

**ECONOMIC ANALYSIS OF
CRITICAL HABITAT DESIGNATION
IN THE COLORADO RIVER BASIN
FOR THE RAZORBACK SUCKER, HUMPBACK CHUB,
COLORADO SQUAWFISH, AND BONYTAIL**

FINAL REPORT

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Executive Summary

The Endangered Species Act (Act) provides for the designation of critical habitat necessary for the survival and recovery of endangered species. Both the administrative actions of listing a species and the designation of its critical habitat can affect economic activities dependent upon resources utilized by the species. When designating critical habitat, the Act requires that only the incremental economic impacts of the designation be determined. The incremental economic impacts of critical habitat designation for four endangered Colorado River fishes — the razorback sucker, the bonytail, the humpback chub, and the Colorado squawfish — are presented in this report.

Economic Methodology

The study region encompasses Arizona, California, Colorado, New Mexico, Nevada, Utah, and Wyoming. Economic input-output (I-O) models were constructed for each State and for the seven-State region. A computable general equilibrium (CGE) model also was developed for the seven-State region. The models are aggregated to 20 representative sectors in the economy. The time frame chosen for the study, 1995 through 2020, is the period projected for recovery of the endangered fishes.

Linkages between the biological requirements for recovering the endangered fishes and the economic activities in the region were assessed and these formed the basis for the economic analysis. The biological requirements include adjustments made in the operations of Federal reservoirs in the Basin and/or conservation actions for nonflow-related activities along the rivers' 100-year floodplain. The effects of recovery efforts on future water depletions in the basin were also taken into consideration. The impacts of these possible changes on current and prospective economic activities were then estimated for each State, the region, and the National economy.

Estimating the economic impacts of the critical habitat designations poses formidable challenges because many impacts will result from future Section 7 consultations pursuant to provisions of the Act. Such consultations between the U.S. Fish and Wildlife Service (USFWS) and other Federal agencies may identify reasonable and prudent alternatives to destruction or adverse modification of critical habitat that allow projects to proceed without significant economic impacts. The Recovery Implementation Program for Endangered Fish Species in the Upper Colorado River Basin and the San Juan Recovery Implementation Program (RIPs) have allowed some water development in the Upper Basin to proceed concurrently with efforts to recover endangered fishes. Participants in these programs intend for the RIPs also to provide reasonable and prudent alternatives to the destruction or modification of critical habitat.

It is impossible, however, to predict the outcome of all future Section 7 Consultations involving endangered fishes in the Colorado River Basin. If the RIPs do not show sufficient and timely progress in recovering endangered fishes, some planned water developments may be modified, scaled back, delayed, or foregone. This assumption provides an upper bound on the potential magnitude of economic effects associated with the critical habitat designations. If the RIPs are successful in achieving their objective, many of the negative economic impacts described in this report can be avoided.

Utilizing projected economic growth data, economic activity levels were projected for the 20 economic sectors. This assumed that no actions were taken to recover the endangered fishes and formed the "without fish" scenario. Incorporating the changes in economic activity necessary to recover the fishes led to a second set of economic projections — a "with fish" scenario. The differences between the "without fish" and "with fish" scenarios formed the net economic impacts of listing and critical habitat designation. A methodology developed by the USFWS for distinguishing between listing and critical habitat actions under the Act was applied to determine the incremental impacts of the critical habitat designation.

Regional Impacts

The incremental regional economic impacts of critical habitat designations are summarized, in part, in Table I-E-1. The data in this table illustrate the first basic conclusion that can be drawn from the study. For the Basin as a whole, regional economic impacts are clearly positive. The stream of impacts over the study period (discounted at 3 percent to yield a present value) yield a positive impact of \$129.40 million (1991\$). These results hold for earnings impacts, tax revenue impacts, and employment impacts. The present value of net earnings impacts for the basin is \$74.07 million, the value of the combined tax revenue impacts, \$23.69 million. Present value is the worth of a future stream of impacts expressed in terms of today's value.

Table I-E-1 reports the differences between the present values of the "without fish" projections and the "with fish" projections expressed as a percentage of the "without fish" projections. The difference for the total output in the Basin is 0.0003 percent (i.e., three ten thousandths of a percent). The figures for the remaining aggregate measures are similar in magnitude. Table I-E-1 also reports annualized values. The annualized value transforms a fluctuating stream of impacts into a levelized equivalent present value. For the Basin economy the annualized value of the output impact is a positive \$6.47 million (1991\$).

The State-level entries in Table I-E-1 demonstrate the second basic conclusion. The impacts of critical habitat designations are not distributed evenly over the individual States in the Basin. In fact, during the study period impacts range from a positive \$335.02 million (California) to a negative \$245.46 million (New Mexico). The reasons for these differences lie in the nature of proposed recovery efforts for the endangered fishes. Streamflow requirements and operational changes at Federal reservoirs may negatively impact recreation, electric power production, and future consumptive water uses in some geographic areas,

**Table I-E-1. State- and Regional-Level Present Value and Annualized Incremental Critical Habitat Impacts
(\$1991 millions) (3% Discount Rate)**

	Output	Earnings	Indirect Business Taxes	Personal Income Taxes
Arizona				
Present Value	-20.9980	-4.0220	-0.9060	-1.0060
% Deviation from Without Fish Scenario	-0.0008	-0.0004	-0.0006	-0.0004
Annualized Values	-1.0490	-0.2010	-0.0480	-0.0500
California				
Present Value	335.0250	57.6040	10.4160	14.4010
% Deviation from Without Fish Scenario	.0013	0.0007	0.0008	0.0007
Annualized Values	16.7510	2.8800	0.5210	0.7200
Colorado				
Present Value	-16.9700	17.0050	-2.2170	4.2510
% Deviation from Without Fish Scenario	-0.0006	0.0020	-0.0020	0.0020
Annualized Values	-0.8480	0.8500	-0.1110	0.2130
Nevada				
Present Value	140.2870	67.3890	11.6430	16.8470
% Deviation from Without Fish Scenario	0.0148	0.0164	0.0182	0.0164
Annualized Values	7.0140	3.3690	0.5820	0.8420
New Mexico				
Present Value	-245.4600	-30.2110	-11.7100	-7.5530
% Deviation from Without Fish Scenario	-0.0279	-0.0110	-0.0204	-0.0110
Annualized Values	-12.2730	-1.5110	-0.5860	-0.3780
Utah				
Present Value	-72.5530	-14.3660	-5.6180	-3.5920
% Deviation from Without Fish Scenario	-0.0060	-0.0039	-0.0090	-0.0040
Annualized Values	-3.6280	-0.7180	-0.2810	-0.1800
Wyoming				
Present Value	-7.1720	-0.9510	-0.4670	-0.2380
% Deviation from Without Fish Scenario	-0.0020	-0.0008	-0.0020	-0.0008
Annualized Values	-0.3590	-0.0480	-0.0230	-0.0120
Colorado River Basin				
Present Value	129.4040	74.0710	2.7160	20.9730
% Deviation from Without Fish Scenario	0.0003	0.0006	0.0002	0.0006
Annualized Values	6.4700	3.7040	0.1360	1.0490

while these same recovery efforts may enhance economic activity in other locations . This phenomenon is particularly notable for California, which diverts water from the Colorado River at the lower end of critical habitat reaches. Increased water availability in the Lower Basin reaches of the river due to upstream recovery efforts may significantly benefit that State's economy.

State-level percentage differences in output range from a negative 0.028 percent in New Mexico to a positive 0.0013 percent in California. The annualized values of the differences range from a negative \$12.27 million (New Mexico) to a positive \$16.75 million (California).

Table I-E-2 presents State- and regional-level incremental impacts on employment over the period of the study. The values in the table represent the deviation in employment, measured as jobs, between the "without fish" and "with fish" scenarios. As discussed above, employment impacts vary from positive to negative among States and over time. For New Mexico, the employment impact is approximately 2 jobs foregone in 1995 and this rises to 613 jobs foregone by the year 2020. That is, there are projected to be 2 fewer jobs in 1995 than there would be without endangered fishes actions. On the other hand, California gains approximately 20 jobs in 1995 and 1,162 jobs by 2020. For the Basin as a whole, the employment impacts are positive through the study period. In 1995, the projected gain is approximately 60 jobs and by 2020 the gain is 393 jobs.

	1995	2000	2005	2010	2015	2020
Arizona	-1.85	-4.68	-7.77	-12.08	-18.86	-25.83
California	19.99	92.57	258.48	475.86	781.18	1161.93
Colorado	8.91	5.16	-6.93	-19.69	-36.86	-55.60
Nevada	34.86	71.52	108.03	143.22	177.25	208.69
New Mexico	-2.17	-27.98	-110.71	-239.60	-415.21	-612.64
Utah	-10.91	-22.30	-34.56	-47.71	-61.06	-74.13
Wyoming	-0.40	-1.40	-2.41	-3.45	-4.35	-5.22
Colorado River Basin	59.94	116.15	178.70	230.02	294.76	392.67

National Efficiency Impacts

A general equilibrium analysis, which is capable of capturing the interactions across the various sectors that make up the economy, is used to evaluate national efficiency impacts. The CGE model takes explicit account of the exchanges between the region and the remainder of the country and world and so reports national economic effects.

Table I-E-3 reports the "without fish" results in terms of the levels of activity. Thus, under Scenario A1, there would be a \$7.92 million dollar (1991\$) expansion in the national economy projected on the basis of the 1982 levels of economic activity. Similarly, there would be an increase in employment of 710 jobs and increases in earnings and government revenues.

Table I-E-3. Colorado River Basin — National Economic Impacts: Levels and Differences (\$1991 in Millions) (Employment in Jobs)

Variable	Without Fish	With Fish Scenario A1	Without Fish vs Scenario A1 With Fish
Real Gross Regional Product	593645.38	593653.43	7.92
Employment	15029220.00	1502930.00	710.00
Earnings	354200.23	354206.85	6.62
Gov't Revenue	203822.01	203825.21	3.20

Scenario A1: There exists sufficient underutilized capacity in the construction and capital equipment sectors (within the Basin or elsewhere in the national economy) that all additions to thermal electric capacity are a net positive addition to the level of national economic activity. The recreation resources within the Basin are unique and the loss of these recreation opportunities cannot be replaced within the U.S. economy.

If it can be assumed that the adjustments to the national economy represented by the CGE results are permanent, then the present value and annualized values reporting the national economic impacts can be estimated for the study period. Table I-E-4 presents these estimates. For output, the discounted present value (3 percent) is \$141.58 million (1991\$).

Based upon the characteristics of the Basin and the nature of the regional economies, the annualized value of \$7.08 million (1991\$) reported in I-E-4 represents the national efficiency impacts of critical habitat.

Table I-E-4. National Efficiency (CGE): Present and Annualized Values

		Annualized Value (1982 \$ millions)				Present Value (1982 \$ millions)			
		0%	3%	5%	10%	0	0.03	0.05	0.1
Scenario A1	Real Gross Regional Product	7.92	7.08	7.29	7.69	205.92	141.58	113.85	72.55
	Earnings	6.62	5.92	6.09	6.43	172.13	118.35	95.17	60.65
	Gov't Rev.	3.20	2.86	2.94	3.11	83.20	57.21	46.00	36.67

Conclusion

The regional impacts depicted in I-6-7 provide three conclusions. First, regional economic and national efficiency impacts are clearly positive. Second, the State-level impacts are not distributed evenly over the individual States in the Basin. Finally, the percent deviation from the "without fish" scenario is small.

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Section 1: Introduction

This analysis presents the economic impacts of designating critical habitat for four Colorado River endangered fishes: razorback sucker, Colorado squawfish, humpback chub, and bonytail. The specifics of this economic analysis — the methods, procedures, and tools used to determine the economic impacts — can be found in Brookshire et al. (1993).

The Endangered Species Act (Act) provides a means to conserve the ecosystems upon which endangered and threatened species depend and a program to provide for the conservation of listed species. The Act provides for the designation of critical habitat necessary for survival and recovery of endangered species. The designation of critical habitat may impact sectors of the economy that depend upon resources re-allocated to these endangered species. Therefore, the Act requires that the economic and other relevant impacts of critical habitat designations be determined.

The process for designating critical habitat for the four endangered fishes consists of three major steps. The first step was to complete a biologically based determination of potential critical habitat areas. This step yielded an inventory of areas that are needed for the survival and recovery of the species. The second step in this process was to determine the potential economic impacts of the critical habitat designation. The final step was to decide which critical habitat areas, if any, should be excluded from designation based on economic or

other relevant impacts, and to determine costs and benefits associated with the final designation.

Proper development of the links between the biology and the economics of the Colorado River Basin (Basin) area is critical to the evaluation of the economic impacts of critical habitat designation. Only if these links are clearly delineated can a dollar value on the impacts of designating critical habitat be determined. Bridging the gap between the biological dimensions of this study and the economic dimensions was a complex process. To properly estimate the impacts of critical habitat designation it was necessary to estimate the combined economic effects of listing and designating critical habitat. The economic effects of critical habitat designation are the incremental effects above and beyond those which may be attributed to listing the species. Thus, economic effects of the critical habitat designation are those that remain after the listing effects have been subtracted from the total effects. Chapter II-14 of Brookshire et al. (1993) presents the methodology for determining the incremental critical habitat impacts.

The economic team's efforts were directed along three principal lines. First, the economics team worked with the U.S. Fish and Wildlife Service's (USFWS) critical habitat team to identify the management practices that may need to be altered in order to ensure the recovery of these fishes. Second, the economics team identified the sectors of the economy that would be impacted based upon the potential alteration of these management practices. These include the agricultural, hydroelectric, mining/gas/oil, recreation, municipal, and industrial sectors. Finally, the economic team developed a series of models to perform the analysis of the economic impacts due to the critical habitat designation.

The economic modeling analyses involved a three-stage approach. First, an input-output (I-O) model was developed for each of the seven States in the study region: Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming. Second, an input-output model was developed for the entire Basin. Third, a computable general equilibrium (CGE) model was developed for the study region. This staged approach allowed the economics

team to determine State, regional and the national effects of critical habitat designation for the period 1995 to 2020. For each model stage, a present and future economic projection without the impacts of species listing and designating critical habitat ("without fish" scenario) was contrasted with a present and future economic projection with the designation of critical habitat ("with fish" scenario). A detailed discussion of the I-O and the CGE modeling approaches can be found in Chapter II-7 of Brookshire et al. (1993).

This analysis presents the economic impacts of the designation of critical habitat as required by the Act. These impacts are incremental impacts over and above those associated with species listing. Section 2 of this analysis presents information on critical habitat in general, species listing history, and critical habitat designation for these four endangered fishes. Section 3 discusses the physical and economic settings of the Basin. An overview of the economic modeling framework is found in Section 4. Section 5 discusses the biological and economic dimensions of the study. This discussion provides the connection between the biological requirements of the fishes and associated economies. The State- and regional-level incremental impacts of critical habitat designation are in Section 6 and Section 7 presents the national economic efficiency impacts.

Section 2: Critical Habitat, Species Listing and the Designation

A. Critical Habitat

The Act provides a means to conserve the ecosystems upon which endangered and threatened species depend. Conservation activities provided to species listed as endangered or threatened under the Act include recognition, recovery actions, Federal protection, and prohibitions against certain specified practices. In some of these cases, current uses of the resources must be altered, and future planned uses must be either changed or curtailed.

Designation of critical habitat is primarily intended to identify the habitat that may be needed for survival and recovery. The designation of critical habitat in an area aids in protection of that area from habitat-threatening activities. Through Section 7 of the Act, designation of critical habitat also may provide a regulatory mechanism for protection in key areas outside those currently occupied by the species.

Section 7(a)(2) of the Act requires Federal agencies to ensure that activities they authorize, fund, or carry out are not likely to destroy or adversely modify critical habitat. This Federal responsibility accompanies the requirement in Section 7(a)(2) of the Act and specifies that Federal agencies must ensure their actions do not jeopardize the continued existence of listed species. Jeopardy is defined as any action that would reduce appreciably the likelihood of both the survival and the recovery of the species. Destruction or adverse modification of critical habitat is defined as any direct or indirect alteration that appreciably diminishes the value of critical habitat for both the survival and the recovery of the species.

Destruction or adverse modification of critical habitat is defined in 50 CFR 402.02 as a direct or indirect alteration that appreciably diminishes the value of critical habitat for both the survival and recovery of a listed species. The regulations also state that such alterations

include, but are not limited to, alterations adversely modifying any of those physical or biological features that were the basis for determining the habitat to be critical.

B. Listing History and Habitat Designations

1. Listing History

The Colorado squawfish and humpback chub were listed as endangered species on March 11, 1967 (32 FR 4001). The bonytail was listed as endangered on April 23, 1980 (45 FR 27713). On May 16, 1975, USFWS published a notice of its intent to determine critical habitat for the Colorado squawfish, humpback chub, and numerous other species (40 FR 21499). On September 14, 1978, USFWS proposed critical habitat for the Colorado squawfish (43 FR 41060). The proposed area included 623 miles of the Colorado, Green, Gunnison, and Yampa rivers. This proposal was later withdrawn (44 FR 12382; March 6, 1979) to comply with 1978 amendments to the Act (16 U.S.C. 1531 et seq.), that required USFWS to include critical habitat in the listing of most species and to complete the listing process within 2 years from the date of the proposed rule or to withdraw the proposal from further consideration. USFWS did not complete the listing process within the 2-year deadline. The razorback sucker was proposed for listing as a threatened species on April 24, 1978 (43 FR 17375). The proposal was withdrawn on May 27, 1980 (45 FR 35410) in accordance with 1978 amendments to the Act that require a determination of critical habitat in the listing of most species. The razorback sucker was listed as endangered in 1991 (56 FR 54957). Critical habitat for all four endangered species was proposed on January 29, 1993 (58 FR 6578).

2. Historical and Current Habitat

a. Razorback Sucker

The razorback sucker is part of a unique fish fauna endemic to the Colorado River Basin. Historical riverine systems provided a wide variety of habitats that razorback suckers occupied, including backwaters, sloughs, and oxbow lakes. The razorback sucker was once abundant throughout the 3,500 miles of the Colorado River Basin, primarily in the mainstem of the Colorado River and its major tributaries in Arizona, California, Colorado, Nevada,

New Mexico, Utah, Wyoming, and in the states of Baja California Norte and the Sonora of Mexico.

USFWS is designating 15 reaches of the Colorado River system (Figure I-2-1) as critical habitat for the razorback sucker. In the Upper Basin, critical habitat designation includes areas of the Green, Yampa, Duchesne, Colorado, White, Gunnison, and San Juan rivers. Portions of the Colorado, Gila, Salt, and Verde rivers are being designated in the Lower Basin. Of the historical range of the razorback sucker, 49 percent is being designated as critical habitat. This area encompasses the major basins of the historical range.

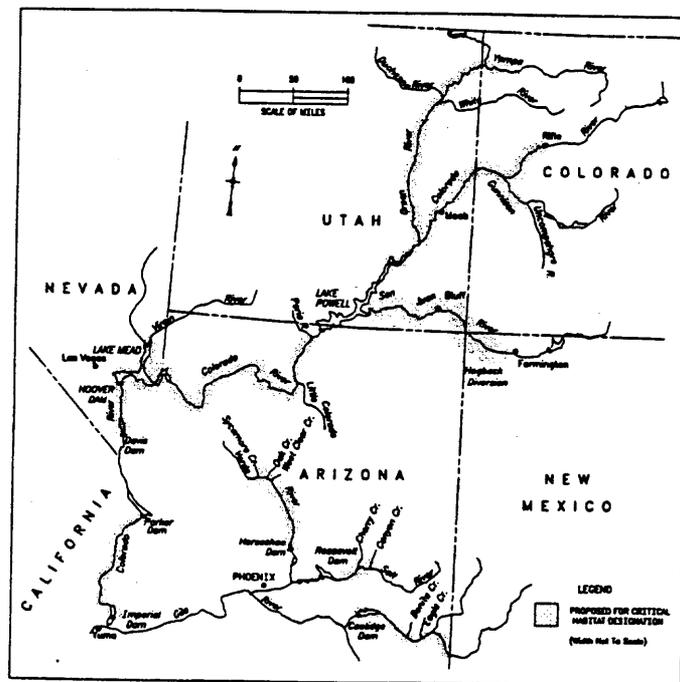


Figure I-2-1. Map of Critical Habitat for the Razorback Sucker.

b. Colorado Squawfish

The Colorado squawfish is the largest in size of the four existing species. Fossils of the mid-Pliocene epoch (about 6 million years ago) indicate that the genus had adopted riverine forms that are similar to modern forms. Historically the Colorado squawfish occurred throughout the Colorado River Basin.

USFWS is designating 6 reaches of the Colorado River system (Figure I-2-2) as critical habitat for the Colorado squawfish. In the Upper Basin, critical habitat includes areas of the Green, Yampa, Colorado, White, Gunnison, and San Juan rivers. Of the historical range of the Colorado squawfish, 29 percent is being designated as critical habitat.

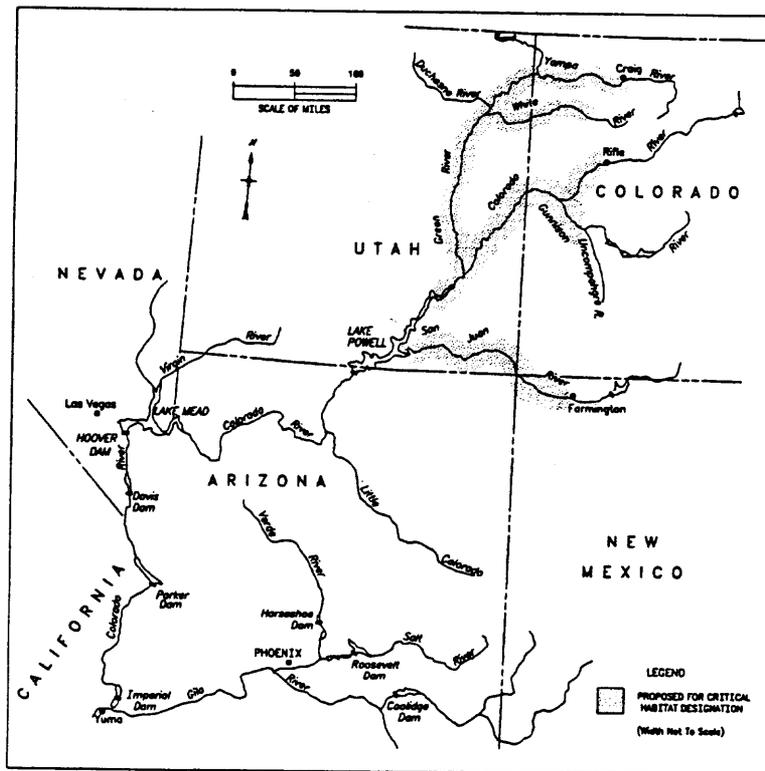


Figure I-2-2. Map of Critical Habitat for the Colorado Squawfish.

c. Humpback Chub

Historically the humpback chub occupied portions of the mainstem Colorado River and at least four of its tributaries: the Green, the Yampa, the White, and the Little Colorado. However, the extent of its original distribution throughout the Colorado River Basin is not known with certainty. A considerable number of alterations were made to the Colorado River system before the 1940s, especially in the Lower Basin, and humpback chub may have disappeared from some river reaches before their existence was documented.

USFWS is designating 7 reaches of the Colorado River system (Figure I-2-3) as critical habitat for the humpback chub. In the Upper Basin, critical habitat includes portions of the Green, Yampa, and Colorado rivers. Portions of the Colorado and Little Colorado rivers are being designated in the Lower Basin. Of the historical range of humpback chub, 28 percent is being designated as critical habitat.

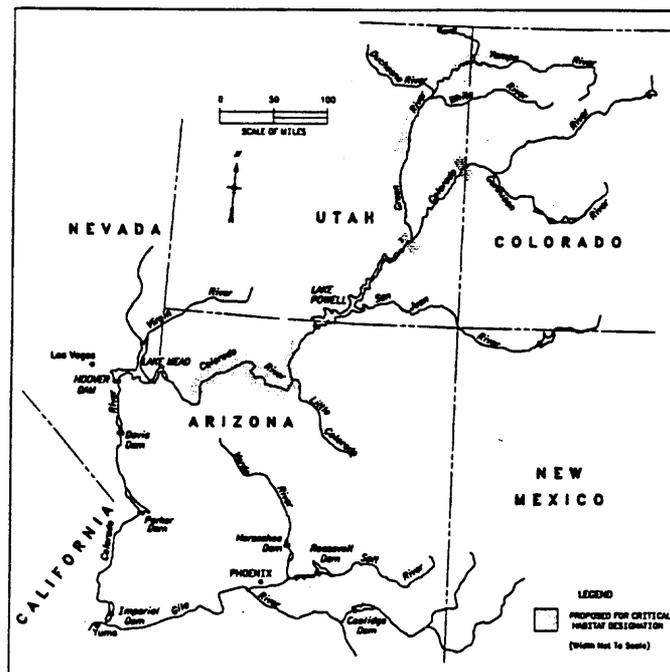


Figure I-2-3. Map of Critical Habitat for the Humpback Chub.

d. Bonytail

The bonytail is the rarest native fish in the Colorado River. Formerly reported as widespread and abundant in mainstem rivers, its populations have been greatly reduced. Of this once abundant species, only a small number of old adult fish (i.e., ages 40 years or more) still exist in Lake Mohave, perhaps other Lower Basin reservoirs, and rarely Upper Basin rivers. The fishes were once common in Lake Mohave.

USFWS is designating 7 reaches of the Colorado River system (Figure I-2-4) as critical habitat for the bonytail. In the Upper Basin, critical habitat includes portions of the Green, Yampa, and Colorado rivers. Portions of the Colorado River in the Lower Basin also is being designated as critical habitat. Of the historical range of bonytail, 14 percent is being designated as critical habitat.

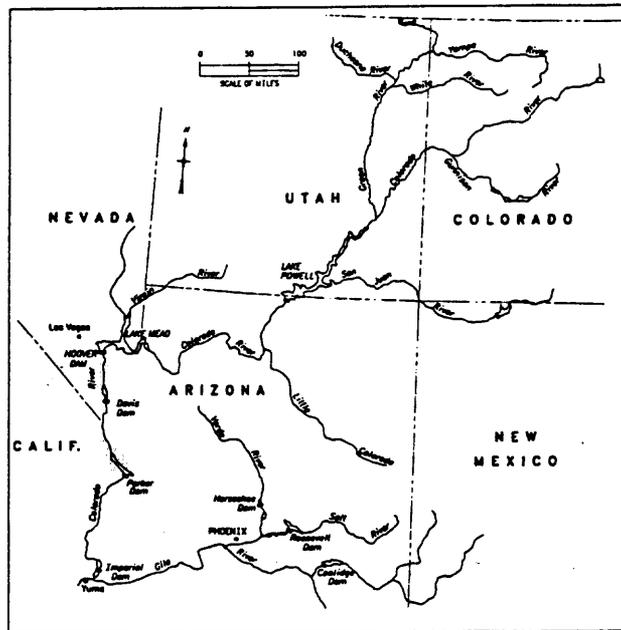


Figure I-2-4. Map of Critical Habitat for the Bonytail.

Section 3: Physical and Economic Settings

A. Physical Setting

The headwaters of the Basin originate in the Rocky, Wasatch, and San Juan mountains of Colorado, Wyoming, Utah, and New Mexico. The Basin drains approximately 242,000 square miles of land in the United States and about 2,000 square miles of land in Mexico. The portion of the Basin that resides in the United States encompasses parts of the States of Arizona, California, Colorado, Utah, Nevada, New Mexico, and Wyoming. To facilitate management of water resources, the Basin was divided into Upper and Lower basins (Figure I-3-1) by agreement between the seven Basin States in the 1922 Colorado River Compact. The Upper Basin begins at the headwaters of the Colorado Basin, and ends just below Lee's Ferry, Arizona (16 miles below Glen Canyon Dam). Major drainages in the Upper Basin include the Upper Colorado, Green, Gunnison, and San Juan rivers. The Lower Basin begins at Lee's Ferry, Arizona, and ends at the United States/Mexico border. Major drainages in the Lower Basin include the Lower Colorado, Little Colorado, Virgin, and Gila rivers. The Gila River drainage also includes the Salt and Verde river drainages.

The size and diversity of the Basin encouraged the development of a variety of fishes. Changes in drainage structure due to geological factors also contributed to the creation of new, isolated fish species that added to the diversity of the Basin. The riparian and wetland areas along the streams and rivers provided habitat for invertebrates, amphibians, reptiles, birds, and mammals. The riparian forests and wetland vegetation provided forage and resting areas for migratory waterfowl and songbirds.

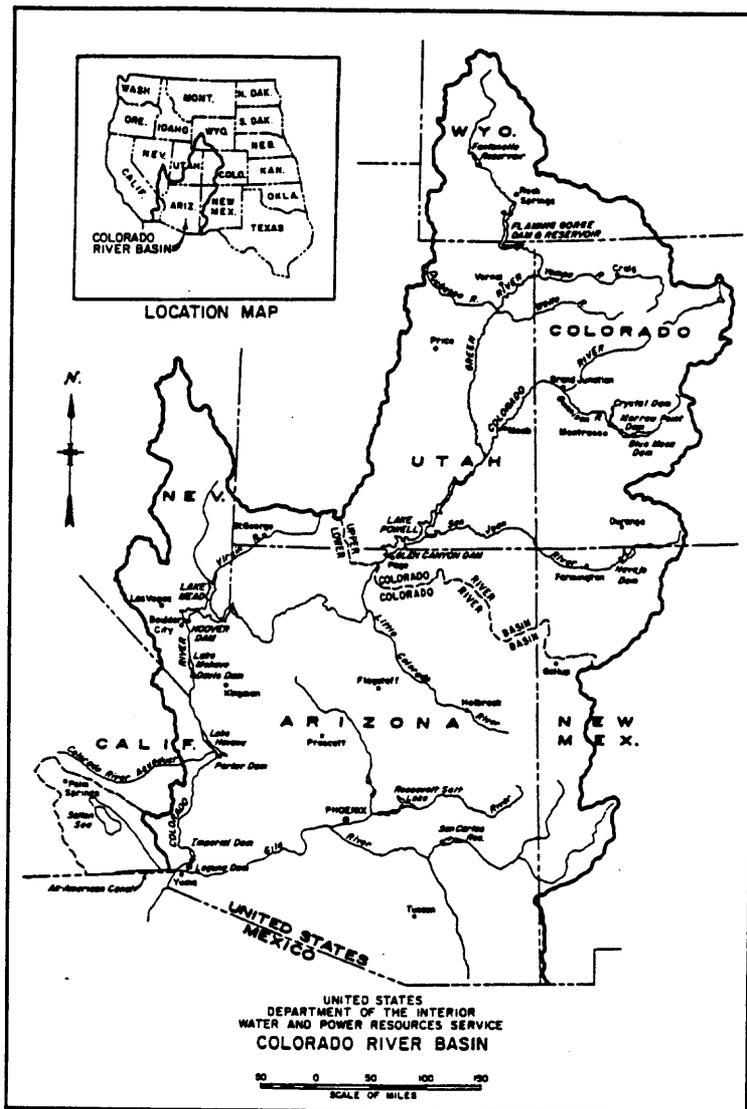


Figure I-3-1. Map of Colorado River Basin.

Of the 36 fish species native to the Basin, 64 percent were not found in other river basins in North America. Historically, only eight fish species in the larger rivers were common to both the Upper and Lower Basin. Of these, four are currently listed as endangered and two others may soon be listed. The large geographical diversity of the Basin also supports a variety of habitats. The biodiversity of the Basin in the past in relation to its current diversity is central to the designation of critical habitat.

B. Physical Factors and Activities in the Determination of the Without Fish Scenario for the Colorado River Basin

Over the last century, the physical characteristics of the Basin have been altered significantly. Historically, barriers to the migration of endangered fishes in the Basin were predominately natural rapids and swift, turbulent waters. While these natural barriers may have impeded the migration of fishes, they were not absolute obstructions. The 1902 Reclamation Act led to major dam development in the Lower Basin. These dams and diversions have fragmented the river systems and obstructed the fishes' ability to migrate. Since 1905, 46 dams have been constructed in the Colorado River Basin. As a result, the physical characteristics of Basin habitats have been altered significantly. These dams have diverted water from the Colorado River system to agricultural, municipal, and industrial uses. Flow regimes have been altered, resulting in changes in water temperature and sediment loading.¹

Coupled with the development of diversions and dams has been the increase in water consumption. Developed, irrigated land in the Basin is now in excess of 2.1 million acres. Table I-3-1 provides estimates of the water consumed for irrigation and other uses. These uses have depleted river flows thus changing the nature of the Basin.

Coupled with the physical changes in the river system, the uses of the river and the impacts of activities occurring along the river have increased significantly over the years. The growth of agriculture over the past 50 years has been phenomenal. Not only has this growth affected the river through water depletion, but also has affected the river in other ways. For instance, contaminant releases from agricultural, loss of flooded bottom lands, and municipal and industrial activities have affected the overall water quality of the river. Furthermore, facilities sited along the river, such as recreation campgrounds, have affected habitat as have industries that develop oil and gas resources.

¹A significant amount of detail is provided in the Draft Biological Support Document regarding the physical changes in the river.

Table I-3-1. Average Water Consumption for the Colorado River 1976-1985

MAJOR ACTIVITY	UPPER BASIN ACRE-FEET (percent)	LOWER BASIN ACRE-FEET (percent)	TOTAL ACRE-FEET (percent)
Irrigation	2,146,530 (56.2)	5,140,430 (44.83)	7,286,960 (47.68)
Transbasin Exports	697,680 (18.27)	4,150,780 (36.20)	4,848,460 (31.72)
Reservoir Evaporation	784,690 (20.55)	1,467,590 (12.8)	2,252,280 (14.73)
Municipal Industrial	190,080 (4.98)	706,340 (6.16)	896,420 (5.86)
Totals	3,818,980 (24.98)	11,465,140 (75.02)	15,284,120 (100)

Source: U.S. Bureau of Reclamation Consumptive Uses and Losses Report.

C. Linking the Biological Dimensions to the Economics

An essential feature of the analysis presented in this report is the linking of the biological and physical requirements of the river system to the economic impacts that result from the protection and recovery of the endangered fishes. The changes in the activities affecting the Colorado River that are needed to recover the fishes must first be expressed in biological and physical terms and then ultimately translated into economic terms. The "with fish" and "without fish" scenarios begin with the premise that the changes in the physical nature of the river and the changes in the economic activities in the area of the river have led to the present circumstance of the endangered fishes. These "with fish" and "without fish" scenarios must be constructed taking into account the fact that recovery of the species will involve a significant period of time.

A complete analysis of the potential impacts of actions taken on behalf of the endangered fishes requires comparing the time path of the economy in the "without fish" scenario and that of the "with fish" scenario. The "without fish" scenario is constructed on the basis that

the river system will be managed without regard to the needs of the endangered fishes. This economic scenario consists of a set of projections of the current and future economic activities, without regards to the needs of the endangered fishes. The "with fish" scenario is constructed on the basis that the river is to be managed to foster recovery of the endangered fishes through species listing and designation of critical habitat. The economic activities that might be altered to enhance the recovery of the endangered fishes must be identified. Thus, the "with fish" scenario consists of a set of economic projections that reflect the activity changes that may be required to recover these fishes. The economic projection of the "without fish" scenario takes into account the levels of economic activity that would occur in the region if no listing and/or critical habitat actions were undertaken. This projection covers the period 1995 through the year 2020 and forms the benchmark for comparing the net economic impacts associated with the species listing and designation of critical habitat. This period was chosen because the biological projections concerning the endangered fishes indicated that recovery may take years.

D. Economic Setting

1. Economic Output

Economic output measures the values of all goods and services produced and/or consumed in a regional economy. The region consisting of seven States, generates approximately \$1.3 trillion in economic output annually. This output is dominated by the combined manufacturing sector and the finance, insurance, and real estate sector, which produce 18.4 percent and 14.9 percent of total output, respectively. The petroleum and gas production sector generates 2.4 percent of the total output, while the recreation services sector produces 7.7 percent of the total output. The electric power production sector comprises about 1.5 percent of the total output. The combined agricultural sectors are responsible for 3.0 percent of the total output, of which the livestock feed sector produces 0.33 percent of total regional output and the other crops sector produces 0.95 percent of the output.

2. Employment

Approximately 22.0 million people are employed in the Basin economy. The largest single employment sector is the public sector (includes all levels of government), which accounts for 16.9 percent of total employment. The combined manufacturing sector is only slightly behind the public sector, with 15.4 percent of total employment within the Colorado River Basin States. The recreation services sector is also a very significant part of total employment at 10.5 percent. The electric power production sector is around 0.5 percent of the total employment. Combined agricultural employment is approximately 4.3 percent of total employment (the livestock feed sector is 0.19 percent of employment, and the other crops sector is approximately 0.17 percent of employment). The petroleum and gas production sector accounts for about 0.2 percent of total employment.

3. Historical Development of the Basin

The rapid urbanization of the Basin has had a significant effect on the endangered fishes. This is reflected in the fraction of the population living in urban areas in 1990 as compared with this fraction in 1950. With the exception of California, this fraction was in the 50-65 percent range in 1950 and is now in the 65-90 percent range.

Section 4: The Economic Modeling Framework

A. Overview

Two types of economic effects are of interest when considering the economic impacts of critical habitat designations: regional economic impacts and national economic efficiency impacts. Regional economic impacts refer to the impact of the critical habitat designations on specific geographic regions, such as States or other sub-regions of the country.

Frequently, regional economic impacts effect a transfer of resources from one region to another. For example, if one State in the Basin increases its consumptive use of Colorado River water, another State may have to forego some of its use of Colorado River water. Thus, a positive regional impact to one State can be a negative impact to another, and vice versa.

Regional economic impacts in this study were analyzed using input-output models which organize the basic accounting relationships that describe the production sector of the economy. The input-output method starts with the assumption that all sectors of the economy are tied together by virtue of economic relations called linkages, and the production of a good or service can be described by a recipe whose ingredients are the outputs of the other sectors of the economy. The primary inputs are labor, capital, and other raw resources. Through its multiplier analysis, the input-output model is capable of generating estimates of the changes in output for sectors, changes in employment, and changes in income due to species listing and critical habitat designation. The models report the total impacts that result from the interactions among the sectors of the economy.

The computable general equilibrium model analyzes resource reallocations (e.g., changes in river flows as represented by increased or decreased hydroelectric generation) in a manner such that the net effects, not just the total effects, are calculated. Given this capability, the CGE is able to estimate net national efficiency impacts at the national level.

National economic efficiency effects refer to the overall net effects on the national economy after the effects of interregional transfers have been accounted for. The goal of a national efficiency analysis is to determine whether a proposed action would have an overall positive or negative impact on the national economy. National economic efficiency impacts were analyzed in this study using a computable general equilibrium (CGE) model. The model captures the economic interactions of consumers, the production sectors, and the government sectors.

B. The Modeling Approach

A set of input-output (I-O) models was developed as part of a staged investigation, where each was stage developed to address a particular issue. During the initial stage, a separate I-O model was developed for each of the States in the affected region: Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming. These models focused on the impacts that are generated by species listing and critical habitat designation within each individual State.

In most cases, impacts in a given State generated impacts in neighboring States. Thus, it was necessary to investigate potential offsetting impacts. As a result, a second model was constructed which investigated the impacts of the entire region (all seven States included). The first two model stages provide estimates of the State and regional-level economic impacts.

The third stage involved the development of a CGE model for the economies of the seven-State area and the rest of the U.S. This model provides a comprehensive aggregate assessment of the national economic efficiency impacts.

C. Without Fish and With Fish Scenarios

1. Without Fish Scenario

The "without fish" economic scenario analyzed in this study consists of projections, over the study period, of the level of economic activities that would be observed if no action were

taken to recover the endangered fishes. The study period of analysis chosen to reflect the recovery projections for the endangered fishes was 1995 through 2020. Economic activity under the "without fish" scenario was estimated using Impact Analysis for Planning (IMPLAN) 1982 data sets updated (to 1989) and then projected through the year 2020 using data from the Bureau of Economic Analysis of the U.S. Department of Commerce. These economic projections formed the "without fish" scenario for determining the impacts due to critical habitat.

2. With Fish Scenario

The "with fish" scenario was constructed by analyzing potential changes in economic activity that may occur due to listing and critical habitat designations and/or other protection and recovery efforts for endangered fishes. These potential changes were projected for specified intervals over the entire study period.

D. Aggregation of Producing Sectors

The IMPLAN input-output data base that serves as a foundation for both the input-output models and the CGE model is composed of 528 producing sectors. For the analyses, this number was reduced by aggregating like sectors. Several considerations affected the level of sectoral aggregation.

The type of analysis is one factor in the determination of the appropriate level of aggregation and the manner in which the aggregation is performed. In general, it is desirable to aggregate those sectors that are not of direct interest to this study. This results in a level of detail that can be managed. Conversely, those sectors that are of interest to the task at hand must be kept separate. Thus, the aggregation scheme adopted for this analysis retains several agriculture sectors, the recreation sector, the electric power sector, and some key mining sectors.

For each stage of the input-output modeling process, 20 economic sectors, aggregated from the original 528, were modeled using the IMPLAN data sets. The 20 sectors are reported in Table I-4-1.

Sector	Industry
1	Livestock
2	Other Crops
3	Livestock Feed
4	Other Agriculture
5	Non-petroleum Mining
6	Petroleum and Natural Gas Mining
7	Construction
8	Combined Manufacturing
9	Food Products
10	Wood Products
11	Petroleum and Coal Products
12	Transportation, Communication, and Utilities
13	Recreational Services
14	Electric Power
15	Wholesale and Retail Trade
16	Finance, Insurance, and Real Estate
17	Household and Business Services
18	Local Amusements
19	Health, Education, and Social Services
20	Government Industries

This aggregation permits investigation of changes in the economic activity of the sectors in the study due to designation of critical habitat. For the CGE model, sectors 19 and 20 in Table I-4-1 were combined into a single sector.

Section 5: Approaches to Economic Activity Changes From the Without Scenario

A. Recovery Implementation Programs and Section 7 Activities

Estimating the economic impacts of the critical habitat designations for endangered fishes poses formidable challenges because many impacts will result, not from current activities but, from future activities set in motion by Section 7 Consultations. Consultation with the USFWS under Section 7 of the Endangered Species Act is initiated when a Federal agency determines that an activity they will authorize, fund, or carry out may affect a listed species or its critical habitat. USFWS then issues a biological opinion finding that the action either is or is not likely to jeopardize the continued existence of the listed species or to destroy or adversely modify its critical habitat. If the USFWS determines that the action is likely to jeopardize the continued existence of the listed species, or to destroy or adversely modify its critical habitat, it develops reasonable and prudent alternatives that would avoid a jeopardy, or adverse modification situation, if such alternatives are available.

The RIPs currently serve as the reasonable and prudent alternatives to jeopardy in the Upper Basin. These have allowed some water development to proceed concurrently with efforts to recover endangered fishes. The Upper Basin RIP is a cooperative effort to recover the endangered fishes in the Upper Basin while providing for water development to proceed in a manner compatible with applicable State and Federal laws. The Recovery Program was implemented in January 1988 by a Cooperative Agreement signed by the Governors of Colorado, Utah, and Wyoming, the Secretary of the Interior, and the Administrator of the Western Area Power Administration.

The San Juan RIP was initiated in the biological opinion issued by the USFWS on the Animas-LaPlata project in Colorado. On October 24, 1991, a Memorandum of Understanding was executed by the USFWS, the Bureau of Reclamation, the Bureau of Indian Affairs, the States of Colorado and New Mexico, the Ute Mountain Indian Tribe, the

Southern Ute Indian Tribe, and the Jicarilla Apache Indian Tribe to set forth certain agreements and to establish a San Juan Recovery Implementation Program (SJRIP). The SJRIP provides the basis for the recovery of the endangered fishes of the San Juan River.

Participants hope these implementation programs will provide reasonable and prudent alternatives to the destruction or adverse modification of critical habitat by future water developments. It is impossible, however, to predict the outcome of all future Section 7 Consultations involving endangered fishes in the Colorado River Basin. If the Upper Basin and San Juan RIPs do not show sufficient and timely progress in recovering endangered fishes, some planned water developments may be modified, scaled back, or foregone. Because the future cannot be predicted with certainty, the economic analysis described in this report is based on the conservative assumption that the RIPs will not show sufficient progress in recovering endangered fishes and that some planned water developments will be foregone as a result. This assumption provides an upper bound on the potential magnitude of economic impacts associated with the critical habitat designations. However, this analysis does not include impacts that may result from projects that have already undergone Section 7 Consultation which may require re-initiation of consultation.²

B. Flow Related Activities

A critical element of the analysis was the determination of the current hydrologic conditions in the Basin. This effort was undertaken by the USFWS and the Bureau of Reclamation.

² Decisions to re-initiate Section 7 Consultation would be determined by the USFWS on a case-by-case basis. For the purposes of this economic analysis, it was assumed that prior consultations would not be affected. In the event a project is re-visited, formal Section 7 Consultation must be re-initiated on these projects if:

- a. New information reveals affects of the project that may affect listed species of critical habitat in a manner of to the extent not previously considered;
- b. The project is modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the biological opinion; or
- c. A new species is listed or critical habitat designated that may be affected by the project.

The current conditions were determined by examining a historical set of flows for the years 1967 through 1985 at 10 United States Geological Survey (USGS) gaging stations. Next, flows for recovery of the fishes were projected as well as depletions for future activities with and without endangered fishes. These projections took into account both listing and critical habitat designations. An illustration of the hydrograph for one gaging station (Colorado River at Cisco, Utah) is shown in Figure I-5-1. The details of this analysis are available in Chapter II-6 of Brookshire et al. (1993).

The hydrologic analysis formed the basis for the "without fish" and the "with fish" scenarios. There are four hydrologic scenarios and these can be discussed in the context of Figure I-5-1:

1. Current depletions without any actions taken on behalf of the endangered fishes (the dotted line in row 1 of the figure);
2. Current depletions but with actions taken on behalf of the endangered fishes (the dashed line in row 1 of the figure);
3. Future depletions to be allowed without considerations of the requirements of the endangered fishes (dotted line in row 2 of the figure);
4. Future depletions taking into account the requirements of the endangered fishes (dashed line in row 2 of the figure).

The solid lines represent USFWS identified flow levels believed necessary for recovery of the endangered fishes after being modified to be compatible with outputs of the Colorado River System Simulation model. A critical element of the economic analysis involved determining the economic impacts in the study region due to changes in the river flows as required for recovery of the endangered fishes. This involved assessing the impacts of revised operating plans of the dam system on recreation, hydroelectric generation, agriculture, municipal, and industrial water uses.

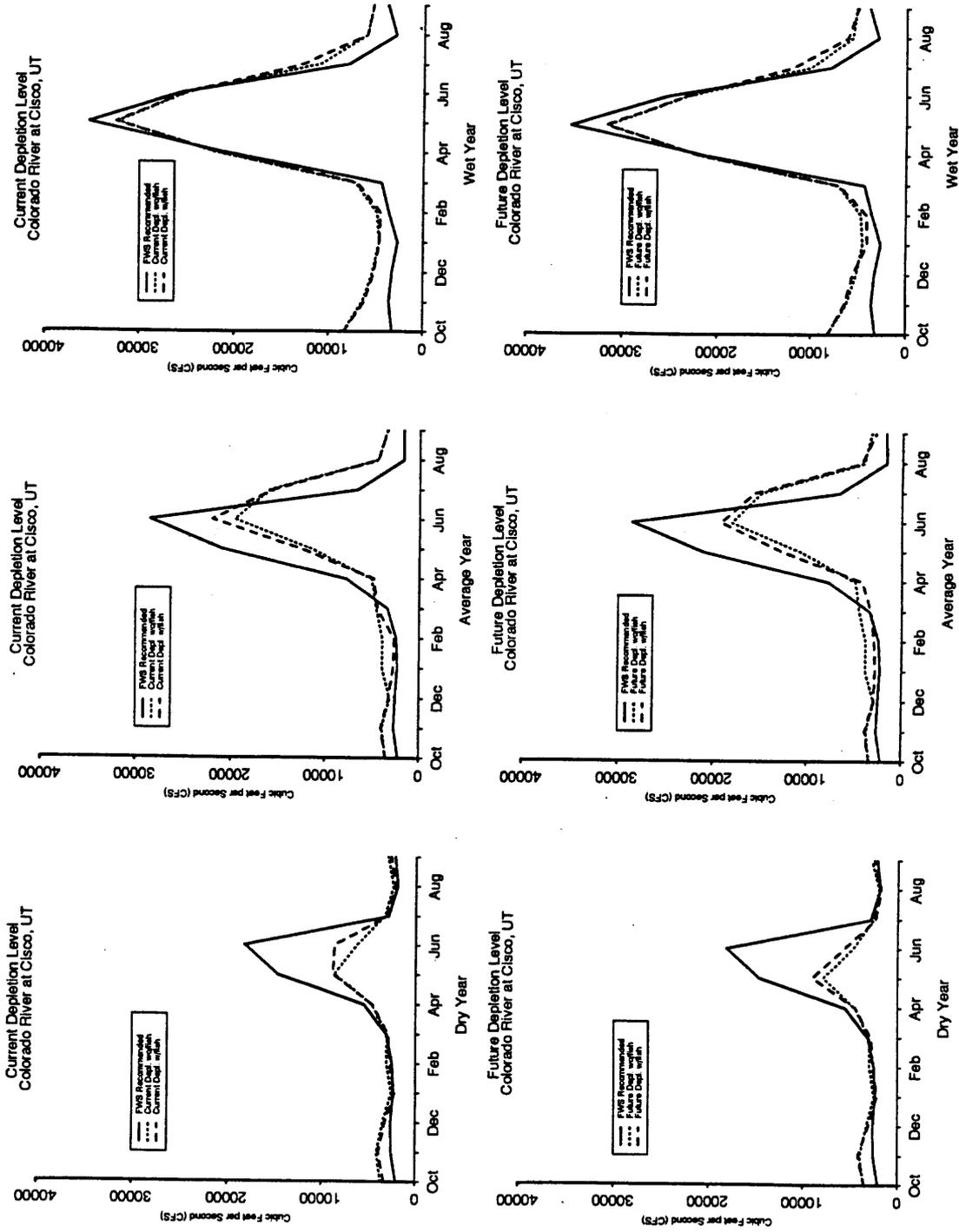


Figure I-5-1. Example Hydrograph: Colorado River at Cisco, Utah

1. Hydroelectric Impacts

Hydroelectric modeling required a cooperative effort among the USFWS, the Bureau of Reclamation, the Western Area Power Authority (Western), and Stone and Webster Consultants, Inc. Utilizing the hydrographs and taking into consideration the alternative depletion frameworks, the Bureau of Reclamation modeled the potential effects of flow requirements for the endangered fishes on monthly hydroelectric generating capacity in the Upper Basin. Western used the data generated by the models to estimate the changes in the amount of marketable power. Finally, Stone and Webster Consultants, Inc. input the data into a model framework that yields the net effects of the change in the power system.

2. Recreation Impacts

A recreation survey was developed that also relied upon the hydrographs. Outdoor planners in the seven States and a variety of Federal agencies were asked to assess the impacts of potentially modified operating plans on recreational activities. Three versions of the survey were generated to meet the needs of different recreation units along the rivers. These were: (a) units outside critical habitat areas but impacted by flow changes; (b) units including critical habitat areas that may be impacted by flow changes; and, (c) units including critical habitat areas that may not be impacted by flow changes.

3. Agricultural Impacts

To assess whether current and future planned agricultural depletions could be met with existing water resources in the relevant scenario, existing State agricultural data and the biological flow recommendations were determined. In cases where adequate flows could not be achieved, the purchase of Upper Basin agricultural water rights was assumed.

4. Municipal and Industrial Impacts

The flow recommendations may, in isolated cases, affect future municipal water acquisitions. However, it was assumed that municipalities would, in fact, acquire the needed water through the acquisition of agricultural water rights. Thus, the impacts appear as foregone agricultural production.

C. Nonflow Related Activities

Nonflow activity related changes from the "without fish" scenario are those that stem from activities generated by oil and gas operations, mining operations (sand and gravel), construction (recreation and/or private dwellings), and the stocking of nonnative fishes. These are activities that might well impinge upon the recovery of the endangered fishes.

1. Oil, Gas, and Other Drilling Activities

Significant amounts of oil and gas have been developed in the Colorado River Basin. Little, however, is known regarding the effects of critical habitat designation on this production. The impacts to society of the additional cost of production resulting from listing or critical habitat designation would be measured by a permanent loss of production. A marginal production facility that is closed due to increased monitoring costs represents a loss of production in the short term. Thus, the critical determination for well-related impacts resulting from contaminants is what percentage of producing wells will be capped and what percentage of the actual production will truly be lost to society. For purposes of this report, given the lack of available information, oil and gas drilling activities were assumed to be unaffected in the seven-State region.

2. Nonnative Fish Stocking and Fish Program

A questionnaire was designed to determine the effects of critical habitat designation on the stocking and fishing programs in the seven-States area. Nonflow effects on these programs were determined through the use of personal interviews with State game and fish personnel.³

3. Other Impacts

Other activities potentially impacted include sand and gravel operations, the construction industry, and public recreation facilities. No data were available for the effects on sand and

³ There was a section of the survey that focused upon flow effects of the stocking program and these results were incorporated into the recreation analysis.

gravel operations and the construction industry. The impacts of public recreation facilities were documented through the recreation survey (section B.2).

D. Direct Economic Impacts

The direct economic impacts due to listing and critical habitat designation occur over several economic sectors and are unique to particular stretches of the rivers. The direct economic impacts were found to stem from both flow alterations and nonflow activity changes. Since complete description of these impacts is beyond the scope of Volume I, they are described in detail in Chapters II-9 and II-10 of Brookshire et al. (1993)⁴.

Table I-5-1 presents the direct economic impacts for each State over the time for critical habitat designation. For Arizona, Colorado, New Mexico, Nevada, Utah and Wyoming, the impacts are predominantly negative. For California, the impacts are all positive. For the Colorado River Basin as a whole, the overall impacts are positive. For the livestock feed, recreation and electric power sectors, the impacts are negative. The other crops, non-petroleum mining, oil and gas production, construction, local amusement, and combined manufacturing impacts are positive. The net effects of these offsetting direct impacts is that the total direct impacts for the Colorado River Basin are positive.

⁴ In addition to the impacts reported prior to the public comment period, impacts to small electric power systems and those arising from agricultural activities within the Navajo Nation Irrigation Project, in the San Juan Basin, have been included in the current analysis.

**Table I-5-1. Direct Economic Impacts (1991\$ Millions)
(Critical Habitat Only)**

Sector	Year					
	1995	2000	2005	2010	2015	2020
Arizona						
Recreation	0.000	-0.028	-0.065	-0.098	-0.130	-0.163
Electric Power	-0.235	-0.253	-0.152	-0.195	-0.403	-0.326
TOTAL DIRECT IMPACTS	-0.235	-0.280	-0.216	-0.293	-0.533	-0.489
California						
Other Crops	0.525	1.908	4.374	5.817	8.387	10.935
Livestock Feed	0.100	0.362	0.827	1.100	1.586	2.054
TOTAL DIRECT IMPACTS	0.624	2.271	5.201	6.917	9.972	12.989
Colorado						
Livestock Feed	-0.345	-0.690	-1.015	-1.072	-1.293	-1.652
Other Crops	-0.063	-0.126	-0.174	-0.223	-0.272	-0.320
Recreation	-0.229	-0.457	-0.457	-0.457	-0.457	-0.457
Electric Power	-0.256	-0.436	-0.949	-0.501	-0.880	-0.033
Non-petroleum Mining	0.153	0.232	0.364	0.162	0.188	0.166
Oil and Gas Mining	0.203	0.020	0.056	0.121	0.531	0.077
Construction	0.804	0.804	0.804	0.804	0.804	0.804
Combined Mfg.	0.576	0.576	0.576	0.576	0.576	0.576
TOTAL DIRECT IMPACTS	0.844	-0.077	-0.796	-0.592	-0.803	-0.841
Nevada						
Recreation	0.000	-0.028	-0.065	-0.098	-0.130	-0.162
Electric Power	-0.114	-0.114	-0.114	-0.114	-0.114	-0.114
Local Amusements	1.863	1.863	1.863	1.863	1.863	1.863
TOTAL DIRECT IMPACTS	1.749	1.722	1.684	1.652	1.619	1.587
New Mexico						
Livestock Feed	0.000	-0.324	-1.186	-1.909	-2.697	-3.312
Other Crops	0.000	-0.657	-2.402	-3.875	-5.476	-6.725
Electric Power	-0.277	-0.556	-0.595	-0.594	-0.593	-0.598
TOTAL DIRECT IMPACTS	-0.277	-1.538	-4.182	-6.377	-8.766	-10.636
Utah						
Livestock Feed	0.000	-0.017	-0.038	-0.076	-0.079	-0.083
Recreation	-0.289	-0.289	-0.289	-0.289	-0.289	-0.289
Electric Power	-0.608	-0.600	-0.620	-0.648	-0.688	-0.717
Non-petroleum Mining	0.109	0.159	0.165	0.147	0.148	0.159
TOTAL DIRECT IMPACTS	-0.778	-0.748	-0.782	-0.866	-0.909	-0.930

**Table I-5-1. Direct Economic Impacts (1991\$ Millions)
(Critical Habitat Only)**

Sector	Year					
	1995	2000	2005	2010	2015	2020
Wyoming						
Livestock Feed	0.000	-0.038	-0.038	-0.038	-0.038	-0.038
Recreation	0.000	-0.011	-0.011	-0.011	-0.011	-0.011
Electric Power	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050
Non-petroleum Mining	0.000	0.000	0.005	0.001	0.012	0.009
TOTAL DIRECT IMPACTS	-0.050	-0.099	-0.094	-0.098	-0.087	-0.090
Colorado River Basin						
Livestock Feed	-0.205	-0.882	-1.680	-2.217	-3.022	-3.720
Other Crops	0.552	0.967	1.438	1.372	2.336	3.530
Recreation	-0.243	-0.372	-0.409	-0.435	-0.461	-0.487
Electric Power	-1.752	-1.806	-2.372	-1.961	-2.546	-1.465
Non-petroleum Mining	0.277	0.398	0.561	0.433	0.262	0.457
Oil and Gas Mining	0.128	0.093	0.295	0.213	0.688	0.143
Construction	0.788	0.804	0.844	0.844	0.844	0.844
Combined Manufacturing	0.753	0.768	0.807	0.807	0.807	0.807
Local Amusements	1.863	1.863	1.863	1.863	1.863	1.863
TOTAL DIRECT IMPACTS	2.159	1.833	1.347	0.918	0.771	1.971

Section 6: Determination of the Incremental Economic Impacts of Critical Habitat

A. The Division Between Listing and Critical Habitat

The Act requires that when designating critical habitat only the incremental impacts of critical habitat designation be quantified. To meet this requirement, a method had to be devised for determining the percentage of an impact that was due to listing and the percentage that was due to designation of critical habitat. This method is discussed in detail in Chapter II-14 of Brookshire et al. (1993). By applying the percentage for the critical habitat designation to the direct impacts reported in Chapters II-9 and II-10 of Brookshire et al. (1993), the incremental impacts of critical habitat designation were determined.

Tables I-6-1 and I-6-2 present the percentage of impacts attributable to listing and critical habitat for the Upper and Lower Basins if recovery were to occur by the year 2003. To derive the direct economic impacts due to the listing of the endangered fishes, the residual percentages were applied to the sectors where direct economic impacts were expected to occur.

When determining the division between listing and critical habitat, all direct agricultural sector impacts were assumed to be flow-related. For Wyoming, 75 percent, and for Utah, 100 percent, of the recreational impacts were assumed to be flow-related. Within Colorado, 75 percent of the Gunnison River recreation impacts were assumed to be flow-related. The nonnative fish category captures the recreation impacts for Arizona and for the San Juan River in Colorado. The remaining 25 percent of the recreation impacts for the Gunnison River in Colorado were assumed to be related to the nonnative fish category.

Table I-6-1. Activity and Percentage of Costs Attributable to Critical Habitat in the Upper Basin with Recovery in the Year 2003.

Year	Flows and Flow Timing	Nonnative Fish	Contaminants	Floodplain	Passage	Recreation
1989	10	4	2	4	4	4
1995	10	19	4	26	4	14
2000	10	34	5	50	4	22
2005	10	38	5	56	4	24
2010	10	38	5	56	4	24
2015	10	38	5	56	4	24
2020	10	38	5	56	4	24

Table I-6-2. The Percentage of Costs Attributable to Critical Habitat in the Lower Basin if Substantial Recovery Has Occurred by 2003.

Year	Flows and Flow Timing	Nonnative Fish	Contaminants	Floodplain	Passage	Recreation
1989	3	3	3	4	3	3
1995	8	7	7	25	11	7
2000	14	11	11	50	20	11
2005	15	13	13	56	23	13
2010	15	13	13	56	23	13
2015	15	13	13	56	23	13
2020	15	13	13	56	23	13

The procedures for determining the incremental impacts due to the critical habitat designation were as follows. The adjusted direct economic impacts (due to listing only) were input into the model stages. The models were run. The data yielded direct and indirect economic impacts due to listing only. These results were then netted from the total (listing plus critical habitat) regional direct and indirect impacts and the net national impacts. This process yielded the incremental impacts associated with the critical habitat designation.

B. State- and Regional-Level Economic Impacts

In this section, the results are organized by the major aggregate measures developed for the models used in the analysis in this report: output, earnings, government revenues, and employment.

1. Output

Table I-6-3 presents the State- and regional-level output impacts by State as well as for the entire Basin. The data reported in the table are the discounted present values of the stream of incremental output impacts associated with the critical habitat designation.⁵

Table I-6-3 illustrates the first conclusion that can be drawn. For the Colorado River Basin as a whole, the overall impacts are clearly positive. The stream of impacts over the study period (discounted at 3 percent to yield a present value) yields a positive impact of \$129.40 million (1991\$) for the Basin.

The remaining entries in Table I-6-3 demonstrate the second basic conclusion. The impacts of the critical habitat designation are not distributed evenly over the individual States in the Basin. In fact, the total impacts range from a positive \$335.02 million (California) to a negative \$245.46 million (New Mexico).

⁵The worth of a future stream of impacts expressed in terms of today's value.

Finally, the entries inside the table illustrate the third conclusion. The impacts of the critical habitat designation are not distributed evenly over the economic sectors that make up the State and the Basin economy. For example, the impacts in the other crops sector range from a positive \$174 million in California to a negative \$94.59 million in New Mexico. The overall impact for the Basin for the other crops sector is \$62.76 million. Livestock feed has impacts that range from a positive impact of \$33.31 million in California to a negative \$47.39 million in New Mexico. And the overall Basin impact for this sector is a negative \$66.91 million.

Similarly, in the recreation services sector the total impacts range from a positive \$4.92 million in California to a negative \$23.30 million in Colorado. The overall impacts across the Basin are a negative \$16.51 million in the recreation services sector. Finally, the electric power production sector impacts are a positive \$2.48 million in California and a negative \$36.88 million in Utah.

Table I-6-3. Present Value (3%) of Incremental Output Impacts for Proposed Critical Habitat Designation for 20 Economic Sectors by State and for the Colorado River Basin (\$1991 millions)⁶

	Arizona	California	Colorado	Nevada	New Mexico	Utah	Wyoming	Colorado River Basin ⁷
Livestock	-0.026	2.090	-2.130	0.106	-4.622	-0.263	-0.053	-1.898
Other Crops	-0.009	174.293	-8.123	0.023	-94.592	-0.026	-0.003	62.755
Livestock Feed	-0.004	33.310	-42.603	0.963	-47.396	-1.669	-1.442	-66.913
Misc. Agriculture	-0.007	15.608	-0.678	0.046	-3.798	-0.020	-0.018	3.853
Non-Petroleum Mines	-0.333	0.330	11.947	0.032	-1.858	5.630	-0.151	19.360
Petroleum and Gas Production	-0.002	3.440	5.800	0.002	-10.133	-1.580	-0.299	5.766
New Construction	-0.893	5.349	46.556	2.959	-5.559	-2.174	-0.226	43.963
Combined Manufacturing	-0.242	10.544	35.905	0.837	-3.588	-1.077	-0.115	52.088
Food Products	-0.093	0.820	-1.417	0.219	-0.414	-0.923	-0.005	-0.245
Wood Products	-0.076	4.382	0.625	0.794	-0.455	-0.364	-0.004	5.102
Petroleum & Coal Products	-0.259	16.471	-3.206	0.001	-9.322	-5.906	-0.575	-16.760
Trans., Comm. & Utilities	-1.293	8.555	-2.850	3.957	-6.423	-4.291	-0.496	-8.505
Recreation Services	-2.865	4.916	-23.302	2.968	-1.877	-18.778	-0.527	-16.506
Electric Power Production	-13.831	2.482	-29.793	-4.732	-30.727	-36.877	-2.980	-113.447
Wholesale/Retail Trade	-0.005	2.215	1.098	0.407	-1.217	-0.140	-0.022	1.819
Finance, Insurance & Real Estate	-0.438	37.830	-7.546	7.919	-17.284	-2.163	-0.199	7.659
Household & Business Services	-0.441	10.126	3.124	8.527	-5.160	-1.519	-0.029	13.984
Local Amusements	-0.026	0.863	-0.136	114.015	-0.125	-0.132	-0.002	136.538
Health, Education and Social Serv.	-0.029	0.422	-0.070	0.738	-0.294	-0.042	-0.010	0.617
Government Industries	-0.126	0.979	-0.171	0.505	-0.623	-0.238	-0.017	0.173
TOTAL	-20.998	335.025	-16.970	140.287	-245.465	-72.553	-7.172	129.404

⁶The results are from individual State-level I-O models and a Colorado Basin I-O model. The time period of analysis for the 20 economic sectors is 1995 to 2020.

⁷Totals for the State models do not and should not equal the value for the Colorado River Basin model.

2. Earnings Impacts

Table I-6-4 presents the present value of earnings impacts organized in the same way as those in Table I-6-3. The conclusions expressed for output hold also for the earnings impacts. In California, Colorado and Nevada the positive impacts outweigh the negative impacts; therefore for California the earnings impacts are a positive \$57.60 million, for Colorado a positive \$17.01 million and for Nevada a positive \$58.11 million. In the remaining States, the impacts are predominately negative. The net earnings impacts for the Basin are a positive \$74.08 million. Incremental earnings impacts in the other crops sector range from a positive \$27.23 million in California to a negative \$10.50 million in New Mexico.

3. Regional Government Revenue Impacts

Table I-6-5 reports the present value of incremental impacts of the critical habitat designation on government revenues from personal income taxes and indirect business taxes.

California's revenues have a positive total impact of \$24.82 million. The impact for New Mexico is a negative \$19.26 million. The Basin impact is a positive \$23.69 million.

4. State- and Regional-Level Employment Impacts

Table I-6-6 presents State- and regional-level incremental impacts on employment over the period of the study. The values in the table represent the deviation in employment, measured as jobs, between the "without fish" and "with fish" scenarios. As discussed above, employment impacts are both positive and negative both across States and over time. For New Mexico, the employment impact is approximately 2 jobs foregone in 1995 and this rises to 613 jobs foregone by the year 2020. On the other hand, for California there is a gain of approximately 20 jobs in 1995 and this positive impact increases to a projected 1,162 jobs by 2020. For the Basin as a whole the employment impacts are positive through the study period. In 1995 the projected gain is approximately 60 jobs. By 2020 the gains in employment are projected to be approximately 393 jobs.

Table I-6-4. Present Value (3%) of Incremental Earnings Impacts for Proposed Critical Habitat Designation for 20 Economic Sectors by State and for the Colorado River Basin (\$1991 Millions)⁸

	Arizona	California	Colorado	Nevada	New Mexico	Utah	Wyoming	Colorado River Basin ⁹
Livestock	-0.008	0.126	-0.128	0.008	-0.280	-0.017	-0.003	-0.115
Other Crops	-0.003	27.231	-0.630	0.003	-10.489	-0.003	-0.000	9.319
Livestock Feed	-0.001	1.122	-1.435	0.052	-1.597	-0.056	-0.049	-2.254
Misc. Agriculture	-0.003	5.296	-0.272	0.042	-1.375	-0.008	-0.006	1.326
Non-Petroleum Mines	-0.205	0.095	4.025	0.015	-0.680	2.180	-0.045	6.994
Petroleum and Gas Production	-0.001	0.243	0.409	0.000	-0.714	-0.111	-0.021	0.407
New Construction	-0.390	1.823	14.710	1.234	-1.723	-0.678	-0.065	14.533
Combined Manufacturing	-0.111	3.419	11.435	0.251	-0.895	-0.305	-0.021	16.712
Food Products	-0.034	0.116	-0.182	0.048	-0.067	-0.116	-0.001	-0.034
Wood Products	-0.034	1.220	0.195	0.987	-0.128	-0.107	-0.001	1.440
Petroleum & Coal Products	-0.056	0.671	-0.125	0.000	-0.345	-0.220	-0.021	-0.673
Trans., Comm. & Utilities	-0.600	2.840	-0.866	3.658	-1.504	-0.954	-0.105	-2.659
Recreation Services	-1.377	1.401	-6.658	0.986	-0.564	-5.684	-0.154	-4.742
Electric Power Production	-3.800	0.321	-3.916	-1.604	-4.062	-4.864	-0.396	-14.769
Wholesale/Retail Trade	-0.003	1.021	0.507	0.214	-0.563	-0.064	-0.010	0.839
Finance, Insurance & Real Estate	-0.136	5.314	-1.059	1.790	-2.225	-0.266	-0.024	1.066
Household & Business Services	-0.226	3.990	1.228	7.828	-2.230	-0.565	-0.009	5.487
Local Amusements	-0.012	0.244	-0.045	41.739	-0.037	-0.041	-0.001	40.758
Health, Education and Social Serv.	-0.017	0.194	-0.033	0.358	-0.142	-0.021	-0.004	0.286
Government Industries	-0.120	0.918	-0.157	0.505	-0.589	-0.221	-0.016	0.162
TOTAL	-7.135	57.604	17.005	58.114	-30.211	-12.121	-0.951	74.082

⁸The results are from individual State-level I-O models and a Colorado Basin I-O model. The time period of analysis for the 20 economic sectors is 1995 to 2020.

⁹Totals for the State models do not and should not equal the value for the Colorado River Basin model. See Chapter II-12 for a discussion.

Table I-6-5. Present Value (3%) of Incremental Indirect Business and Personal Taxes Impacts for Proposed Critical Habitat Designation for 20 Economic Sectors by State and for the Colorado River Basin (1991\$ Millions)¹⁰

	Arizona	California	Colorado	Nevada	New Mexico	Utah	Wyoming	Colorado River Basin ¹¹
Indirect Business Taxes	-0.906	10.416	-2.217	11.643	-11.710	-5.618	-0.467	2.716
Personal Income Taxes	-1.006	14.401	4.251	16.847	-7.553	-3.592	-0.238	20.973
Total Tax Impacts	-1.912	24.817	2.034	28.490	-19.263	-9.210	-0.705	23.689

¹⁰The results are from individual State-level I-O models and a Colorado Basin I-O model. The time period of analysis for the 20 economic sectors is 1995 to 2020.

¹¹Totals for the State models do not and should not equal the value for the Colorado River Basin model.

Table I-6-6. State Employment - Incremental Impacts Over Time of Critical Habitat Designation (Jobs)

	1995	2000	2005	2010	2015	2020
Arizona	-1.85	-4.68	-7.77	-12.08	-18.86	-25.83
California	19.99	92.57	258.48	475.86	781.18	1161.93
Colorado	8.91	5.16	-6.93	-19.69	-36.86	-55.60
Nevada	34.86	71.52	108.03	143.22	177.25	208.69
New Mexico	-2.17	-27.98	-110.71	-239.60	-415.21	-612.64
Utah	-10.91	-22.30	-34.56	-47.71	-61.06	-74.13
Wyoming	-0.40	-1.40	-2.41	-3.45	-4.35	-5.22
Colorado River Basin	59.94	116.15	178.70	230.02	294.76	392.67

5. Present Value and Annualized Incremental Impacts

Table I-6-7 presents three ways of representing the impacts associated with the designation of critical habitat for the aggregate measures of economic activity. The values presented in Table I-6-7 were previously presented in Tables I-6-3, I-6-4, and I-6-5 and are included here for comparison purposes. In addition, Table I-6-7 reports the annualized values and the present value of the impacts as a percent of the present value using the "without fish" scenario projections.¹² This provides a relative comparison of the size of the incremental critical habitat impacts between the "without fish" and "with fish" scenarios.

An examination of the percentage deviations reported in Table 1-6-7 illustrates that incremental critical habitat impacts represent a small deviation from the level of economic activity projected in the "without fish" scenario. For example, for the Basin as a whole, the deviation in total output is 0.0003 percent (three ten thousandths of a percent).

California and Nevada experience positive impacts as a result of the critical habitat designation. For California the present value of the increase in output is \$335.02 million (1991\$) which is equivalent to an annualized value of \$16.75 million. Earning impacts are positive in California, Colorado and Nevada. In Nevada, earnings are projected to increase by \$67.39 million (present value).

¹²The annualized value transforms a fluctuating impact stream into a levelized equivalent present value.

Table I-6-7. State- and Regional-Level Present Value and Annualized Incremental Critical Habitat Impacts (\$1991 millions) (3% Discount Rate)

	Output	Earnings	Indirect Business Taxes	Personal Income Taxes
Arizona				
Present Value	-20.9980	-4.0220	-0.9060	-1.0060
% Deviation from Without Fish Scenario	-0.0008	-0.0004	-0.0060	-0.0004
Annualized Values	-1.0490	-0.2010	-0.0480	-0.0500
California				
Present Value	335.0250	57.6040	10.4160	14.4010
% Deviation from Without Fish Scenario	.0013	0.0007	0.0008	0.0007
Annualized Values	16.7510	2.8800	0.5210	0.7200
Colorado				
Present Value	-16.9700	17.0050	-2.2170	4.2510
% Deviation from Without Fish Scenario	-0.0006	0.0020	-0.0020	0.0020
Annualized Values	-0.8480	0.8500	-0.1110	0.2130
Nevada				
Present Value	140.2870	67.3890	11.6430	16.8470
% Deviation from Without Fish Scenario	0.0148	0.0164	0.0182	0.01640
Annualized Values	7.0140	3.3690	0.5820	0.8420
New Mexico				
Present Value	-245.4600	-30.2110	-11.7100	-7.5530
% Deviation from Without Fish Scenario	-0.0279	-0.0110	-0.0204	-0.0110
Annualized Values	-12.2730	-1.5110	-0.5860	-0.3780
Utah				
Present Value	-72.5530	-14.3660	-5.6180	-3.5920
% Deviation from Without Fish Scenario	-0.0060	-0.0039	-0.0090	-0.0040
Annualized Values	-3.6280	-0.7180	-0.2810	-0.1800
Wyoming				
Present Value	-7.1720	-0.9510	-0.4670	-0.2380
% Deviation from Without Fish Scenario	-0.0020	-0.0008	-0.0020	-0.0008
Annualized Values	-0.3590	-0.0480	-0.0230	-0.0120
Colorado River Basin				
Present Value	129.4040	74.0710	2.7160	20.9730
% Deviation from Without Fish Scenario	0.0003	0.0006	0.0002	0.0006
Annualized Values	6.4700	3.7040	0.1360	1.0490

Section 7: Determination of the National Economic Efficiency Impacts of Critical Habitat

A. Direct Economic Impacts as National Efficiency Effects

Evaluating the national economic impacts of the changes in resource allocations for recovering the endangered fishes requires comparing the levels of economic activity before and after this reallocation of resources. An implicit assumption underlying such comparisons is that the resource use in the "without fish" scenario is the highest valued use. Further, it is assumed that the economy returns to a new equilibrium after the initial direct impacts have worked through the economy. Thus, the projected allocation of resources for the "with fish" scenario is the new highest valued use. These assumptions allow the comparison of the total value of the output of the economy before impacts to the total value of the output after impacts. The difference is the measure of the national economic impacts. The appropriate measure of the cost of resources is their opportunity cost. This is the value of what these resources are capable of producing in their next best use. These costs or benefits are sometimes referred to as efficiency costs or benefits. Specifically, national efficiency measures are computed as changes in the consumer and producer surplus. These measures capture the net gains and losses resulting from the resource reallocation.

Typically, economists have not been able to measure the generalized changes in consumer and producer surplus, and, thus, approximate approaches have been developed. A value is placed on the output change by utilizing existing prices. This assumes that the value of the direct output given up in designating critical habitat is equal to the cost of the resources necessary to undertake the new activities represented by the reallocation. This procedure yields national efficiency impacts.

Computing national efficiency impacts in this fashion is an acceptable approximation if several assumptions are satisfied. First, to use prices to value the resources displaced by the impact requires that the market for the good in question be free of distortions so that the

market prices truly reflect the opportunity cost of the resources used to produce a good (Assumption 1). Second, all other markets in the economy must be operating completely free of distortions (Assumption 2). That is, the price paid by consumers must be identical to the cost of producing the good in all markets. Third, the entire national-level impact must be identical with the regional-level impact (Assumption 3). That is, resources do not flow across regional boundaries.

With these assumptions in mind, an estimate of the national efficiency benefits of the incremental impacts due to the critical habitat is made by determining the value of the direct impacts. This estimate is presented in Table I-7-1 for various years through the study period. For the regional economy, this measure would yield a value of \$2.16 million for the impacts in 1995 as a value for the benefits associated with the listing and critical habitat actions in that year. Similarly, the value for the year 2010 would be \$.92 million.

The present value (at a 3 percent discount rate) of the impacts measured by the traditional national efficiency measure, based on the data reported in Table I-7-1, would be a positive \$54.02 million (1991\$). The annualized value of these impacts over the study period would be \$2.08 million.

For the purposes of the current analysis of the endangered fishes, assumptions 2 and 3 are arguably not fulfilled. For instance, Assumption 2 is violated since in an integrated economy all markets are more or less interdependent. An exogenous impact in one market will cause responses in other markets through changes in relative prices of the outputs of the markets. If all of the indirectly affected markets in the economy are free of distortions, then reallocating resources among these markets would generate a series of offsetting effects.¹³

¹³An illustration of why markets are not free of distortions can be found in the case of indirect business taxes which drive a wedge between the price paid by consumers and the cost of producing the good.

**Table I-7-1. Direct Impacts for the Colorado River Basin
(Critical Habitat Only)
(1982 \$ Millions)**

Sector	Year					
	1995	2000	2005	2010	2015	2020
Livestock Feed	-0.205	-0.882	-1.680	-2.217	-3.022	-3.720
Other Crops	0.552	0.967	1.438	1.372	2.336	3.530
Recreation	-0.243	-0.372	-0.409	-0.435	-0.461	-0.487
Electric Power	-1.752	-1.806	-2.372	-1.961	-2.546	-1.465
Non-petroleum Mining	0.277	0.398	0.561	0.433	0.262	0.457
Oil and Gas Mining	0.128	0.093	0.295	0.213	0.688	0.143
Construction	0.788	0.804	0.844	0.844	0.844	0.844
Combined Mfg.	0.753	0.768	0.807	0.807	0.807	0.807
Local Amusements	1.863	1.863	1.863	1.863	1.863	1.863
Total Direct Impacts	2.159	1.833	1.347	0.918	0.771	1.971

Assumption 3 is also violated for the Colorado River Basin region since there is considerable movement of goods across the boundaries of this region. Thus, it is likely that the impacts reported in Table I-7-1 spill over regional boundaries and affect the economy elsewhere. Although the region comprised of the seven States within the Colorado River Basin represents a very extensive economy, there are considerable flows of goods and services between this region and the rest of the U.S. (as well as the rest of the world). What is needed is a framework that captures the net effects of adjustments in consumer and producer surplus. Thus, the need for a more general framework than that discussed above is needed. This framework is provided by a CGE model.

B. A Computable General Equilibrium Framework

The economic consequences of the critical habitat designation can be evaluated from the perspective of national efficiency impacts in such a manner that the above assumptions are violated to a minimum degree. A CGE analysis captures the interactions across the various sectors that make up the economy and takes explicit account of the exchanges between the

region and the remainder of the economy.¹⁴ Decisions, however, concerning the extent to which the resource changes represent national impacts or the extent to which they are pure transfers from elsewhere in the economy still must be made. In what follows, four alternative scenarios are analyzed. These scenarios represent bounds on the results where it is either assumed there is or is not excess construction capacity and whether or not substitute recreation sites exist outside the region.

1. Scenario A1 — Construction-Related Impacts¹⁵

The distinction between region-level impacts and national efficiency effects is due to the fact that some region-level impacts are canceled out at the national level through transfers of resources from other parts of the economy. The extent to which the impacts are pure transfers depends on the extent to which capacity remains unused in the relevant economic sectors elsewhere in the economy. The thermal generation capacity expansion, projected to be required to offset losses in hydroelectric generation, involves the construction sector and the combined manufacturing (capital equipment) sector. These are sectors which are sensitive to the overall state of the economy. During economic slowdown periods there is typically considerable excess capacity in these sectors and the expansion within the Colorado Basin Region will draw these idle resources from the national economy. In this case, the net national direct impacts in these sectors will be the same as the regional impacts. This constitutes Scenario A1 in the following discussion.

Table I-7-2 reports the impacts associated with the critical habitat designation in terms of percentage deviation from the "without fish" scenario. Under Scenario A1 there is an expansion in the national economy and this expansion is reported in Table I-7-2 relative to the level of economic activity in the Colorado River Basin region. Thus, the expansion represents 0.0013 percent of the gross regional product of the Colorado River Basin. This

¹⁴ A presentation of consumer surplus and producer measures can be found in Chapter II-15 of Brookshire et al. (1993).

¹⁵ Alternative scenarios are presented in Brookshire et al. (1993) and results do not incorporate additional data provided by public comment period.

gross regional product expansion would be added to the output of the national economy. Similarly, there are expansions in employment (0.0047 percent), earnings (0.0017 percent), and government revenues (0.0016 percent).

Table I-7-3 reports the results of national efficiency in terms of the levels of activity in the "without fish" data set. Thus, under Scenario A1, there would be a \$7.92 million dollar expansion (1991\$) in the national economy projected on the basis of the 1982 levels of economic activity. Similarly, there would be an increase in employment of 710 jobs and increases in earnings and government revenues.

2. Present Value and Annualized Incremental Impacts

If it is assumed that the adjustments to the national economy represented by Scenario A1 results are permanent, then the present value and annualized values can be estimated. Table I-7-4 presents these results. For output, the discounted present value (3 percent) is \$141.58 million for Scenario A1. In comparison, the traditional approach would provide a value of \$54.02 million, which falls within the range as projected by the CGE model. This is also the case for the annualized values.

**Table I-7-2. Colorado River Basin: National Efficiency Results (CGE)
(Critical Habitat Only)**

(Percentage Deviation from Without Fish Scenario)

Variable	Scenario A1 vs Without Fish
Real Gross Regional Product	0.0013%
Employment	0.0047%
Earnings	0.0017%
Gov't Revenue	0.0016%

Notes:

Scenario A1: There exists sufficient underutilized capacity in the construction and capital equipment sectors (within the Basin or elsewhere in the national economy) that all additions to thermal electric capacity are a net positive addition to the level of national economic activity. The recreation resources within the Basin are unique and the loss of these recreation opportunities cannot be replaced within the U.S. economy.

**Table I-7-3. Colorado River Basin — National Economic Impacts: Levels and Differences
(1991\$ in Millions) (Employment in Jobs)**

Variable	Without Fish	With Fish Scenario A1	Without Fish vs Scenario A1 With Fish
Real Gross Regional Product	593645.38	593653.43	7.92
Employment	15029220.00	1502930.00	710.00
Earnings	354200.23	354206.85	6.62
Gov't Revenue	203822.01	203825.21	3.20

Table I-7-4. National Efficiency (CGE): Present and Annualized Values

		Annualized Value (1991 \$ millions)				Present Value (1991 \$ millions)			
		0%	3%	5%	10%	0	0.03	0.05	0.1
Scenario A1	Real Gross Regional Product	7.92	7.08	7.29	7.69	205.92	141.58	113.85	72.55
	Earnings	6.62	5.92	6.09	6.43	172.13	118.35	95.17	60.65
	Gov't Rev.	3.20	2.86	2.94	3.11	83.20	57.21	46.00	36.67

Conclusion

The regional impacts depicted in I-6-7 provide three conclusions. First, regional economic and national efficiency impacts are positive. Second, the State-level impacts are not distributed evenly over the individual States in the Basin. Finally, the percent deviation from the "without fish" scenario is small.

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