least 1.5 million acre-feet of incremental runoff per year, either because the wilderness areas would not be available as direct target areas or because seeding material released elsewhere could drift

over and affect wilderness lands. Although experimental seeding has been permitted over some wilderness areas, there remains a degree of uncertainty as to whether long-term operational programs would be allowed, and if so, under what kind of regulatory controls. Implementation of the Colorado River Snow Enhancement Test should help resolve these uncertainties.

The prohibition against permanent installation of automatic snow gages in the larger wilderness areas has reduced the efficacy of forecasting stream-flow conditions, but this has been partially offset by establishing correlation sites in nearby areas.

Wild and Scenic Rivers Act

On January 3, 1975, Congress directed that portions of twelve rivers in Colorado be studied for potential inclusion in the national wild and scenic rivers system (Table 5). Draft or final reports, including separate assessments of the Upper and Lower Dolores, have been published for each study corridor. The report for the Big Thompson River determined that the study segment is ineligible because of its short length and lack of outstanding features to compensate for the length criterion. Positive recommendations have been submitted to Congress for portions of the Conejos, Elk, Encampment, Gunnison, Los Pinos, Piedra, and Upper Dolores Rivers. Final recommendations for the Cache la Poudre, Colorado, Green, Lower Dolores, and Yampa are still under administrative review.

Study rivers are explicitly protected against water-project development during the period which Congress allocates for their study and for an additional three-year period after the study reports are completed and submitted to Congress. Such protection has expired for the Upper Dolores, Encampment, and Gunnison Rivers because Congress failed to take legislative action within

the three-year grace period. Protective status of the other rivers is uncertain, since none of the other study reports was transmitted to Congress by the mandated deadline of October 2, 1979.

Both the Forest Service and the Department of the Interior contend that study status and protection against development remain effective until Congress has had an opportunity to review the completed reports. This proposition was formalized by the Reagan Administration in a legislative proposal submitted to Congress on September 13, 1982 (Interagency Task Force, 1982). The proposed amendment would clarify Section 7(b) of the Wild and Scenic Rivers Act by applying protection from the date that Congress designates a river for study until three years after transmittal of the study report to Congress, even if submittal of the report extends past the deadline that Congress mandated for completion. If Congress fails to act on the recommendation within the three-year review period, then study and protective status would automatically terminate at the end of the period. The Administration's proposed amendment also recommended extending the deadline for completion and submittal of study reports for the Cache la Poudre, Colorado, Green, and Yampa Rivers from October 2, 1979, to January 1, 1986.

Clarification of the existing uncertainty regarding protective status should be pursued, either by supporting the Administration's proposal or by supporting an alternative amendment that would set a definitive termination date. Failure to clarify the uncertainty could result in the filing of opposition lawsuits and unnecessary delay for any developments initiated on the affected rivers. The Administration's proposal to defer completion of study reports for the Cache la Poudre, Colorado, Green, and Yampa Rivers until January 1986 appears to be unduly cautious. Further delay in completing the Cache la Poudre report can be justified only if sponsors can be found

who are willing to fund an extension of the water-project study just concluded for the Colorado Water Conservation Board (Tudor Engineering, 1982a, 1982b, 1983). Completion of the Colorado, Green, and Yampa reports should be forthcoming shortly after the Fish and Wildlife Service publishes its conservation management plan for the endangered Colorado River fishes. This also applies to the Lower Dolores report which the Administration is still reviewing but did not mention in its proposed amendment.

Three potential options exist for disposition of the individual study rivers: nondesignation, designation under the federal preservation system, or designation under a state-administered preservation system. Table 28 summarizes the known opportunity costs of designating each river. As noted, the available data do not reveal any explicit conflicts involving projects of demonstrated technical and economic feasibility. This is not surprising in view of the poor information base for development opportunities and the non-existent information base concerning the instream flows needed for river preservation purposes. Determination of instream flow requirements for river preservation purposes should be made an integral part of the Congressionally authorized study procedure. Without such information, it is impossible to gage the prospective constraints on upstream or tributary development even if project operating characteristics are fully known. Although the information base for development opportunities could undoubtedly be improved through additional inquiry of a general nature, it is unreasonable to expect that detailed feasibility data can or should be acquired in all cases, at least at public expense. This report, for example, does not include data on low-head hydroelectric potential, since collection of such information would constitute a major research effort in its own right.

Table 28. Known Opportunity Costs of Designating Colorado's Wild and Scenic Study Rivers^a

Study River	Known Opportunity Costs
Cache la Poudre	None in the two-thirds of the river corridor containing wilderness lands, except to eliminate the possibility of a Presidential exemption. Designation would prevent construction of the potential Grey Mountain-Idlywilde Project, providing the project gains an active sponsor and is shown to be economically feasible.
Colorado	Prevent development of a conditional storage decree in Horsethief Canyon, providing the project is shown to be economically feasible. Development within the corridor may be excluded in any event because nearly all of the stream mileage is considered critical habitat for the endangered Colorado squawfish or humpback chub. Upstream projects might be affected if flow releases for the endangered fishes are not adequate for wild and scenic river purposes.
Conejos	None in the wild river corridor, except to eliminate the possibility of a Presidential exemption in the South San Juan Wilderness. Designation of the recreational corridor might affect development of 0.68 MW of hydroelectric potential at Platoro Dam, but no plans now exist for harnessing this potential.
Elk	None in the 11 miles of river corridor located in the Mt. Zirkel Wilderness, except to eliminate the possibility of a Presidential exemption. Designation of the remaining corridor is not likely to jeopardize construction of a diversion structure for the proposed Grouse Mountain Reservoir.
Encampment	No existing or proposed developments within the river basin. Designation would eliminate the possibility of a Presidential exemption in the 17.5 miles of river corridor located in Mt. Zirkel Wilderness and Davis Peak further planning area.
Dolores (McPhee Dam to Bedrock)	Will not jeopardize completion of the Dolores and Paradox Valley Projects, but might affect other development opportunities, including a potential pumped-storage hydroelectric site in Dolores Canyon. Flow releases might have to be made to protect downstream critical habitat for the endangered Colorado squawfish in the Colorado Mainstem; such releases might alleviate constraints imposed by wild and scenic rivers designation.
Green	None in the corridor itself, which lies in Browns Park National Wildlife Refuge and a portion of Dinosaur National Monument that has been endorsed for wilderness status. Designation of the segment below Echo Park might affect development opportunities in the Yampa River Basin, providing that river flows needed to sustain critical habitat for the Colorado squawfish in the lower Yampa and Green Rivers are inadequate for wild river purposes.
Gunnison	None within the upper 12.7 miles of river corridor, except to eliminate the possibility of a Presidential exemption in Black Canyon of the Gunnison Wilderness. The lower 13.5 miles of river corridor lie within the Gunnison Gorge Wilderness Study Area. Wilderness or Wild and Scenic Rivers designation would prevent construction of the proposed Smith Fork hydroelectric project or the proposed Cedar Flats hydroelectric-conservation storage project. (Only one of the two projects could be built because of overlapping reservoir tailwaters; economic feasibility has not been determined for either project.) Designation of any portion of the corridor might affect upstream project opportunities.
Los Pinos	None, except to eliminate the possibility of a Presidential exemption in Weminuche Wilderness.
Lower Dolores	None within the river corridor itself, but designation might affect upstream project opportunities.
Piedra	None in the upper river corridor, except to eliminate the possibility of a Presidential exemption in the 9.3-mile segment located within Weminuche Wilderness. About 5 miles of the lower corridor lie within the Piedra Wilderness Study Area, which has been endorsed for wilderness status. Wilderness or Wild and Scenic Rivers designation would prevent development of hydroelectric potential at the O'Neal Park site, although no plans currently exist for such development.

(continued)

Table 28. (continued)

Study River	Known Opportunity Costs
Yampa	None within the corridor itself, which lies within a portion of Dinosaur National Monument that has been endorsed for wilderness status. The lower portion of the corridor contains the only documented spawning habitat for the endangered Colorado squawfish, and basin outflow is essential to preservation of other critical habitat in downstream reaches of the Green River. Hence flow releases needed to sustain the Colorado squawfish may represent a greater constraint to upstream projects than designation of the corridor as a wild river.

^aExcludes opportunity costs that might accrue in Wyoming (Encampment River) or Utah (Colorado, Green, and Lower Dolores Rivers).

All or portions of the Cache la Poudre, Conejos, Elk, Encampment, Gunnison, Los Pinos, and Piedra study rivers lie within designated wilderness areas and are thus already protected against construction activities within the affected corridor boundaries. The only opportunity cost of placing these segments into the national wild and scenic rivers system would be to remove the possibility of a Presidential exemption as permitted under Section 4 of the Wilderness Act. Except for the Cache la Poudre and Gunnison, designation of the entire eligible segments of the same rivers would appear to foreclose little or no development opportunities. Any further consideration to designate the Gunnison should await completion of BLM's wilderness suitability study of Gunnison Gorge and completion of the ongoing feasibility investigation of the City of Delta's Smith Fork hydroelectric project. Designation of the Cache la Poudre would apparently exclude only the potential Grey Mountain-Idlywilde Project. All of the other project configurations identified earlier in Table 19 are either economically infeasible or would require a Presidential exemption because of their location within existing wilderness areas. Economic viability of the Grey Mountain-Idlywilde Project has yet to be conclusively demonstrated.

Whether designation of the Colorado, Green, and Yampa Rivers would actually constrain project development is largely conditional upon final determinations yet to be made by the Fish and Wildlife Service regarding critical

habitat and instream flow needs of the endangered Colorado River fishes. Endangered species considerations might possibly be more restrictive than any constraints imposed by wild and scenic river designation. Opportunity costs of designating the Green and Yampa Rivers would be confined in any case to upstream areas. Project construction within the Green River corridor is highly unlikely because of its location within a national wildlife refuge and national monument. Construction within the Yampa corridor is similarly unlikely because of its location within the same national monument. Both monument segments have also been administratively endorsed for inclusion in the national wilderness preservation system.

Designation of the Dolores River, including the segment below Gateway, should not create any major near-term conflicts. The 1975 enabling legislation, which established study status for the Dolores, excluded those segments of the river needed for construction of the Dolores and Paradox Valley Projects, and the Dolores study team considered the Dolores Project as being "in place" during its evaluation of the corridor located below the McPhee Dam site (U.S. Forest Service and U.S. Bur. Outdoor Recreation, 1976a, p. 2). The long-term impact of designation on development opportunities cannot be adequately assessed from the available data base. As of 1976, there were no conditional storage rights and only five conditional direct-flow rights totaling 6.47 cubic feet per second located within the eligible corridor itself (U.S. Forest Service and U.S. Bur. Outdoor Recreation, 1976b, App. Table A-2). However, numerous conditional rights exist in upstream and tributary watersheds, and these might be affected by designation. Conversely, some river flows may have to be released to protect Colorado squawfish habitat in the reach of the Colorado Mainstem below its confluence with the

Dolores (U.S. Fish and Wildlife Service, 1980b). Such releases might also suffice for wild and scenic river purposes.

Judging from the general lack of active support given to date by Colorado's Congressional delegation, especially by Congressman Ray Kogovsek, who represents the district containing all but one of the rivers, it appears that few if any of the study rivers will ever be added to the national preservation system. Reluctance to sponsor wild and scenic rivers legislation can probably be explained by the strong political support for water development in Colorado, the general antagonism toward federal control of water resources in the state, and the highly protective stipulations that would apply if the rivers were designated.

Under Section 7(a) of the Wild and Scenic Rivers Act, the Federal Energy Regulatory Commission is prohibited from licensing any construction works on or directly affecting designated corridors, no federal department or agency can assist construction projects that would have a direct and adverse effect on the values for which the corridors are designated, and no federal assistance can be extended to upstream, downstream, or tributary projects that would invade the corridors or unreasonably diminish their ecological values. These restrictions could interfere with final water rights perfected under state law by increasing the costs of maintaining existing water structures or by preventing changes in the water decrees. More importantly, conditional water rights and new appropriation filings would be jeopardized if the exercising of such rights creates harmful effects. Designation would automatically convey a reserved water right to the federal management agency, with the appropriation date being the date of Congressional action in designating the river.

The restrictive character of Section 7(a) could be alleviated in some cases by excluding a specific project in the enabling legislation. This was done, for example, under the Wilderness Act in creating the Hunter-Fryingpan and Holy Cross Wilderness areas. Similar Congressional exemptions could undoubtedly be made under the Wild and Scenic Rivers Act. Perusal of the summaries in Table 28 reveal that most exemptions would be needed only for project development in upstream or tributary areas, not within the corridor boundaries themselves.

The only other means of striking some kind of balance between river development and protection would be to create a state-administered preservation system. At least 23 of the 50 states have adopted some form of protective legislation for rivers located within their boundaries (Alling and Ditton, 1979). The practicality of this approach in Colorado would clearly require federal cooperation, since most of the lands bordering the eligible river segments are federally owned, and would probably also require amending that portion of the State Constitution which establishes the basic tenets of state water law. The likelihood of creating a meaningful state-administered river preservation system in Colorado appears remote, but is nonetheless worthy of further investigation.

Endangered Species Act

The Endangered Species Act directs all federal departments and agencies to conserve those species of fish, wildlife, or plant which are in danger of extinction throughout all or a significant portion of their range (endangered species) and those species which are likely to become endangered within the foreseeable future (threatened species). Fifteen such species are currently listed for Colorado (Table 1). The black-footed ferret and Eskimo curlew have not been positively identified in the state for many years. The Arctic

peregrine falcon occurs only as an occasional migrant and is therefore unlikely to affect project development. The bonytail chub appears to have been extinguished from Colorado and most other downstream areas that would be affected by project development in the state. The American peregrine falcon, bald eagle, greenback cutthroat trout, and the five species of endangered plants could affect local development opportunities, but no major constraints have been identified in this study.

By far the most serious constraints to project development will be those imposed by the Colorado squawfish, humpback chub, and whooping crane. Further depletions of streamflow in either the North Platte or South Platte Rivers would adversely affect the critical habitat of the whooping crane in central Nebraska if such depletions occur during the periods February 1-May 10 or September 16-November 15 (Fig. 3, Table 8). Accordingly, new developments will be given nongeopardy biological opinions only if they can meet the required flow regime, either by providing storage releases or replacement waters, or if they can offset the adverse effects of small depletions by funding habitat manipulation or acquisition of additional habitat lands. Enforcement of these limitations could preclude full development of Colorado's remaining compact entitlement to South Platte River flows, assuming that such development would otherwise be feasible. Early development of South Platte water should be pursued by metropolitan Denver and other Front Range cities in order to enhance the prospects of receiving a nonjeopardy opinion.

Approval of project developments affecting the endangered Colorado River fishes have already been made contingent upon project operators implementing or funding one or more conservation measures, namely: (1) bypassing of minimum flows or blending of water temperature releases, (2) determining the feasibility of fish passage around or through the dams, (3) research and

monitoring of fish populations and habitat preferences, (4) habitat manipulation by gravel placement, creation of still-water areas, or other means, (5) establishing a fish culture and stocking program, and (6) establishing reservoir fisheries that do not compete with the endemic species (Table 10). Some of the recommended conservation measures are site-specific; others will become part of a comprehensive management plan currently being devised by the Fish and Wildlife Service for the entire Upper Colorado River Basin. The plan is expected to focus on conservation of the critical habitat river segments identified in Table 9 and shown in Figure 5.

Reservoir construction is likely to be flatly prohibited only in the lowermost portions of the Yampa and Colorado Mainstem Rivers. Impoundment of the Yampa River below Harding Hole would inundate the only documented spawning habitat for Colorado squawfish, and impoundment of the Colorado Mainstem below Grand Junction would flood critical habitat for either squawfish or humpback chub. Placement of reservoirs on the lower White and Gunnison Rivers will be permitted, even though construction will inundate occupied squawfish habitat. Approval of new water depletions in the Yampa, White, Colorado Mainstem, Gunnison, and Dolores River basins is likely to involve some restrictions regardless of project location. Whether cumulative water depletions may reach a critical stage at some future date, such that no new projects would be allowed, cannot be determined from the available information. In this connection, it should be emphasized that consumptive water use in the Colorado River Basin is ultimately limited by provisions of the Colorado River Compact of 1922, the Upper Colorado River Basin Compact of 1948, and, possibly, by the Mexican Treaty of 1944. Additional study is needed to determine if these downstream flow commitments can be managed so as to minimize the constraints imposed by preservation of the endangered fishes.

The cumulative effects policy of the Fish and Wildlife Service, which allows projects to proceed on a first-come-first-served basis, could place Colorado in a competitive race to develop its unused compact entitlements to South Platte and Colorado River waters. Specifically, Colorado, Utah, and Wyoming each contribute river flows that affect preservation of the endangered fishes, and Colorado, Wyoming, and Nebraska each contribute flows that affect preservation of the whooping crane. The legality of the Endangered Species Act in using federal regulatory powers to abrogate state water rights and interstate compact allocations is presently being litigated in the case of *Riverside Irrigation District v. Stipo* (Hobbs, 1982). Both the State of Colorado and various water agencies have intervened on behalf of the plaintiffs, Public Service Company and Riverside Irrigation District, who contend that the United States must obtain a state-administered water right in order to keep water in the Platte River for benefit of the whooping crane.

If the court denies the plaintiffs' suit, then Colorado should be prepared to accelerate development of those projects that can serve a demonstrated water demand. The other alternative is to request an exemption from the Endangered Species Committee on a project-by-project basis. Section 7 of the Endangered Species Act permits exemptions to be made if there are no reasonable and prudent alternatives to the proposed action, if the benefits of such action clearly outweigh the benefits of alternative courses of action consistent with conserving the species or its critical habitat, if the action is in the public interest, and if the action is of regional or national significance.

The development-preservation conflict examined in this study creates some unavoidable economic costs. Project planning costs are increased because time and personnel must be invested in complying with procedural requirements of the laws. Capital or operating costs may be increased because of construction

delays, required engineering design changes, or required changes in the spatial location of project facilities. In some cases, project development opportunities may be completely foregone. On balance, however, there is no reason to conclude that wilderness preservation has yet generated any substantial net costs to the citizens of Colorado.

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