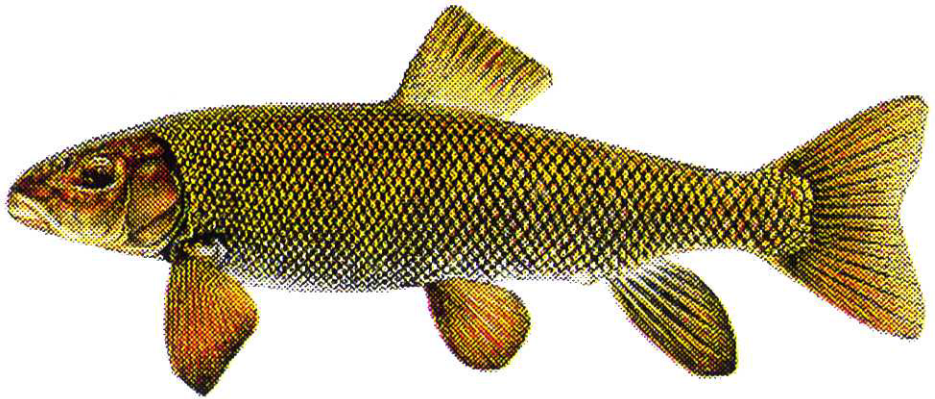


JUNE SUCKER (*Chasmistes liorus*)

RECOVERY PLAN



Region 6
U.S. Fish and Wildlife Service
Denver, Colorado

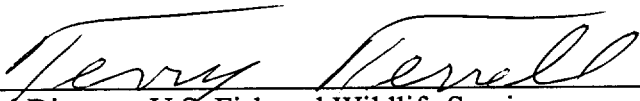
June Sucker (*Chasmistes liorus*) Recovery Plan

Prepared by:
June Sucker Recovery Team

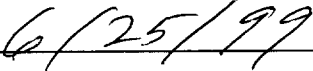
for

Region 6
U.S. Fish and Wildlife Service
Denver, Colorado

Approved:


Regional Director, U.S. Fish and Wildlife Service

Date:



June 1999

TABLE OF CONTENTS

DISCLAIMER	iii
LITERATURE CITATIONS	iv
ACKNOWLEDGMENTS	v
EXECUTIVE SUMMARY	vi
PART I INTRODUCTION	1
SYSTEMATIC CHARACTERIZATION	1
DISTRIBUTION AND STATUS	3
Refugia populations	8
Interim Experimental and Production Facilities	9
HABITAT DESCRIPTION	9
BIOLOGY AND LIFE HISTORY PATTERNS	10
Age Structure and Growth	10
Reproductive Biology	10
Feeding Habits	12
Habitat Use	12
REASONS FOR LISTING	13
Habitat Alteration	13
Fisheries and Nonnative Introductions	20
Loss of Recruitment	21
CONSERVATION MEASURES	22
STRATEGY OF RECOVERY	22
PART II RECOVERY	24
OBJECTIVE AND CRITERIA	24
NARRATIVE OUTLINE FOR RECOVERY ACTIONS ADDRESSING THREATS	24
Step Down Outline	24
Step Down Narrative	28
LITERATURE CITED	48
PART III IMPLEMENTATION SCHEDULE	52

DISCLAIMER

Recovery plans delineate reasonable actions which are believed to be required to recover and/or protect listed species. Plans are published by the U.S. Fish and Wildlife Service, sometimes prepared with the assistance of recovery teams, contractors, State agencies, and others. Objectives will be attained and any necessary funds made available subject to budgetary and other constraints affecting the parties involved, as well as the need to address other priorities. Recovery Plans do not necessarily represent the views, official positions, or approvals of any individuals or agencies involved in the plan formulation, other than the U.S. Fish and Wildlife Service. They represent the official position of the U.S. Fish and Wildlife Service only after they have been signed by the Regional Director or Director as approved. Approved recovery plans are subject to modification as dictated by new findings, changes in species status, and the completion of recovery tasks.

Cover Photo: June sucker (*Chasmistes liorus*). Executed by © Joseph Tomerelli. Used with permission.

LITERATURE CITATIONS

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Bethesda, Maryland 20814
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The fee for the plan varies depending on the number of pages of the Plan.

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The Recovery Plan was prepared by the Utah Division of Wildlife Resources (UDWR) and Utah State University (USU) through contractual agreement with the U.S. Fish and Wildlife Service. Leo Lentsch (formerly of UDWR), Todd Crowl and Janet Mizzi were the principal authors.

EXECUTIVE SUMMARY

Current Status: The June sucker (*Chasmistes liorus*) is a lakesucker endemic and unique to Utah Lake, Utah. The species was federally listed as an endangered species with critical habitat on April 30, 1986 (51 FR 10857). Included as critical habitat was the lower 7.8 km (4.9 mi) of the main channel of the Provo River, from the Tanner Race diversion downstream to Utah Lake. The species had a documented wild population of fewer than 1,000 individuals at the time of listing (51 FR 10857). The current estimates of the wild adult spawning population size in Utah Lake is closer to 300 individuals (Keleher et al. 1998).

Habitat Requirements and Limiting Factors: Predation and/or competition by nonnative fish species and changes in aquatic habitat (e.g. loss of littoral zones, alteration of historical flows and degraded water quality) created conditions which have combined to reduce recent recruitment of June sucker. Due to this paucity of recruitment, little is known about the life-history of young June suckers.

Adult June suckers, which range from 9 to 43 years in age, (G.G. Scoppettone, Service, Pers. Comm.) use the lower Provo River, Utah Lake's largest tributary, for spawning in late May and June. Larvae drift downstream to Utah Lake at night after emerging from spawning beds (Modde and Muirhead 1990).

Recovery Objective: Prevent extinction, downlist to threatened status, delist.

Recovery Criteria: Preventing Extinction. The goal of this plan is to prevent the extinction of the June sucker within its native range, to downlist the species to threatened status, and to delist. The short term goal of preventing extinction of the June sucker will be achieved when (1) a permanent, self-sustaining refugia population has been established and protected and (2) the decline of the extant population in Utah Lake have been reversed.

Downlisting. The June sucker may be downlisted to threatened status when (1) Provo River flows essential for June sucker spawning and recruitment are protected, (2) habitat in the Provo River and Utah Lake has been enhanced and/or established to provide for the continued existence of all life stages, (3) nonnative species which present a significant threat to the continued existence of June sucker are reduced or eliminated from Utah Lake, and (4) an increasing self-sustaining spawning run of wild June sucker resulting in significant recruitment over ten years has been re-established in the Provo River.

Delisting. Interim criteria established for the delisting of the June sucker include: (1) establishment of a second self-sustaining, protected, refugia population of June sucker within the Utah Lake Basin; (2) establishment of an additional self-sustaining spawning run of June sucker in Utah Lake. This will require adequate protection of instream flows and available habitat, as well as successful recruitment to the spawning run of June sucker naturally produced in the Lake; and (3) removal of other threats to the continued existence of June sucker including those associated with the required physical, chemical and biological environment of Utah Lake necessary for survival of the species. Final delisting criteria will be determined after an analysis

to determine quantified objectives is completed including a definition of a self-sustaining June sucker population.

Actions to Achieve Recovery Include:

1. Conserve genetic integrity of June sucker.
2. Monitor status and trends of June sucker population.
3. Evaluate and minimize factors limiting recruitment of June sucker.
4. Enhance June sucker population in Utah Lake and its tributaries.
5. Develop and conduct Utah Lake ecosystem and June sucker information and education programs.
6. Implement measures to protect the June sucker during its spawning run.
7. Further define criteria necessary for the recovery of the June sucker.

Cost of Recovery: \$50 Million

Date of Recovery: 2040

JUNE SUCKER RECOVERY PLAN

PART I

INTRODUCTION

The June sucker (*Chasmistes liorus*) is a lakesucker endemic to Utah Lake, Utah, (Figure 1). The species was federally listed as endangered with critical habitat, effective April 30, 1986 (51 FR 10857). Critical habitat was defined as the lower 7.8 km (4.9 mi) of the Provo River from Utah Lake upstream to the Tanner Race Diversion Dam. At the time of listing the species had a documented wild population of fewer than 1,000 individuals (51 FR 10857). Current estimates, based solely on spawning adults, are closer to 300 individuals (Keleher et al. 1998). The June sucker was federally listed as endangered due to: a) its localized distribution; b) failure to recruit new adult fish; and c) threats to its continued survival. Decline in abundance of June suckers can be attributed to habitat alteration through dewatering, channelization of tributary streams and degrading water quality, competition and predation by nonnative species, commercial fishing, and killing of adults during the spawning run. The Fish and Wildlife Service (Service) has given the species a recovery priority of 5C. A 5C designation applies to a species with a high degree of threat of extinction, a low recovery potential, and the presence of conflict. Water development and sportfish management are the primary conflicts to June sucker recovery.

The recovery of these fishes and the ecosystem they depend upon will require the input and cooperation of numerous Federal, state, county, city, as well as local organizations and individuals who own or manage land and water resources. Implementation of this Recovery Plan may improve sportfishing management and opportunities within Utah Lake, enhance aquatic resources, including trout populations, in the Provo River, and benefit wetland, riparian, and other water-related resources in the Utah Lake area.

SYSTEMATIC CHARACTERIZATION

Lakesuckers (genus *Chasmistes*) are mid-water planktivores, which are differentiated from other members of the family Catostomidae by their thin, separated lips that may lack papillae, branched dendritic gill rakers, and large, terminal, obliquely positioned mouths. The four recognized species of lakesuckers are located in four different hydrologic basins: June sucker (*C. liorus*) in the Bonneville Basin of Utah, shortnose sucker (*C. brevirostris*), in the Klamath River basin of Oregon and California, cui-ui (*C. cujus*) in the Truckee River basin of Western Nevada (Pyramid Lake), and the Snake River sucker (*C. muriei*) of the upper Snake River in Wyoming, which is thought to be extinct. All three of the extant *Chasmistes* species are federally listed as endangered (32 FR 4001; 51 FR 10857; 53 FR 27134).

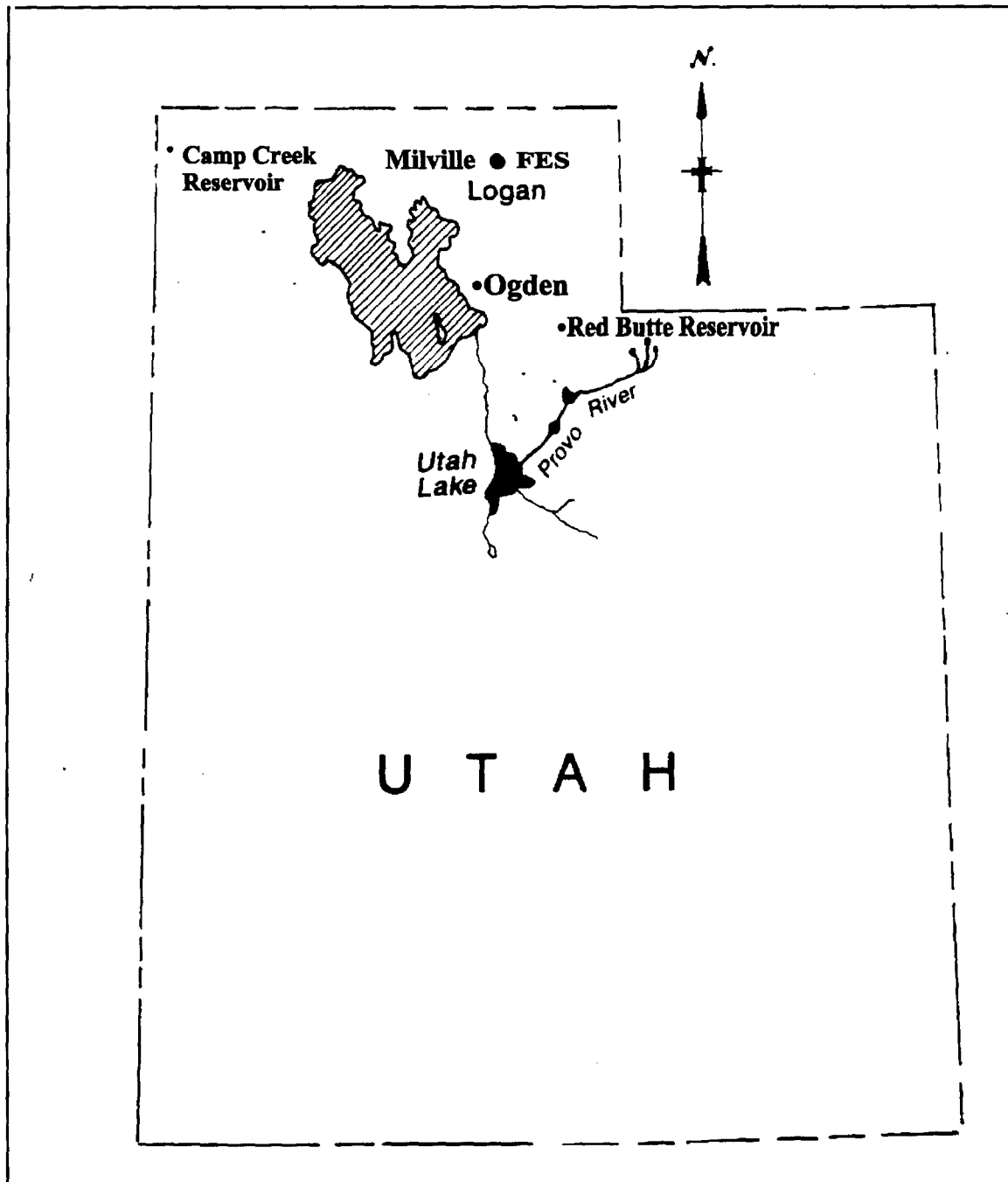


Figure 1. Known locations of June sucker in Utah. (1) Provo River and Utah Lake; (2) Genetic reserves at (a) Fisheries Experiment Station (FES), (b) Utah State University, Logan, (c) Millville Ponds, Millville, (d) Camp Creek Reservoir, (e) Red Butte Reservoir, Salt Lake City and (f) Ogden Nature Center.

June suckers were first collected and described by Jordan (1878). The nomenclatural history is complex and has caused considerable confusion over the systematics of Utah Lake suckers. Jordan (1878) described three species of suckers in Utah Lake: the June sucker, webbug sucker (*Catostomus fecundus*), and Utah sucker (*Catostomus ardens*). Information presented by Miller and Smith (1981) however, suggest that only two species, the June sucker and Utah sucker, inhabited Utah Lake. In their review of the genus *Chasmistes*, they concluded that June sucker specimens collected in the 1880's were different from those currently occurring in Utah Lake. They suggested that during the 1932-35 drought, when sucker populations in Utah Lake were stressed, June and Utah suckers hybridized. As sucker populations increased in abundance, new genes that were incorporated into the Utah Lake sucker populations resulted in hybrid characteristics becoming dominant in the June sucker. Miller and Smith (1981), therefore, assigned *C. liorus liorus* to specimens collected in the late 1800's and *C. liorus nictus* to specimens collected after 1939. Their work remains uncorroborated. However, in a draft report, Evans (in prep.) suggests that the current assemblage of suckers in Utah Lake is a result of repeated hybridization induced by environmental bottlenecks (e.g. droughts). He also reports that the June sucker genome in Utah Lake is genetically distinct from any other suckers found throughout the Bonneville Basin. Since it has maintained its distinctiveness from other suckers, the Service listed the endangered June sucker as *C. liorus* (51 FR 10857).

In recent years a morphological form, intermediate between the cui-ui and Tahoe sucker (*Catostomus tahoensis*), has appeared in Pyramid Lake, Nevada. Brussard et al. (1990) used gel electrophoresis to distinguish between cui-ui, Tahoe sucker, and artificially propagated hybrids. The same electrophoretic techniques, however, did not substantiate distinguishable differences between cui-ui and morphological variants that were presumed to be naturally-spawned hybrids. Despite morphological divergence in mouth and head morphology, the cui-ui and morphological variants had identical genotypes. Consequently, significant doubt that these variants are in fact hybrids has been raised. They are believed to be cui-ui with a varying morphology. The genetic basis for these morphological differences is not known. It may be a developmental phenomenon which either reflects phenotypic plasticity or polymorphism with a genetic basis (Brussard 1990). Current research into the hybridization of the shortnose sucker with the Klamath largescale sucker (*Catostomus snyderi*) is in process. Preliminary results match those of the cui-ui (Scoppettone in press). It may be that all three extant lakesucker species, including June sucker, exhibit similar morphological variability. Similar genetic studies, funded by the Bureau of Reclamation (Reclamation) and the Central Utah Water Conservancy District (District), have been completed in Utah and are currently being reviewed.

DISTRIBUTION AND STATUS

The June sucker is endemic to the Utah Lake drainage in central Utah (Figure 2). The fish has historically been captured in Utah Lake throughout the year and in the Provo River during its annual spawning migration. It is also reported that, historically, June sucker spawned in other tributaries to Utah Lake (Cope and Yarrow 1875). Utah Valley settlers provided

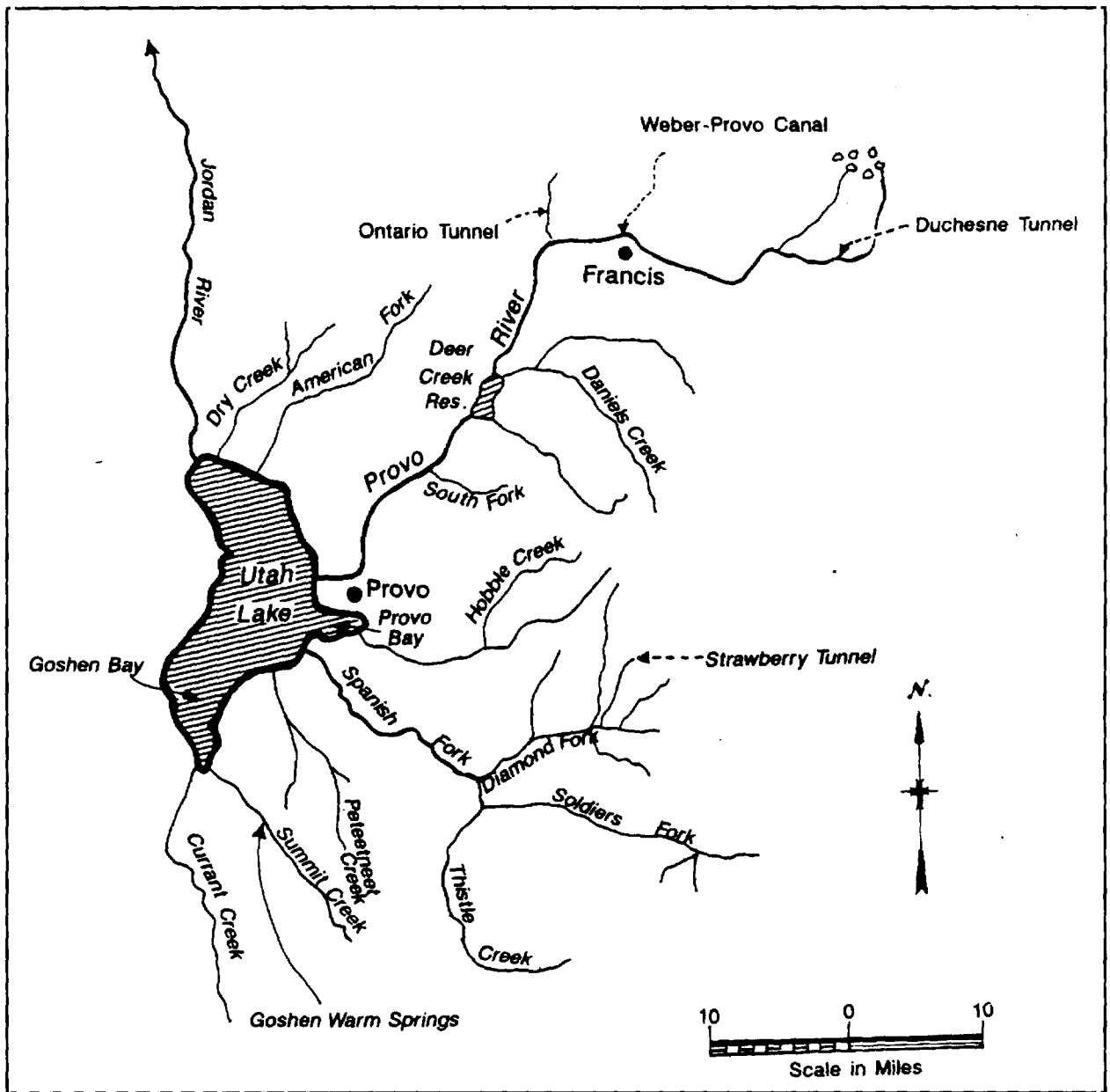


Figure 2. Utah Lake watershed and its major drainages.

valuable insight into characteristics of the historical June sucker population. Early accounts indicated that Utah Lake was a pristine lake that supported an enormous population of these fish (Heckmann et al. 1981). In the 1850's, June sucker were caught during their spawning runs and were widely utilized as fertilizer and food (Carter 1969). Native Americans, as well as white settlers, captured and dried spawning fish for consumption. On his 1889 visit, Jordan reported Utah Lake was full of suckers and proclaimed the lake "the greatest sucker pond in the universe".

The first major reductions in the number of June sucker were noted in association with development of Utah Valley. In the late 1800's, an estimated 1,500 metric tons of spawning suckers were killed when about 3.3 km (2.1 mi) of the Provo River was dewatered (Carter 1969). Hundreds of tons of suckers were also lost when Utah Lake was nearly drained dry during a 1932-35 drought (Tanner 1936). After the drought, sucker populations (June and Utah suckers) gradually increased. By 1951, as many as 1,350 suckers were taken in a day of commercial seining (Lowder 1951). Due to the combined impacts of drought, overexploitation, and habitat destruction, however, the population never returned to its historical level (Heckmann et al. 1981).

Declines in the June sucker population continued after 1950. Utah Division of Wildlife Resources (UDWR) gill netting data collected from the 1950's to the mid 1970's indicate a dramatic decline in Utah Lake sucker populations. Investigators, however, did not always differentiate between June and Utah suckers. In 1955 and 1956, 0.68 suckers per net hour were caught in Utah Lake (UDWR unpublished data 1956). By 1959 the sucker gill net catch rate had dropped to 0.16 fish per net hour (Arnold 1959). In 1970, similar netting efforts captured only 0.01 suckers per net hour (White and Dabb 1970). Gill netting in 1978-79 and 1982-83 produced no suckers (Radant et al. 1987), however, one June sucker was captured during UDWR annual Utah Lake fish monitoring in both 1983 and 1989 (D. Sakaguchi, UDWR, Pers. Comm.). An intensive inventory of the Utah Lake fish community in 1978-79 utilized a variety of sampling gear and resulted in 2,097 separate net collections. A total catch of 34,292 adult fish was recorded, of which only 102 (0.3%), were identified as June suckers. During this same period, no young-of-year (YOY) June sucker were identified from 53,364 YOY fish collected (Radant and Sakaguchi 1981). This dramatic decline in sucker abundance since the 1950's corresponds with the introduction of predaceous walleye (*Stizostedion vitreum*) and white bass (*Morone chrysops*) which were introduced into Utah Lake in 1952 and 1956, respectively (Figure 3). In 1995 the use of gill nets was discontinued and replaced by trapnetting in order to reduce the risk of mortality of June sucker. From 1995 to 1997, no June sucker were sampled during the standard Utah Lake monitoring activities. Further analysis indicated that though there was a decrease in the total number of fish caught using trap nets vs. using gill nets, the same species and relative abundance captured did not change significantly.

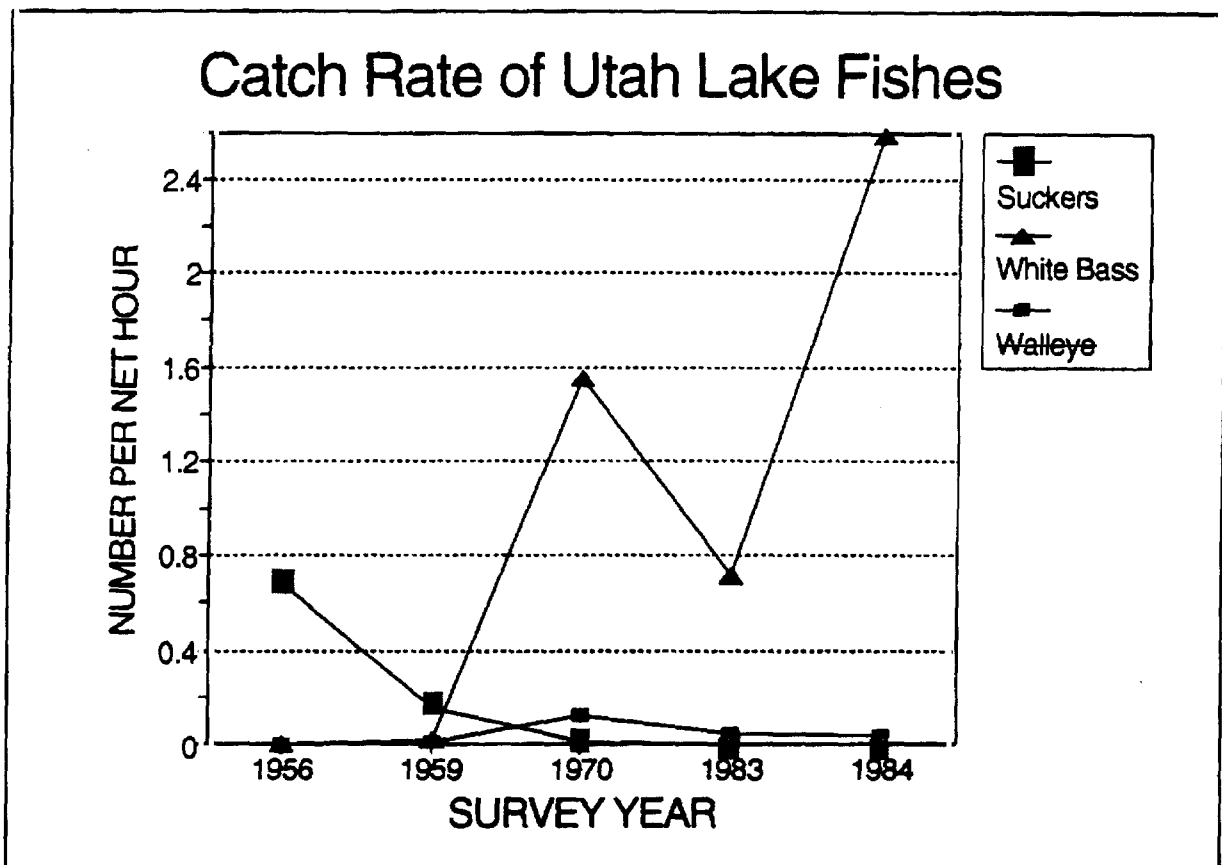


Figure 3. Catch rates of June sucker and predatory fishes in Utah Lake since 1956.

June sucker declines have been reflected in the spawning population as well. From 1979 to 1985, the total number of spawning June sucker present in the Provo River never exceeded an estimated 500 individuals (Radant et al. 1987). The last year when aggregations of 30-50 June sucker spawners were common was 1985. From 1986 to 1998 the number of adult spawners has diminished and large spawning aggregations (>30 fish) have not been observed (Dennis Shirley, Chris Keleher, CUWCD, Pers. Comm.). High flows during early June of 1990 precluded sampling of any June sucker. In 1991, only 38 June suckers were captured in the Provo River before river flows rose to a level which precluded sampling. In drought years 1992 and 1994, when Provo River flows had to be supplemented to sustain June sucker spawning and water quality, only 46 and 65 adult spawners were collected, respectively. During the high flow year of 1993, 30 adult June sucker were collected during a short, four day collection effort.

As one measure of adult population trends, the number of adults spawning each spring in the Provo River has been monitored over the past seven years. Night time spot lighting as well as captures associated with weir operations for artificial spawning were employed to capture all

possible adult spawning June suckers. A population estimate developed using the “running schnabel” mark/recapture technique (Ricker 1975) came to $N=388$ with 95 percent confidence limits of $311 < N < 515$ (Table 1; Keleher et al. 1998). Assumptions of the “running schnabel” technique include: no immigration or emigration between samples, no mortality or recruitment has occurred between samples, each fish has an equal probability of capture, marked fish randomly mix with the entire population after being released, and the sample adequately represents the entire population. Based on these assumptions, this population estimate is possibly higher than the actual population because of a violation of the no mortality assumption of the technique.

Table 1. Parameters used for running Schnabel population estimate.

t	C_t	M_t	$C_t M_t$	r_t	%recap	N	95% C.I.
1991	35	0	0	0	0	-	-
1992	46	35	1610	0	0	-	-
1993	38	81	3078	1	2.6	4688	$837 < N < 46880$
1994	67	118	7906	19	28.3	630	$409 < N < 1032$
1995	24	166	3984	11	45.8	535	$376 < N < 789$
1996	29	179	5191	19	65.5	435	$330 < N < 588$
1997	14	189	2646	13	92.9	388	$311 < N < 515$

t = time (year)

C_t = Captures at time t

M_t = total marks at time t

r_t = total recaptures at time t

N = population estimate

It is probable that the June suckers historically migrated far upstream into the Provo River drainage, since cui-ui spawning migration distances have been documented at 40 km (25 mi) (Snyder 1917). It is also probable that the June sucker once spawned in the Spanish Fork River, but irrigation depletions and habitat alteration have left this area uninhabited. Radant and Sakaguchi (1981) reported collecting ripe, prespawning June sucker in the lower Spanish Fork River in May, 1979. Subsequent surveys of the Spanish Fork River in 1984 and 1985 located no June suckers (Radant and Shirley 1987).

Only minimal recruitment of June suckers has been documented in the last decade. Since about 1978, when UDWR researchers started to document June sucker catch rates separately from Utah sucker, almost all June suckers collected have been large adults. Scoppettone (unpub. data, 1992) analyzed the opercles from spawning suckers and found only a few June suckers under 10

years of age. While small numbers of June sucker have continued to spawn in the Provo River, larvae produced (15-23,000 per day; Modde and Muirhead 1990) rarely survive in the lake environment.

In 1994, UDWR began stocking hatchery reared June sucker back into Utah Lake to enhance the existing wild population. Over the next four years, nearly 6,000 1-3 yr old June sucker were released in both the Provo River and Utah Lake, with additional releases planned for 1999. Fish have been captively reared until they reach a size of at least 5 inches so as to minimize the effects of white bass predation. Each fish has been weighed, measured and tagged with a passive integrated transponder (PIT) prior to stocking. Since these stocking activities have begun, nine marked fish have been recaptured. Two of these, captured in 1997, exhibited growth rates in the lake averaging 0.2075mm/day and 0.8015g/day, suggesting at least partial success of these stocking efforts.

Refugia populations

Five populations of June sucker external to Utah Lake currently exist. A population at Camp Creek Reservoir (a private holding) was established in 1990. Camp Creek Reservoir is approximately 5 acres and is located in West Box Elder County, near the town of Etna, Utah. Camp Creek Reservoir has a maximum depth of 16 feet and is used for irrigation by the landowner. In 1987, the Utah Division of Wildlife Resources introduced 204 juvenile June sucker into Camp Creek Reservoir. These fish were the progeny of June sucker caught in the Provo River during 1985 and spawned at the Division's Springville Hatchery. Camp Creek Reservoir has been monitored annually since 1988. Successful recruitment, and multiple age classes of June sucker in the Reservoir has increased the 1998 population to an estimated 612 individuals two years old or older.

The largest population of June sucker is in Red Butte Reservoir, Salt Lake City, Utah. Red Butte Reservoir is located on the Wasatch-Cache National Forest and covers approximately 13 surface acres with a maximum depth of 30 feet. The population was established in 1992 with the stocking of approximately 3200 fish. These fish were comprised of 1987, 1989 and 1991 year class fish that were artificially spawned and reared at USU. Since their stocking, these fish have now exhibited natural recruitment in at least three different years. This population has been monitored by the Utah Division of Wildlife Resources since it was stocked, with current population estimates of the 1995 year class, the only year class recaptured in the mark-recapture study, at approximately 4500 fish.

Finally, two ponds, Arrowhead and Teal Ponds (approximately 0.5 acres each), at the Ogden Nature Center, Ogden, Utah, have also been stocked with June sucker. Both ponds have a maximum depth of 5-6 feet and are filled year round by groundwater, preventing complete winter freezing. Arrowhead Pond was first stocked in 1993 with 13 PIT-tagged June sucker. Arrowhead Pond was again stocked in 1994 with 120 June sucker. Later in 1994 both Ponds were stocked with an additional 500 June sucker (250 fish from both the 1989 and 1992 year classes). Arrowhead Pond has been monitored yearly since 1995 while Teal Pond has not been monitored since 1995 because no June sucker were captured that year. Low oxygen levels

recorded in the Pond are thought to have eliminated this population. A current (1998) population estimate of June sucker in Arrowhead Pond is 93 individuals.

Interim Experimental and Production Facilities

As of 1998, interim facilities at the Fisheries Experiment Station (FES), UDWR, Logan, and the Millville Experimental Pond facility at USU have been completed. Both facilities are currently operating at maximum capacity. The FES facility was designed as a brood stock holding facility and has been operating in that capacity since its completion. The Utah State facility was originally designed and built as a joint venture between USU, the Bureau of Reclamation and the Utah Division of Wildlife Resources as an experimental facility for endangered fishes and an interim holding facility for June sucker. This facility has great potential to be refitted as an interim production facility if required.

A permanent production facility, a warm water native fish hatchery, is in the planning stages. The Utah Reclamation Mitigation and Conservation Commission is in the process of conducting the necessary environmental reviews. Production of the endangered June sucker will be a priority for this facility.

HABITAT DESCRIPTION

Utah Lake (see Figure 2) covers approximately 38,400 hectares (95,000 surface acres) and is located in Utah County, Utah, about 65 km (45 mi) south of the Great Salt Lake. The lake is historically shallow having an average depth of only 2.8 m (9.2 ft) and maximum depth of 4.2 m (13.8 ft) at compromise elevation of 1,368 m (4,489 ft) (Fuhrman et al. 1981). It is approximately 38 km (23.6 mi) long and 21 km (13 mi) wide (Radant and Sakaguchi 1981). Utah Lake has a large area to depth ratio and frequent winds prevent stratification from occurring. Initial information recorded by Father Escalante and his party in 1776, documents a Utah Lake shoreline with abundant pastures, marsh communities filled with reeds and marsh grasses, as well as adjacent swamps replete with macrophytes (*Lemna* and *Chara*) (Wakefield 1933). Historically, the lake environment experienced relatively stable water levels based solely on natural balances (e.g., precipitation, evaporation, and riverine input/outflow). These stable lake levels allowed for long-term maintenance of macrophyte beds, commonly used as nursery habitat by native fish species.

Riverine habitat used by spawning adult June sucker and developing larval fishes was probably far more abundant historically than today. Prior to the settlement of Utah Valley, several large tributaries (e.g., the Spanish Fork River, Hobbie Creek, and the Provo River) provided suitable spawning habitat, entering the lake through large delta's which provided braided, slow, meandering channels. For example, historic maps of the Provo River display seven separate channels that enter the lake. Multiple channels of differing dimensions probably provided a range of diverse habitats, suitable to different age-classes of June sucker and different runoff regimes. Furthermore, their tree-lined banks would have provided warmer, slow water pools and marsh habitats suitable for enhanced larval development while also providing a refuge from

predation by larger fishes present in the deeper water habitat of Utah Lake. However, river channelization, irrigation and water storage have severely impacted these tributaries, resulting in significantly reduced, and less complex, habitat. Currently, the only habitat known to be used by spawning June sucker is the lower approximately three miles (4.8 km) of the Provo River up to the Geneva Road Diversion. In very high water years an additional 1.9 miles (3 km) above this diversion is sometimes accessible as well.

BIOLOGY AND LIFE HISTORY PATTERNS

Life history information for the June sucker is scarce. Most of the biological information collected for the June sucker has been restricted to their reproductive period in the Provo River. Studies to obtain additional life history information have been ongoing since the species was listed in 1986. Preliminary results of these studies as well as previously known information are summarized below.

Age Structure and Growth

Examination of opercles from spawning June suckers indicates that they are a long-lived species. Using opercles from spawning June suckers illegally killed in 1983, 1984, 1987, and 1988, Scoppettone (Service, Pers. Comm.) estimated the age of the fish ranging from 14 to 42 years. Analysis of additional fish collected in 1992 indicated that a few fish were under 10 years of age (Scoppettone, Service, Pers. Comm.), suggesting limited survivorship and recruitment of larval June sucker over the past two decades. Belk (1998) analyzed age and growth of June sucker from otoliths of ten additional fish which had died from unknown causes, seven from 1992 and three from 1994. Estimated ages of these fish ranged from 10 to 42 years of age. All were reproductively mature at time of death. Using back-calculated lengths at age, Belk estimated that growth was rapid in the first 3-5 years and averaged 69% of mean total length. Following this rapid period of growth, he estimated that intermediate growth rates occurred until about age 8-10 years with approximately 85% of mean total length being achieved by the tenth annulus. He indicated that growth after age 10 was further reduced. Assuming that decreased growth rate indicates probable maturation, June sucker may mature as early as age five, but at least by age ten (Belk 1998).

Reproductive Biology

June sucker adults begin to concentrate in and around the mouth of the Provo River during April and May, depending on flow and temperature regimes (Radant and Hickman 1984, C. Keleher, CUWCD, Pers. Comm.). The adults generally initiate the spawning migration into the Provo River during the second and third weeks of June (Radant and Hickman 1984), again depending on overall environmental conditions. In 1990 and 1991, spawning adults migrated into the river as early as mid May (Gutermuth and Lentsch 1993). Radant and Sakaguchi (1981) observed single females spawning with two or more males. Most spawning is completed within a span of five to eight days.

Total length measurements collected in 1980 for 45 spawning male June suckers averaged 499 mm (19.6 in) and ranged from 440 to 610 mm (17.3 to 24.0 in). Length measurements for 51 spawning females ranged from 490 to 600 mm (19.3 to 23.6 in) and averaged 547 mm (21.5 in). The average weight of 126 June suckers collected in Utah Lake during that year was calculated at 1.6 kg (3.5 lb) (Radant and Sakaguchi 1981). In comparison, during 1991, total length measurements for 10 spawning males averaged 526 mm (20.7 in) and 26 spawning females averaged 571 mm (22.5 in). Thirty-six of the 38 June suckers collected in the spawning aggregation averaged 2.34 kg (5.2 lb) in weight (Gutermuth and Lentsch 1993). It is assumed that the overall increase in spawner average length and weight from those reported in 1981 is indicative of a population composed of old, mature individuals with very little recruitment.

Water velocities where June sucker spawning occurs averages approximately 37 cm/s (1.21 ft/s) and ranges from 6 cm/s to 98 cm/s (0.20 ft/s to 3.2 ft/s) (Radant et al. 1987). Water depth at spawning sites typically ranges from 30 cm to 86 cm (11.8 to 33.1 in) with a mean of 51 cm (20.0 in) (Shirley 1983). Mean river temperatures during spawning ranges from 11 to 15°C (52 to 60°F) (Radant and Sakaguchi 1981; Gutermuth and Lentsch 1993).

June sucker eggs are pale yellow, demersal, and weakly adhesive. Larval development and hatching periods have been described by Shirley (1983) and Snyder and Muth (1988). Shirley (1983) indicated that June sucker eggs hatched in four days at 21.1°C (70°F) and in ten days at 10.6°C (51.1°F). Generally, 84.4 to 106.0°C degree-days, where a degree-day is equivalent to the average daily temperature multiplied by the number of days from fertilization to hatching, have been required for hatching. Egg development time, measured in the river as the period between peak egg drift and peak larval drift (incubation plus time to full yolk absorption), was 19 days in 1987 (12 to 16°C; 53.6 to 60.8°F) and 9 days in 1988 (15 to 19°C; 59 to 66.2°F). In the laboratory, larvae remained quiescent on the bottom for ten days after hatching (106 degree-days) at 10.6°C (51.1°F) (Shirley 1983). At 17°C (62.6°F), larvae swam up in seven to eight days post-hatch (119 to 136 degree-days) (Gutermuth and Lentsch 1993). These data indicate that June sucker development, from fertilized egg through full yolk absorption, requires from 200 to 300 degree-days - approximately 100 degree-days to hatch, and up to 200 degree-days more to swim up.

After hatching, emergent June sucker larvae drift downstream in the river during nighttime hours (Modde and Muirhead 1990, Crowl and Thomas 1997, Keleher et al. 1998). Peak larval drift densities of June suckers occurred between June 17-24, 1987 and June 20-24, 1988 (Modde and Muirhead 1990), and between June 10-24 in 1996 (Crowl and Thomas, 1997). Sampling within the lake environment has not yielded larval fish. Historically, it is thought that young June sucker would migrate into Utah Lake and utilize abundant aquatic vegetation as cover and refugia (Crowl and Thomas 1997). However, aquatic vegetation is currently unavailable for June sucker early life stages to utilize for cover and refugia. Furthermore, the altered river, which has been channelized and now contains little low velocity habitat, is now conducive to rapid transport of drifting larvae out of the river and into the lake environment. Further studies are required to determine the length of time that larval June sucker historically remained in the river.

Feeding Habits

Research on other *Chasmistes*, and the morphological adaptations of the June sucker, indicate that the species is a mid-water planktivore (Miller and Smith 1981; Scopettone et al. 1986; T. Crowl, USU, Pers. Comm.). Too few specimens, however, remain in Utah Lake to verify food habits. Modde and Muirhead (1990) found the feeding behavior of larval and juvenile June suckers to be both discriminate and opportunistic. Both larval and juvenile June sucker fed on planktonic prey. Target size selection included continuously larger prey items being consumed with increasing fish size. Scopettone et al. (1986) observed that the diet of adult cui-ui in Pyramid lake was almost exclusively composed of zooplankton. Similarly, Modde and Muirhead (1990) found that growing June sucker continued feeding on zooplankton following metamorphosis to the adult form.

A number of studies determining YOY and 1-3 yr old June sucker feeding habitats have been completed. Using limno-corrals, Crowl et al. (1995b) found that YOY June sucker selectively fed on small-bodied zooplankton, especially cladocerans. While many large, mobile copepods were present, 85% of the sucker diets was comprised of small ceriodaphnia, bosmina and rotifers. In 1996, a similar study was performed at the mouth of the Provo River and in Utah Lake (Crowl et al. 1995b; Crowl and Thomas 1997; Crowl et al. 1998a, 1998b). While results were similar, June sucker diets were much more general than in the previous study, with some zoobenthos as well as larger bodied cladocerans found in the guts. Crowl et al. (1998b) reported that while June sucker consumed some larger-bodied prey in macrophyte beds, growth rates were lower than when suckers fed in the open water on small-bodied zooplankton. These findings were corroborated in a cage study performed in Red Butte Reservoir (Crowl et al. 1998b), with YOY June sucker growth being significantly greater in open water where many small-bodied cladocerans were available as compared to cages in macrophytes, where suckers consumed larger-bodied aquatic insect larvae.

Radant and Shirley (1987), observed a post-spawning aggregation of suckers in the mouth of Provo Bay in July and August. It is suspected that these fish reside in Provo Bay until the fall. Although reasons for this concentration of June suckers are not fully understood, it is assumed that the fish are responding to high food productivity in the bay. Eyring Research Institute, Inc. and Brigham Young University (1982) reported mean zooplankton densities in July and September greater than three times higher in Provo Bay than in other lake areas. These high densities of zooplankton potentially provide abundant food to meet the energy demands of post-spawn suckers.

Habitat Use

While Provo Bay appears important to June suckers in general, and post-spawners in particular, the species likely inhabits all areas of Utah Lake. In the mid and late 1950's, captures of June sucker in mid-water gill nets were common. Since the 1960's, most suckers have been captured in Provo Bay and Utah Lake shoreline areas. Trawling in open water regions of Utah Lake, in 1978 and 1979, from 1982-1989, and 1990-1993 resulted in collection of only four June suckers (Radant and Sakaguchi 1981; Sakaguchi and Thompson 1986, D. Sakaguchi, UDWR, Pers.

Comm.). From these data, it could be inferred that June suckers use shallow habitats rather than deeper zones in Utah Lake. However, sampling effort has been more intensive in shallow habitats. June sucker have been found to move considerable distances in Utah Lake, especially to take part in spawning events. Radant and Sakaguchi (1981) reported recapture information for three of the 196 suckers tagged during their 1978-1979 field studies. One of the suckers was recaptured near its original capture site. The second, which had been tagged in the Provo River in June 1979, was recaptured in Provo Bay in August. The third, tagged along the east shore of Goshen Bay in 1979, was recaptured in the Provo River in June 1980. Trawling activities were also conducted from 1995 - 1997, however none of the suckers that were tagged in the 1978-1979 studies were recaptured. In fact, the only June sucker captured in 1995 and 1996 were associated with the spawning run in the Provo River. Between 1997 and 1998, nine PIT-tagged fish released from USU and FES were recaptured. Recaptured fish showed excellent growth between the time of stocking and recapture. One recaptured fish reached sexual maturity and was captured in the Provo River spawning run.

While the number of recaptured fish is low, this is primarily due to the low stocking density, only one fish per 20 surface acres. Stocking efforts have proved successful and shown that captively reared June sucker stocked into Utah Lake are able to survive, grow, reach sexual maturity, and locate suitable spawning habitat.

REASONS FOR LISTING

Human actions have profoundly changed the Utah Lake drainage and have affected the entire ecosystem. Human-induced changes include habitat alteration and the introduction of nonnative fishes. Habitat alterations include the following: (1) water development has altered natural flow events, reduced annual lake-level stability, and blocked migration corridors; (2) changes in water quality have resulted in higher monthly river and lake temperatures, reduced dissolved oxygen levels, increased sedimentation rates and levels of dissolved solids, and increased turbidity; and (3) urbanization has resulted in development of the Provo River flood plain, channelization of the river and a reduction in available nursery habitat. The introduction of nonnative fishes has resulted in competition and predation as well as water quality changes such as increased turbidity. Loss of recruitment has resulted from a combination of the above factors.

Habitat Alteration

Water Development

Water development has occurred in the Utah Lake drainage for over 100 years. In March 1849, a group of settlers established the first colony on the Provo River, called Fort Utah. In the same year, the first water diversion structure on the Provo River was constructed. The "Bean Ditch" irrigation canal provided water for over 200 acres of crops (USBR 1989). By 1850, several larger diversions were constructed near the mouth of Provo Canyon. Water-propelled industry, such as sawmills, became common. In 1853 the first irrigation company was formed.

Legislation allowed this company to remove up to half the water in the Provo River (USBR 1989).

Development of Utah Lake as a storage reservoir began in 1872. A low dam was placed at the Jordan River outflow. The barrier increased the storage capacity of Utah Lake. A permanent irrigation pumping plant was built in 1902. Utah Lake is currently the largest water storage facility in the Provo River basin and lake water levels are manipulated without concern for the lake communities' ecological integrity. The lake environment has changed dramatically in the past 100 years leading to a marked degradation of habitat historically required by June sucker. This degradation may be most profound in the almost-complete destruction of historically-abundant aquatic plants within Utah Lake.

In 1889, efforts commenced to construct high mountain reservoirs to store high spring flows for the low summer irrigation periods. Large water storage projects, including construction of Deer Creek Reservoir, were initiated after the drought of the early 1930's (USBR 1989). Deer Creek Reservoir, the principle feature of the Provo River Project, was completed in 1941. It has an active storage capacity of 152,564 acre-feet. Approximately 120,800 acre-feet of Provo River water is stored in Deer Creek Reservoir. Deer Creek Reservoir also stores water imported from the Weber and Duchesne Rivers. Up to 37,200 acre-feet of water can be diverted annually from the Weber River for storage in Utah Lake.

Jordanelle Reservoir, also on the Provo River, is ten miles upstream from Deer Creek Reservoir and was first filled to capacity in the spring of 1996. It has a storage capacity of 372,000 acre-feet and is operated by the Central Utah Water Conservancy District.

Since 1849, the Provo River has been modified by multiple main channel diversion structures (Figure 4). Their construction, design, and placement have significantly reduced June sucker access to the Provo River. The Fort Fields Diversion dam, approximately 6 km (3.8 mi) upstream from Utah Lake, has functioned as a migration barrier in all but high flow years. The Tanner Race Diversion Dam, 7.8 km (4.9 mi) upstream of Utah Lake, is the upstream barrier to June sucker migration and spawning.

Because June sucker spawning is limited to the lower Provo River, water withdrawal and reservoir operations can have significant, negative impacts. Natural Provo River flows are diverted during irrigation season by direct flow water right holders. Direct flow diverters can reduce Provo River flows to critically low or completely dewatered levels during June sucker spawning and larval occupation periods. Additionally, large storage facilities, including Deer Creek and Jordanelle Reservoirs, store Provo River spring flows, thereby reducing the magnitude and duration and altering the timing of spring peak discharges. Reservoir operations also impact June sucker spawning when reservoirs alter operations rapidly. Spawning June sucker may enter the Provo River when flows are at $1.70 \text{ m}^3/\text{s}$ (60 cfs) and be subjected to a flow increase of greater than $14.15 \text{ m}^3/\text{s}$ (500 cfs) when Deer Creek Reservoir reaches capacity and spills. This can wash spawning adults, eggs and larvae out of the river and into Utah Lake, interrupting spawning and resulting in the loss of a year's reproduction. Conversely, fish may enter the river during high flows ($>7.0 \text{ m}^3/\text{s}$; 250 cfs) and experience a flow reduction and subsequent loss in

spawning and incubation habitat. It is believed these fluctuations in flow affect the spawning June sucker by forcing them to seek more acceptable velocities. Additionally, the high flows have made it difficult for biologists to effectively sample the population. An Instream Flow Incremental Methodology (IFIM) study showed that a reduction in spawning flows from 7.0 m³/s to 0.3 m³/s (250 cfs to 10 cfs), causes a 40% loss of incubation habitat (Radant et al. 1987). In the extreme case, biological oxygen demand (BOD) at low flows causes sections of the river to reach anoxic and life-threatening conditions, such as those that occurred in 1992 (Gutermuth et al. 1993 and 1994). Further research, coordination, and cooperation is needed to develop water operation plans that minimize negative impacts of water use.

The timing and quantity of river flows into Utah Lake may also affect June sucker populations. Historically, unregulated flows within the tributaries probably stimulated the annual June spawn. Water development in the Provo and Spanish Fork watersheds have altered the historic hydrograph to one that is dependent on upstream irrigation withdrawals and dam operations. These long-term temporal changes in the flows of local rivers, as noted above, affect the timing of June sucker spawning behavior. In recent years, ripe Utah sucker have been found in the Provo River in late May rather than April, when they traditionally spawned. Ripe June sucker, on the other hand, have been sampled in the river earlier than their historic June spawning period (Gutermuth and Lentsch 1993).

June sucker prefer low velocity waters, 13 cm/s to 51 cm/s (0.5 to 2.0 ft/s), for spawning (Radant et al 1987), yet flows are not always constant during their spawning migration. In recent years, while researchers have been collecting June sucker in the Provo River, flows have been altered drastically by water project operations (Figure 5). Increased river discharge during spawning alters local velocities. This, in turn, may impact the survivability of the eggs that have been deposited and inhibit the ability of later migrants to successfully spawn. In the spring of 1998 high flows were found to have dislodged eggs and embryonic fish (pre-emergent larvae) from spawning redds. A better understanding of the cues which govern June sucker spawning will be critical in the recovery of this fish. In addition, YOY suckers prefer low velocity nursery habitats (Crowl and Thomas 1997). Changes in flow regime, coupled with channelization have severely reduced the quantity of such low-velocity habitats in the Provo River, resulting in larvae being transported immediately towards the lake where temperature and predator regimes can be severe.

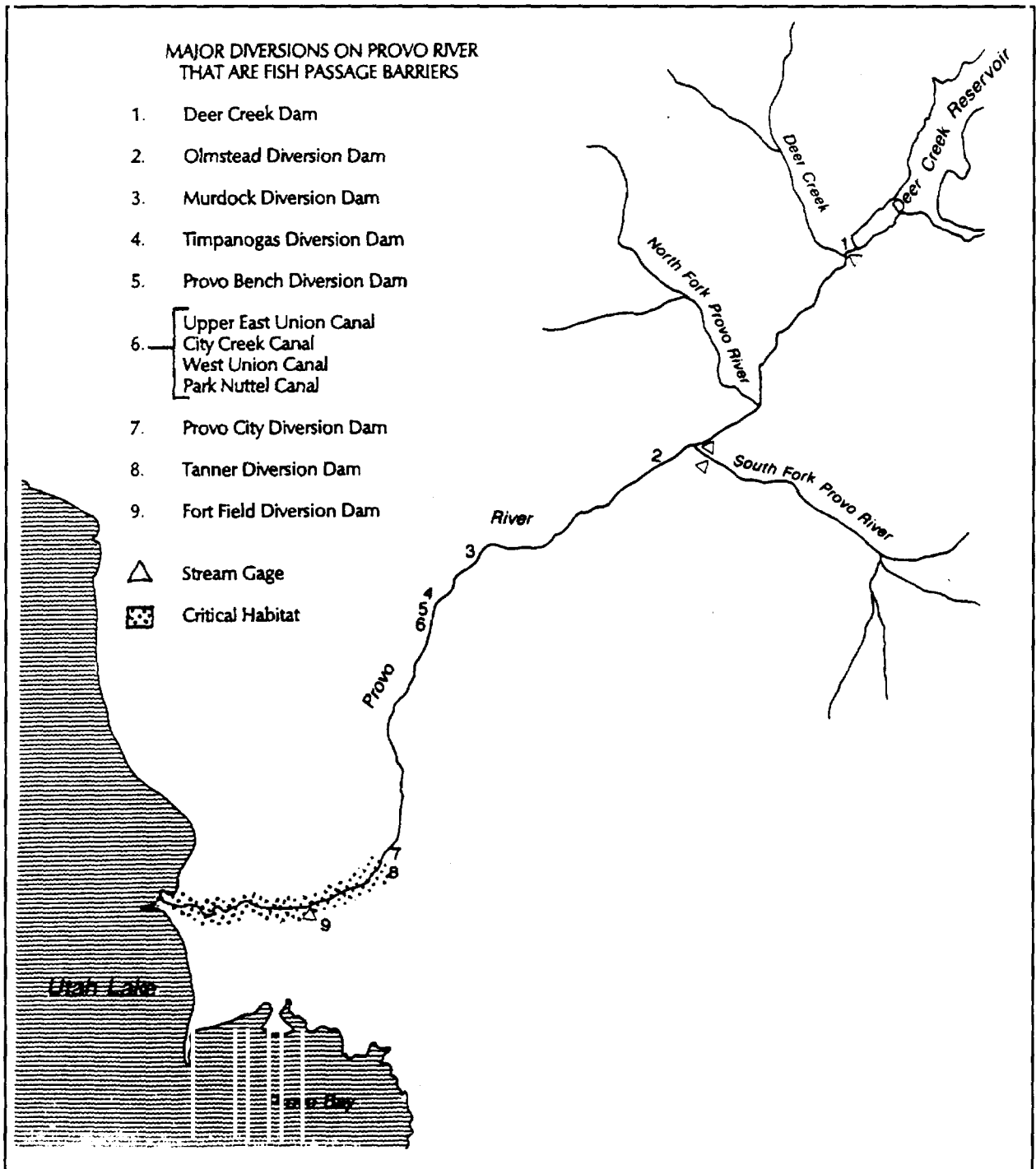


Figure 4. The lower Provo River, its major tributaries and diversions.

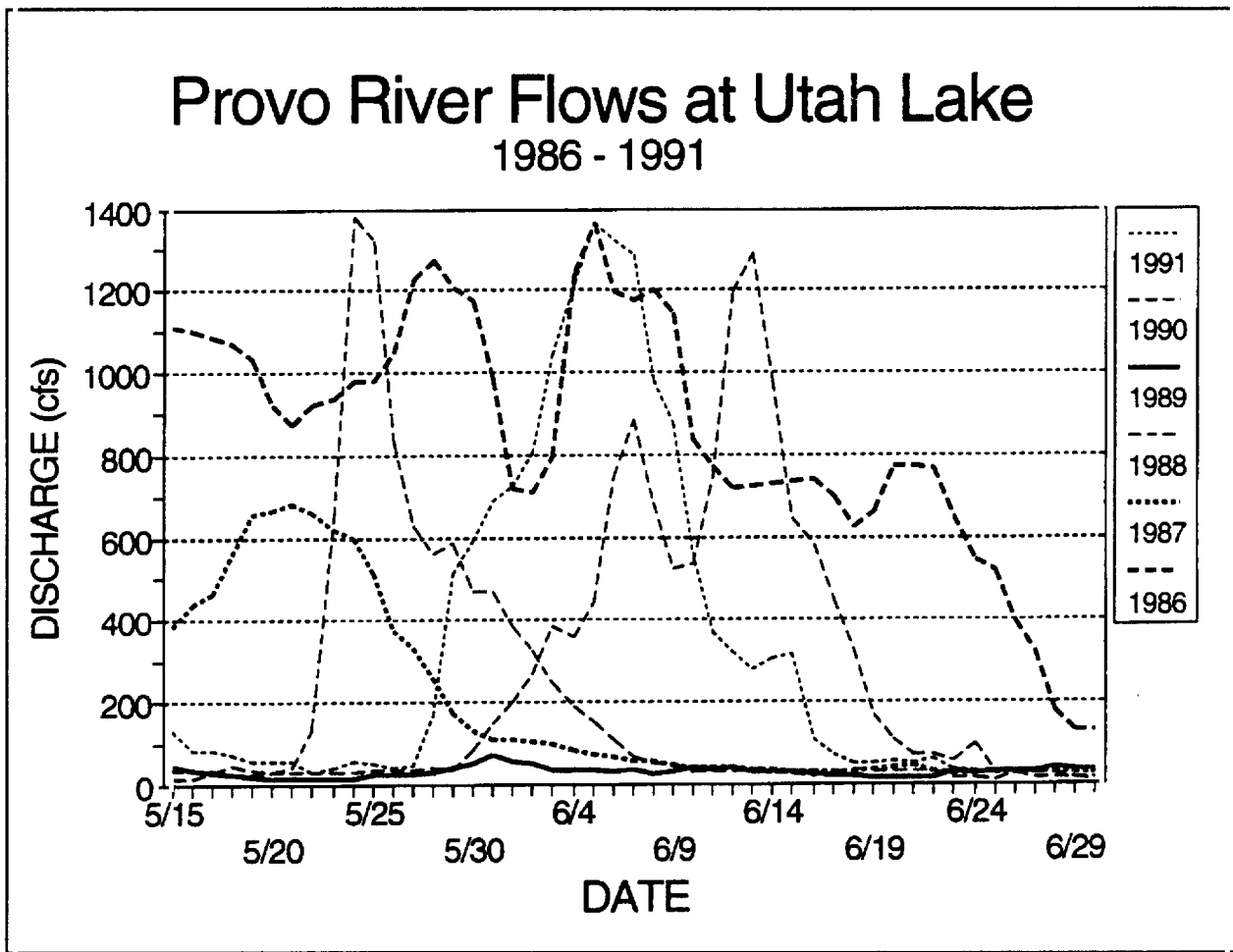


Figure 5. Provo River flows during June sucker spawning run, 1986-1991.

Water Quality

Utah Lake is located in a sedimentary drainage basin which provides a high nutrient inflow. Human development in the drainage has increased the inflow of warm water, sediments, nutrients, and industrial residues (Fuhrman et al. 1981). According to the Utah Division of Water Quality (1998), the receiving waters of Utah Lake are currently impaired for total phosphorus, total dissolved solids, and trophic state index. However, the trophic state index was shown to improve from the period 1989 to 1996. Eyring Research Institute, Inc. and Brigham Young University (1982) reported that pesticide, herbicide, and heavy metal pollution in Utah Lake is minor. Fuhrman et al. (1981) reported that evaporation naturally removed about 50% of the total water inflow and doubled the mean salt concentration. This loss of water and the resultant complete mixing of the shallow lake produced its turbid appearance. The interaction of evaporation and deposition of fine sediments from irrigation return is believed to have a large

bearing on the plant and animal community and may be profoundly impacted by riverine input to the near shore region (Brimhall and Merritt 1981). The impact of these relationships on the June sucker population, as well as impacts which have resulted from impoundment, channel alteration, and dewatering of the Provo River, are being evaluated.

While Utah Lake is highly eutrophic and experiences high algal productivity, its overall level of algal productivity is controlled by a combination of high alkalinity, hardness, and turbidity. These attributes appear to cause the precipitation or chemical bonding of phosphorous (Fuhrman et al. 1981) and result in a reduction of total productivity. However, due to high available nitrogen and phosphorus during summer months, the lake exhibits large blue-green algal blooms, which greatly affect overall food web dynamics (Crowl et al. 1998b).

Available geologic data indicate that Utah Lake has had a filling rate of about 1 mm (0.03 in) per year over the past 10,000 years, but this rate has likely more than doubled with the urbanization of Utah Valley (Brimhall and Merritt 1981). Concurrently, faults under the lake appear to be lowering the lake bed at about the same rate as sediment has been filling it (Brimhall and Merritt 1981). The combination of inputs of nutrient-rich sediments with the lake's high evaporation rate concentrates ions in the water and results in an extensive exchange of impurities between water and sediment (Brimhall and Merritt 1981).

Turbidity in Utah Lake is high (Secchi disk = 0.3 m) due to a combination of algae production, fine bottom sediment mixing, and nutrient loading. Historically, Utah Lake was dominated by rooted aquatic vegetation which probably protected the shorelines and shallow lake areas from wind-driven wave disturbance, thereby reducing turbidity levels. The increase in Lake level fluctuations have eliminated much of the aquatic vegetation. Native fish populations present in Utah Lake prior to human settlement indicate the Lake was historically less turbid. Sediment cores, however, suggest that Utah Lake may have been turbid for the last 100-200 years (Brimhall and Merritt 1981). Lake bed mixing, due to historical Utah Lake water level manipulations for water storage, and common carp foraging, which further disturbs the substrate, may have biased the quality of minimal core samples analyzed by Brimhall and Merritt (1981).

Riverine water quality has been impacted by water withdrawal, agricultural and municipal effluents, and habitat modification. Water withdrawals reduce the ability of the Provo River to effectively transport sediments and other materials from the river channel. Subsequently, extensive colonization by aquatic plants and algae occurs in the warmer temperature, reduced flow river channel, creating extreme daily dissolved oxygen fluctuations that are harmful to June sucker. Agricultural and municipal effluents enrich production of aquatic vegetation, further impacting daily dissolved oxygen levels. These effluents can also cause fish kills if significant runoff from agricultural and municipal properties occurs during low flow periods. Habitat modification, including channelization, that reduces habitat complexity and decreases the river's natural ability to cleanse pollutants, and reduction in riparian canopy above the river which allows for increased daily river temperatures, are detrimental to June sucker.

Altered water quality during spawning periods can limit June sucker spawning success in remaining riverine habitat. Warmer water temperatures prior to spring runoff, due to water

storage and early diversions, may cause early June sucker migrations, forcing Utah and June suckers to spawn at the same time, possibly resulting in competition for spawning sites and hybridization. Warmer river temperatures also occur following spring runoff due to increased agricultural diversions. As these depletions reduce flows to critically low levels, increased river temperature and extremely low dissolved oxygen levels can impact spawning success. In the summer of 1992, while Provo River flows were less than 10 cfs, several adult June sucker died from low dissolved oxygen levels. Low dissolved oxygen levels, created by reduced river flows, may also cause mortality in eggs or larval June sucker.

Water quality parameters, including changing salinity levels and increased turbidity levels (due to both suspended solids and increased eutrophication), need to be considered as factors which might limit June suckers in Utah Lake. The physiological tolerance levels of June suckers for salinity is not yet known. However, salinity in Utah Lake is high, which makes it substantially different from other freshwater lakes in the intermountain west. The extreme salinity levels found in the lake are the result of high levels of sodium chloride (NaCl) present in the Utah Lake watershed. Since the late 1800's, the salinity levels in the lake have increased as a result of irrigation waters seeping through NaCl laden croplands surrounding the lake (Sanchez 1904). Hatten (1932) suggested that salinity increased four fold from the early 1900's to the 1930's.

Decreased water quality, and especially water clarity, have repeatedly been shown to decrease feeding efficiencies of planktivorous fish (T. Crowl, USU, Pers. Comm.), such as the June sucker. The nutrient loading to the lake is extremely high. Natural nutrient loading to the lake has probably always been high due to the nutrient-rich, sedimentary-rich watershed surrounding the lake. However, human-induced nutrient loading is also extremely high. Sewage effluent accounts for 50, 75, and 80 percent of all nitrogen, total phosphorus, and ortho-phosphate, respectively, entering the lake. In the mid-1970's the lake had a mean total phosphorus loading of 218 ug/l and an inorganic nitrogen loading of 2065 ug/l, the latter being five times what is considered average for eutrophic loading.

Urbanization

Increased urbanization on the Provo River's historic flood plain has stimulated extensive flood and erosion control activities within the lower Provo River channel and reduced available land for recreating historic river channel conditions. Channelization for flood control, and additional channel manipulation for erosion control, further reduced riverine habitat complexity, and reduced the total length of river for spawning and early life stage use.

Because of the human activity in the basin, river use by spawning suckers has been severely limited. Also, a reduction in the available river habitat, which has been significantly simplified and shortened (e.g. channelized), may have caused enough of a reduction in available nursery habitat so that historical growth rates are no longer possible. Additionally, there may no longer be enough river habitat available to allow adequate time for larval fish to progress from the swim-up stage to the dispersal stage before they enter the lake environment. The Provo River historically had braided channels with side-channel and other low velocity refuge areas. This riverine composition probably resulted in faster growth of larval fishes due to both slower

downstream dispersal and the possibility of residence in higher temperature, slow water areas. As a result, juvenile June sucker would have been much larger, with better swimming abilities, when they reached Utah Lake. Loss of shallow water habitat (with lake-edge vegetation) due to fluctuating lake levels in Utah Lake is also of concern. The importance of these shallow water nursery habitats to other lake-dwelling fish species has been well documented in Utah Lake (Heckmann et al. 1981), as well as for the *Chasmistes* genus (USFWS 1983).

Fisheries and Nonnative Introductions

Commercial fishing has historically been an important part of Utah Lake, but has gradually decreased since the 1950's. Though commercial fishing was a significant factor in the extirpation of the Bonneville cutthroat trout (*Oncorhynchus clarki utah*) from Utah Lake, and resulted in large numbers of suckers being harvested (Heckman et al. 1981), current commercial fishing pressures are not a major factor in the decline of the June sucker. Today, June sucker cannot be taken commercially and fishing is no longer considered to be a threat to the species.

Introductions of nonnative fish species into Utah Lake, which began in the late 1800's, has resulted in a change of the lake fish community. June sucker, Utah sucker, Bonneville cutthroat trout, and Utah chub (*Gila atraria*) were historically the predominant native fish found in Utah Lake. Of these, only the June and Utah suckers and Utah chub remain in Utah Lake today and all three are considered rare.

Twenty-four fish species have been introduced into Utah Lake. Those which were particularly successful include common carp (*Cyprinus carpio*) (1886), channel catfish (*Ictalurus punctatus*) (1919), black bullhead (*Ameiurus melas*) (1893), largemouth bass (*Micropterus salmoides*) (1890), walleye (1952), and white bass (1956). These species still play a prominent role in the sport fishery. Smallmouth bass, introduced into Deer Creek Reservoir in 1987, were recently collected in the lower Provo River and are expected to migrate downstream to Utah Lake in the future.

The decline in sucker numbers appears to correspond closely with the introduction and population expansion of walleye and white bass in the mid-1950's (see Figure 3). Both species are voracious predators (Crowl et al. 1995a; Crowl and Thomas 1997; Crowl et al. 1998a, 1998b). Since introduction of these predators, both Utah chub and yellow perch have become rare, and June sucker YOY have not been found in the lake environment (Heckman et al. 1981). Additionally, common carp, combined with lake level manipulations, significantly reduce aquatic vegetation within Utah Lake. Aquatic vegetation is critical to early June sucker life stages within Utah Lake (T. Crowl, USU, Pers. Comm.).

To understand the biological parameters and their mechanisms which potentially limit June sucker population dynamics, additional research, including identification of possible competitors and predators in the system, is appropriate. Current research (Crowl et al. 1995a; Crowl and Thomas 1995, 1997; Crowl et al. 1998a, 1998b) indicates that a number of introduced species are of primary concern. White bass, channel catfish and walleye are all potentially threatening to successful recruitment of June suckers into the lake as they may feed on young June sucker.

However, preliminary data from recent studies suggests that young June sucker, when provided vegetative cover in Utah Lake, can successfully avoid introduced predators (T. Crowl, USU, Pers. Comm.).

The threat of illegal or accidental introductions of fish such as gizzard shad or other planktivorous fish, which would compete with June sucker for food, is also of special concern. The interactive effects of these fish and the zooplankton community (Figure 6), which appears to be the critical food resource for June suckers, needs to be understood in detail in order to rehabilitate the Utah Lake environment and to restore the June sucker population.

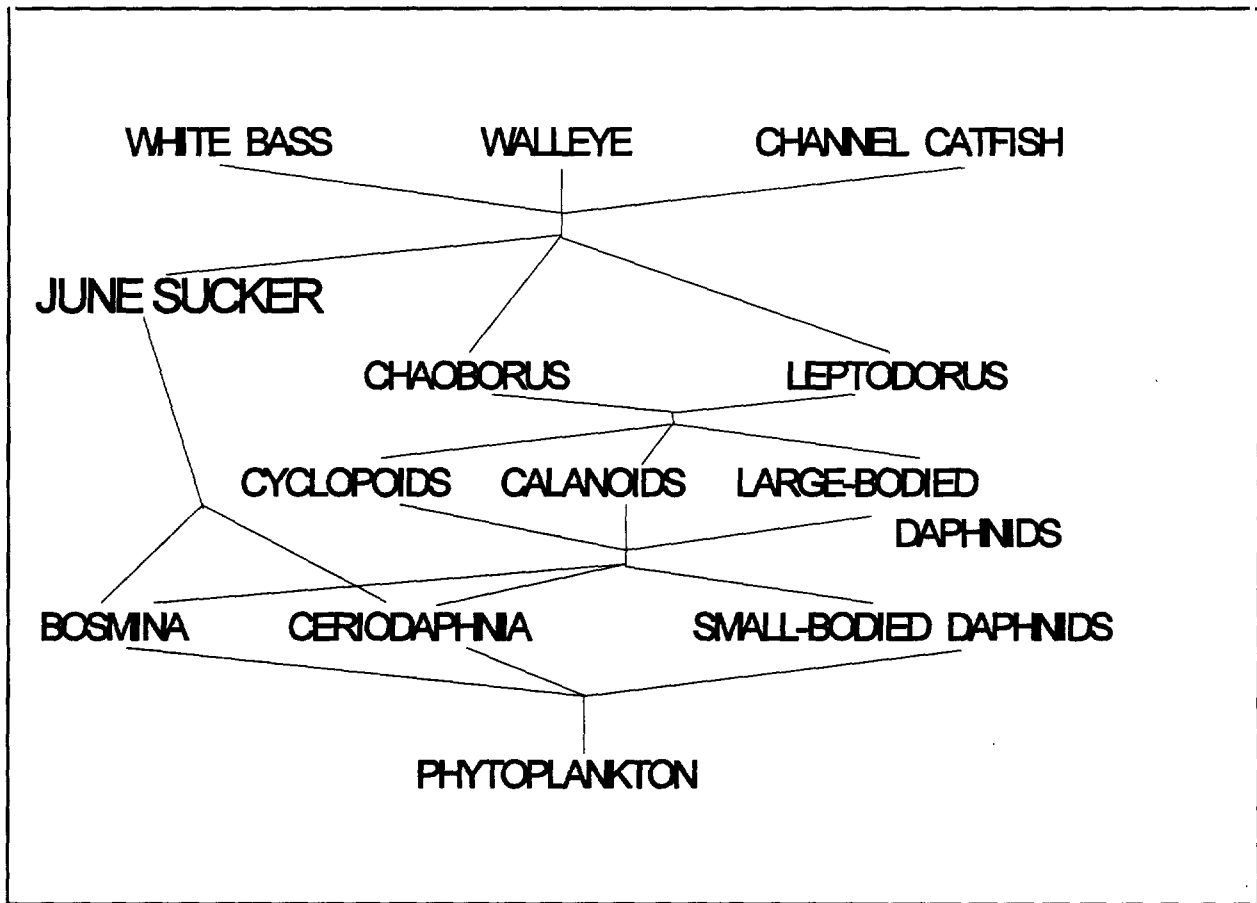


Figure 6. Generalized food web for Utah Lake. *Bosmina* and *Ceriodaphnia* are preferred food sources for June sucker.

Loss of Recruitment

The combination of altered flow regimes, water extraction, turbidity increases from run-off and the introduction of carp has resulted in Utah Lake becoming a relatively homogeneous lake

ecosystem. The loss of aquatic vegetation due to the above activities has led to an almost complete loss of refugia habitats for small suckers which makes them highly susceptible to fish predation. In addition, the channelization and fragmentation of the Provo River has resulted in very little nursery habitat for juvenile and young June suckers. This results in their immediate transport into Utah Lake which is now void of structural habitat and refugia. These conditions have led to the loss of recruitment of young June suckers.

CONSERVATION MEASURES

Conservation activities to preserve and recover the endangered June sucker have been ongoing since before the listing of the species was finalized in 1986. The Service officially established the June Sucker Recovery Team (Team) in 1992. The Team has established recovery priorities, and coordinated conservation and recovery efforts. Conservation and recovery actions taken to date have included: (1) development of brood stock and an interim facility for propagation of June sucker for reintroduction and establishment of refuge populations; (2) planning for a warm-water fish hatchery within the State of Utah, primarily for June sucker production; (3) development and maintenance of refuge populations; (4) enhancement of the June sucker population in Utah Lake; (5) population monitoring; (6) acquiring funding for and implementing numerous research projects including evaluating genetics of June sucker in Utah Lake and those being held for bloodstock and refuge development, estimating larval drift velocities in the Provo River, larval habitat use studies of the Provo River, early life history characteristics of the June sucker, and use of vegetation mats as cover; (7) enhancement of spawning and nursery flows in the Provo River to simulate a natural hydrograph; (8) minimalization of nonnative impacts; (9) construction of a weir in the lower Provo River to facilitate capture of spawning suckers for monitoring and taking of eggs and to restrict nonnative fishes from entering the river; (10) defining the criteria necessary for the recovery of June sucker; (11) conservation of the genetic integrity of the June sucker and; (12) increased presence of law enforcement and biologists on the Provo River during the spawning run to deter vandals. A Draft June Sucker Recovery Plan was prepared and distributed for comment in 1995.

The Service has addressed continued and possible future adverse impacts to the June sucker from Federal projects through the Endangered Species Act Section 7 arena. In order to facilitate cooperative and coordinated efforts at recovering the June sucker, an effort is now under way to develop a Recovery Implementation Program for the species.

STRATEGY OF RECOVERY

The first goal of this recovery plan is to prevent the extinction of the June sucker. The Service has designated a recovery priority of 5C for the June sucker, identifying it as a species with a high degree of threat of extinction, a low recovery potential and the presence of conflict. To prevent the extinction of the species, priority has been given to preserving the genetic integrity of the species and developing brood stock and refugia populations. To conserve and recover the June sucker in its native habitat, priority has and will continue to be given to monitoring the

spawning run, designing, constructing and managing a weir in the Provo River to facilitate capture of spawning suckers for monitoring and taking of eggs and to restrict nonnative fishes from entering the river, establishment of a permanent warm water native fish hatchery to propagate June sucker, determination and enhancement of Provo River instream flows necessary for successful spawning and recruitment of June sucker, restoration of habitat in the Provo River and Utah Lake for all life stages of the species, protection from nonnative species impacts, and establishment of a self-sustaining spawning run of June sucker.

PART II

RECOVERY

OBJECTIVE AND CRITERIA

The immediate objective of this recovery plan is to prevent extinction of the June sucker by establishing at least one secure refuge population and halting and reversing the decline of the extant population in Utah Lake. The second objective of this recovery plan is to recover the species to a point where downlisting and delisting can be considered. The June sucker may be downlisted to threatened status when (1) Provo River flows essential for June sucker spawning and recruitment are protected, (2) habitat in the Provo River and Utah Lake has been enhanced and/or established to provide for the continued existence of all life stages, (3) nonnative species which present a significant threat to the continued existence of June sucker are reduced or eliminated from Utah Lake, and (4) an increasing self-sustaining spawning run of wild June sucker resulting in significant recruitment over ten years has been re-established in the Provo River.

The June sucker may be delisted when the following interim criteria established for the delisting of the June sucker are met: (1) establishment of a second self-sustaining, protected, refugia population of June sucker within the Utah Lake Basin; and (2) establishment of an additional self-sustaining spawning run of June sucker in Utah Lake. This will require adequate protection of instream flows and available habitat, as well as successful recruitment to the spawning run of June sucker naturally produced in the Lake; and (3) removal of other threats to the continued existence of June sucker including those associated with the required physical, chemical and biological environment of Utah Lake necessary for survival of the species. Final delisting criteria will be determined after an analysis to determine quantified objectives is completed including a definition of a self-sustaining June sucker population.

NARRATIVE OUTLINE FOR RECOVERY ACTIONS ADDRESSING THREATS

Step Down Outline

- 1.0 Conserve genetic integrity of June sucker.
 - 1.1 Develop a genetics conservation management plan.
 - 1.1.1 Characterize the genetics of the June sucker.
 - 1.1.1.1 Determine a genetic baseline for June sucker using historic samples.
 - 1.1.1.2 Determine degree of hybridization with Utah sucker.
 - 1.1.1.3 Determine genetic variability within existing populations and year-classes.
 - 1.1.1.4 Determine genetic integrity and variability of existing refugia populations.
 - 1.1.2 Develop protocols to protect optimal genetic integrity of captive stock.

- 1.1.3 Synthesize existing information to maximize genetic diversity in a management plan.
- 1.2 Implement the genetics conservation management plan.
 - 1.2.1 Establish a primary refuge population.
 - 1.2.1.1 Identify and select potential sites.
 - 1.2.1.2 Secure selected refuge site.
 - 1.2.1.3 Introduce June sucker into selected refuge site.
 - 1.2.1.4 Monitor and maintain refuge population.
 - 1.2.2 Establish secondary refuge populations, with at least one located in the Utah Lake historic drainage.
 - 1.2.2.1 Identify and select potential sites.
 - 1.2.2.2 Secure selected refuge sites.
 - 1.2.2.3 Introduce June sucker into selected refuge sites.
 - 1.2.2.4 Monitor and maintain refuge populations.
 - 1.2.3 Maximize genetic diversity of captive stock through collections of wild adult June sucker and/or spawn.
- 2.0 Monitor status and trends of June sucker population in Utah Lake, the Provo River and other tributaries.
 - 2.1 Refine and implement protocols for monitoring fish in the Provo River and other tributaries.
 - 2.1.1 Refine and implement protocols for monitoring YOY production.
 - 2.1.2 Refine and implement protocols for monitoring adult spawning population.
 - 2.2 Monitor fish in Utah Lake.
 - 2.2.1 Develop methods and implement a plan for monitoring June sucker in Utah Lake.
- 3.0 Evaluate and minimize factors limiting recruitment of June sucker.
 - 3.1 Provide flows for spawning and recruitment in the Provo River.
 - 3.1.1 Refine flow requirements including timing, magnitude, and duration to maintain and enhance June sucker spawning and recruitment.
 - 3.1.2 Identify flexibility in current flow operations and determine strategies and mechanisms for acquiring June sucker spawning and nursery flows.
 - 3.1.3 Acquire and protect flows.
 - 3.2 Restore or provide habitat limiting recruitment of June sucker in Provo River.
 - 3.2.1 Analyze past and present habitat characteristics and complexity in the Provo River.
 - 3.2.2 Develop and implement management plan to enhance and maintain habitat complexity in Provo River by increasing low velocity and structural habitats.
 - 3.2.2.1 Provide low velocity habitats.
 - 3.2.2.2 Provide structural refugia.
 - 3.2.3 Monitor effectiveness of habitat management plan.
 - 3.3 Protect June sucker from nonnative fish impacts in the Provo River.

- 3.3.1 Determine measures and alternatives necessary to protect June sucker from nonnative impacts.
 - 3.3.1.1 Investigate river-lake interface interactions.
 - 3.3.1.2 Investigate feasibility of mechanically controlling nonnative fish predators within the river.
- 3.3.2 Minimize nonnative impacts.
 - 3.3.2.1 Provide flows that minimize nonnative use of the river.
 - 3.3.2.2 If determined feasible, mechanically control nonnative fish predators within the river.
- 3.3.3 Monitor effectiveness of measures implemented.
- 3.4 Restore or provide habitat limiting recruitment of June sucker in Utah Lake.
 - 3.4.1 Develop and implement a plan to increase habitat complexity in Utah Lake.
 - 3.4.1.1 Investigate and implement alternatives for increasing habitat complexity.
 - 3.4.2 Evaluate, develop and implement a plan to manage Utah Lake water elevation to enhance aquatic vegetation for June sucker recruitment.
 - 3.4.2.1 Evaluate Utah Lake water elevation instability impacts.
 - 3.4.2.2 Evaluate relationship between Utah Lake water elevations and riverine flows.
 - 3.4.2.3 Develop and implement plan to manage Utah Lake water elevations and enhance aquatic vegetation.
 - 3.4.2.4 Monitor and evaluate effectiveness of plan.
- 3.5 Improve water quality in Utah Lake.
 - 3.5.1 Determine and reduce or eliminate specific impacts of water quality on June sucker in Utah Lake.
 - 3.5.1.1 Develop and implement a plan to improve water quality.
 - 3.5.1.2 Monitor impacts of water quality changes on June sucker.
- 3.6 Protect June sucker from impacts due to presence of nonnatives in Utah Lake.
 - 3.6.1 Remove nonnative fish predators.
 - 3.6.1.1 Evaluate feasibility of Utah Lake nonnative fish eradication.
 - 3.6.1.2 Implement appropriate control techniques or removal of nonnative fish.
 - 3.6.2 Investigate other impacts of nonnatives on June sucker.
 - 3.6.3 Ascertain alternatives to protect June sucker from predation and other impacts due to nonnatives.
 - 3.6.3.1 Evaluate feasibility of alternative forage as a potential buffer for predation effects.
 - 3.6.4 Monitor and evaluate effectiveness of nonnative control strategies.
- 3.7 Evaluate food availability for June sucker in Utah Lake.
 - 3.7.1 Determine nutritional needs of June sucker.
 - 3.7.2 Investigate food availability and abundance in Utah Lake.
- 4.0 Enhance June sucker population in Utah Lake and its tributaries.

- 4.1 Refine and continue to implement procedures augmenting existing June sucker population in Utah Lake
 - 4.1.1 Establish a hatching and rearing facility to propagate June sucker for introduction into Utah Lake.
 - 4.1.1.1 Identify and select potential sites for the facility.
 - 4.1.1.2 Procure and secure preferred site.
 - 4.1.1.3 Design and construct the facility.
 - 4.1.1.4 Secure brood stock at preferred site.
 - 4.1.2 Develop propagation procedures for captive brood stock.
 - 4.1.2.1 Develop production goals and augmentation plan.
 - 4.1.3 Propagate and stock June sucker into Utah Lake.
- 4.2 Establish and maintain spawning stocks in other viable tributaries to Utah Lake.
 - 4.2.1 Investigate potential for establishing spawning stocks in other tributaries.
 - 4.2.1.1 Analyze past and present habitat characteristics and complexity of other tributaries.
 - 4.2.1.2 Determine barriers to establishing a spawning stock in other tributaries.
 - 4.2.1.3 Develop and implement habitat rehabilitation program to improve suitability of other tributaries for spawning stock.
 - 4.2.2 Develop guidelines for introduction of June sucker in other tributaries.
 - 4.2.3 Establish spawning stocks in other tributaries.
 - 4.2.4 Monitor and evaluate effectiveness of establishing tributary spawning stocks.
- 5.0 Develop and conduct interpretation and education highlighting the value of the Utah Lake ecosystem and the June sucker and associated recovery efforts.
- 6.0 Implement measures to protect the June sucker during its spawning run.
 - 6.1 Maintain presence of law enforcement officials and biologists in the Provo River to protect the June sucker during the spawning run.
- 7.0 Further define criteria necessary for the recovery of June sucker.
 - 7.1 Conduct an analysis to refine quantified objectives for June sucker recovery including a definition of a self-sustaining June sucker population.

Step Down Narrative

1.0 Conserve genetic integrity of June sucker.

When a species becomes as rare as the June sucker, genetic "bottlenecks" are common. In order to insure the survival and recovery of the species, the genetic integrity of the June sucker must be protected and maintained. Modern genetic techniques are currently being used to elucidate the genetic components of the June sucker. These techniques will be important to determine management actions that will maintain the natural genetic integrity and highest degree of variability within the June sucker population.

1.1 Develop a genetics conservation management plan.

In order to develop a plan to manage the June sucker for optimal genetic diversity, the complete genetic character of the June sucker must be determined. Once the genetics have been characterized, a management plan containing specific protocols will be developed. Protocols will include spawning procedures for wild and captive populations, and establishment and monitoring of refugia populations.

1.1.1 Characterize the genetics of the June sucker.

Meristic studies (Miller and Smith 1981) indicated that the current population of June sucker is a hybrid with Utah sucker. However, recent genetic studies of other lakesucker species indicates that "hybrids" are actually pure lakesuckers with slight morphological differences. In order to properly manage the June sucker species and maintain as wide of genetic diversity as possible, the complete character of June sucker genetics must be understood. Information to date, using molecular techniques, suggest that some hybridization between June sucker and Utah sucker has occurred, however the Utah Lake populations of both species remain unique.

1.1.1.1 Determine a genetic baseline for June sucker using historical samples.

Studies are currently under way to determine the historical genetic character of the June sucker. Scientists are studying genetic makeup of museum specimens collected from the late 1800's and early 20th century. A drought in the 1930's caused the death of a large portion of the June sucker population in Utah Lake. The genetic diversity of the fish may have been altered due to this catastrophic event. Understanding the genetic baseline for the June sucker will be important in determining the degree of hybridization with Utah sucker - if hybridization has occurred - and in planning

management actions that select for a high degree of genetic variability in the existing stock.

1.1.1.2 Determine degree of hybridization with Utah sucker.

Studies to determine the presence and extent of hybridization with Utah sucker are under way in relation to the historical genetic baseline study. Understanding the degree of hybridization present in the June sucker population will be necessary to determine the purest stock for use in refugia and the propagation program outlined in Task 41.

1.1.1.3 Determine genetic variability within existing populations and year-classes.

The catastrophic drought of the 1930's and the current low population may indicate that much of the genetic variability of the current June sucker population has been lost. This low diversity may be compounded during artificial spawning activities if closely related individuals are paired. In order to manage for a high degree of genetic variability, the extent of the current diversity within the population and the existing known year-classes must be determined.

1.1.1.4 Determine genetic integrity and variability of existing refugia populations.

In order to manage for a high degree of genetic variability, the extent of the current diversity within refugia populations must be determined. If the variability is low, these refugia populations should be supplemented with additional June sucker containing a high degree of genetic variability.

1.1.2 Develop protocols to protect optimal genetic integrity.

After the genetic character of the June sucker is understood, protocols to maintain the highest degree of natural variability should be developed. Individual fish or year-classes with questionable genetics should be maintained for experimental purposes only, while year-classes representing the optimal genetic integrity and the highest level diversity should be utilized in artificial propagation programs or maintained as refuge stock.

- 1.1.3 Synthesize existing information to develop a brood stock plan that will maximize genetic diversity and maximize the effective population size of the wild population.

Once the genetics have been characterized, a management plan containing specific protocols will be developed to manage June sucker brood stock to obtain optimal genetic diversity in propagation. Protocols will include spawning procedures for captive populations.

- 1.2 Implement the genetics conservation management plan.

After the genetics of the June sucker have been characterized, the Service will implement the management plan to secure the natural genetic variability of the species. Actions under this management plan will include establishing and monitoring refuge populations to maintain the genetic integrity of the species.

- 1.2.1 Establish a primary refuge population.

The existence of only one natural spawning run of June sucker makes the species extremely vulnerable to extinction from catastrophic events. Therefore, it is important to establish an additional stock of June sucker that contains the natural genetic diversity of the species. Until a permanent propagation facility is completed, naturally propagated June sucker from the refuge source can also serve to enhance the wild population in Utah Lake. A reproducing population has been established within the Great Salt Lake historic drainage in Red Butte Reservoir, Salt Lake City, Utah. As of 1998, three year classes of suckers have been naturally produced at this site. Permanent protection of this refuge population of wild adults and their offspring will secure the June sucker from extinction.

- 1.2.1.1 Identify and select potential sites.

Criteria must be developed by which selection of a permanent refuge site will be based. Using this criteria, one site will be selected to hold naturally reproducing June sucker. This site should be within the Bonneville Basin and have a natural water source. Red Butte Reservoir has been selected for its lack of nonnative predators, similarities to Utah Lake and location.

- 1.2.1.2 Secure selected refuge site.

The site selected for introduction of June sucker must be purchased or otherwise secured for a long-term commitment. The precarious status of the species indicates that the refuge population will be

essential to the survival of the June sucker for many years. If outright purchase of the refuge site is not an option, a binding long-term agreement with the landowner or management agency must be obtained before June sucker can be introduced. The future control of Red Butte Reservoir is unknown to date and should either be finalized, or an alternative site must be established.

1.2.1.3 Introduce June sucker into selected refuge site.

If Red Butte Reservoir can be officially established as the primary refuge site, additional suckers from other family lots and year classes should be stocked to maximize the genetic diversity of the population. If the long term maintenance of Red Butte can not be guaranteed, June sucker should be introduced after the refuge site has been obtained. Protocols shall be developed for capture, transport, introduction, and management of June sucker in this refuge population.

1.2.1.4 Monitor and maintain refuge population.

An important aspect to the success of the genetics conservation management plan is the continued monitoring of the refuge population. June sucker introduced into the refugium need to be maintained and monitored annually for survivability, health, growth, and reproductive success. Additional June sucker may need to be stocked in the refugium to maintain the genetic diversity of the stock.

1.2.2 Establish secondary refuge populations, with at least one located in the Utah Lake historic drainage.

Establishment of secondary refuge populations will further assure catastrophic loss does not eradicate the species and can also serve as a source of naturally propagated fish for reintroduction into Utah Lake.

1.2.2.1 Identify and select potential sites.

Criteria must be developed by which selection of a permanent refuge site will be based. Using this criteria, sites will be selected to hold naturally reproducing June sucker. At least one of these sites should be within the Utah Lake historic drainage. Using offspring from varied genetic stocks, June sucker should be stocked into a local water body. Members of this population and their offspring would be used to study June sucker life history and to possibly augment Utah Lake. In the event that Utah Lake is

found to be irreversibly altered and unable to support a self-sustaining June sucker population, this site will be used to test the appropriateness of another location for June sucker establishment. A possible site being considered at this time is Mona Reservoir.

1.2.2.2 Secure selected refuge sites.

The sites selected for introduction of June sucker must be purchased or otherwise secured for a long-term commitment. The precarious status of the species indicates that the refuge population will be essential to the survival of the June sucker for many years. If outright purchase of the refuge sites is not an option, a binding long-term agreement with the landowner or management agency must be obtained before June sucker can be introduced.

1.2.2.3 Introduce June sucker into selected refuge sites.

Protocols shall be developed for capture, transport, introduction, and management of June sucker in these refuge populations. June sucker have been introduced into Camp Creek Reservoir and ponds at the Ogden Nature Center for this purpose. The Camp Creek Reservoir population is exhibiting natural recruitment.

1.2.2.4 Monitor and maintain refuge populations.

The populations established in the Ogden Nature Ponds and Camp Creek Reservoir are monitored annually. Due to early, unknown artificial spawning practices, and until genetic evaluations are completed, measures should be taken to ensure that offspring from these fish are used exclusively for research. Once the genetic variability of these populations is known, they may need to be supplemented to enhance the genetic variability.

1.2.3 Maximize genetic diversity of captive stock through collections of wild adult June sucker and/or spawn.

Continue to develop family lots for brood stock development to maximize genetic variability through collections of wild June sucker and/or spawn. Spawn from adult June sucker in the Provo River has been collected annually, when flow conditions permit, to captively rear additional family lots necessary for brood stock development and reintroduction efforts.

2.0 Monitor status and trends of June sucker population in Utah Lake, the Provo River and other tributaries.

Information concerning the present status of the population in Utah Lake and Provo River is needed to establish a baseline for comparison after recovery actions have been implemented. Due to the extreme rarity of the June sucker and the large size of Utah Lake, the majority of population monitoring will take place in the Provo River during spawning.

2.1 Refine protocols for monitoring fish in the Provo River and other tributaries.

In the past, the most successful method of monitoring June sucker status and trends has been to construct a temporary weir across the lower Provo River during the spring spawning migration. The spawning migration is the only time of the year that June sucker are readily available to sampling gear. Protocol must be established and personnel ready to take advantage of the full amount of time the June sucker are spawning. Varying flow levels and other changing habitat conditions in the Provo River increase the chances of harm to June sucker due to monitoring activities. Establishing exact procedures for monitoring, capture, and holding of June sucker will result in more efficient and successful monitoring.

2.1.1 Refine and implement protocols for monitoring YOY production.

Annual monitoring of June sucker in the Provo River must proceed under established protocols if we are to understand temporal trends in recruitment dynamics. Over the past four years, USU and the UDWR have set up drift stations and light trap areas to sample YOY June suckers. These stations and the methodology employed needs to be continued and updated to optimize information regarding YOY production.

2.1.2 Refine and implement protocols for monitoring adult spawning population.

UDWR has developed a protocol for spot-lighting spawning June Sucker in the Provo River over the past seven years. With the addition of the permanent weir, those protocols should be refined and sampling continued to provide long-term population estimates of the spawning population size. In addition, population estimates based on mark-recapture information have been refined. That effort should also be continued annually. A signed agreement - either a Memorandum of Understanding or an addendum to the established sampling permit - between the various parties involved in monitoring activities will guarantee that safe, effective monitoring is carried out each year.

In conjunction with construction of the weir, Reclamation, UDWR, the Service, and the City of Provo signed a Memorandum of Understanding for operation and management of the permanent weir. In this agreement, UDWR will maintain ownership and be responsible for primary

maintenance of the weir. City of Provo will operate the weir during the non-June sucker migration season to prevent carp migrations upstream into the city.

2.2 Monitor fish in Utah Lake.

Information on June sucker life history in Utah Lake outside of the spawning season is limited. Little knowledge of June sucker distribution and abundance within Utah Lake also exists. Methodology for monitoring June sucker in Utah Lake needs to be developed. This plan for systematically monitoring June sucker in Utah Lake would lead to a better understanding of the species' life history and habitat requirements during the majority of its life span when the fish inhabits Utah Lake.

2.2.1 Develop methods and implement a plan for monitoring June sucker in Utah Lake.

Past attempts to monitor June sucker in Utah Lake have met with little success probably due to their low numbers. Techniques for effective monitoring of these fish in Utah Lake need to be developed. A plan should also be developed to standardize monitoring procedures and define time frames for activities in Utah Lake.

3.0 Evaluate and minimize factors limiting recruitment of June sucker.

June sucker historically thrived in Utah Lake. Today, natural recruitment has been reduced to very low numbers. Though both physical and biological components of the ecosystem have changed, priority should be placed on reestablishing the June sucker in its native habitat. Habitat and flow manipulation/rehabilitation will be necessary to achieve recovery and will be coordinated with the appropriate land and water management agencies. Hatchery propagation and reintroduction may be necessary if natural recruitment is not sufficient to increase the wild population following habitat manipulation. The key to recovery of the June sucker is to reestablish a viable population of the species in Utah Lake. Two key habitats are used by the species: the lower Provo River is used by adults for spawning and by young as a movement and potential growth corridor, and the lake itself is used by adults and young for growth and sustenance.

3.1 Provide flows for spawning and recruitment in the Provo River.

Historic and recent water development in the Provo River basin has altered the timing, magnitude, and duration of spring flows necessary to initiate and maintain June sucker spawning. Additionally, depletions from numerous diversion dams further reduce instream flows during critical June sucker larval nursery periods.

- 3.1.1 Refine flow requirements including timing, magnitude, and duration to maintain and enhance June sucker spawning and recruitment.

Alteration of natural flow timing, magnitude, and duration for spawning and nursery activities has negatively affected the success of June sucker spawning and recruitment. It is necessary to identify the timing, magnitude, and duration of flows to allow for successful June sucker spawning and nursery activities. Some of this work has already been completed, but additional investigations are necessary. If other tributaries are restored for June sucker spawning, similar flow investigations will be necessary.

- 3.1.2 Identify flexibility in current flow operations and determine strategies for acquiring June sucker spawning and nursery flows.

Numerous alternatives may occur to provide water, as defined in 3.1.1 above, for June sucker riverine needs. This might include water exchanges, transfer of water rights, and conversion of water use. Future coordinated operations of federal facilities should take into consideration the needs of the June sucker. Additionally, as part of the Central Utah Project Completion Act, funds have been identified for instream flows within the lower Provo River, which may alleviate some impacts to June sucker. Direct flow water right users should be approached to investigate flexibility in operations and willingness to allow certain flows to pass their facilities during critical June sucker activities.

- 3.1.3 Acquire and protect flows.

Successful long-term protection and ultimate recovery of June sucker is dependent on the acquisition and protection of instream flows. Some funds for acquisition of instream flows in the lower Provo River have already been authorized. However, additional funds will be necessary. Water acquired for June sucker could be converted to instream flows, benefitting the entire aquatic community in the lower Provo River. Flows so acquired should be legally tendered to Utah Division of Wildlife Resources in accordance with the laws of the State of Utah for purposes of instream flow.

- 3.2 Restore or provide habitat limiting recruitment of June sucker in Provo River.

The Provo River is the only remaining natural spawning habitat for the species. Although adult June sucker still spawn in the river, it is believed that habitat and flow alterations are factors in reduced spawning success or recruitment.

3.2.1 Analyze past and present habitat characteristics and complexity in the Provo River.

Historic aerial photography shows that the Provo River was braided and meandering prior to emptying into Utah Lake. Seven separate channels existed prior to channelization of the river, providing a variety of habitat types, structure and flows.

3.2.2 Develop and implement management plan to enhance and maintain habitat complexity in Provo River by increasing low velocity and structural habitats.

The lower Provo River has been drastically altered from its historic channel configuration and no longer provides the cover and variety of habitats necessary for successful recruitment. The potential for restoring important components, such as restoration of aquatic vegetation, instream structure, channel complexity, and off-channel habitats, of the historic lower Provo River habitat should be explored. Actions that increase June sucker larvae and young-of-year survival should be implemented.

3.2.2.1 Provide low velocity habitats.

In a series of light trapping sampling efforts, June sucker larvae were found almost exclusively in low velocity habitats within the Provo River. Using cage experiments, it has also been determined that growth and survivorship rates are higher in lower velocity habitats than in other habitats. Both flow operations and habitat restoration activities should be pursued to provide back channel or eddy type hydraulic habitats and braided channels for YOY June suckers to maximize survivorship.

3.2.2.2 Provide structural refugia.

Through a series of studies conducted at USU, it is clear that vegetated habitats are important for growth and survivorship of YOY suckers. These kinds of habitat provide small fish refugia from larger predatory fish and also provide a physical context for thigmotactic behaviors. These habitats should be reestablished in the lower Provo River through channel reconstruction or other means.

3.2.3 Monitor effectiveness of habitat management plan.

Monitor effectiveness of implemented actions and amend plan as necessary to achieve maximum success.

3.3 Protect June sucker from nonnative fish impacts in the Provo River.

Adult June sucker are large enough to avoid predation while occupying the Provo River. However, adult June sucker may experience water quality degradation due, in part, to increased turbidity from common carp feeding habits, as recorded during 1992. Young June sucker may be vulnerable to predation from nonnative species during their riverine occupation. Mechanisms to reduce nonnative impacts to June sucker while in the Provo River should be developed.

3.3.1 Determine measures and alternatives necessary to protect June sucker from nonnative impacts.

There are several methods that could be employed to reduce nonnative impacts to June sucker in the Provo River that have yet to be investigated.

3.3.1.1 Investigate river-lake interface interactions.

Studies should be initiated to explore the importance of the lake/river interface to YOY June suckers. This area has high food availability and low velocity habitats essential to high growth and survivorship of suckers. However, this area is currently heavily utilized by nonnative fish predators. Further understanding of this area is important.

3.3.1.2 Investigate feasibility of mechanically controlling nonnative fish predators within the river.

With the completion of the weir, it may be possible to use netting and direct removal of nonnative fish. Similar projects are being undertaken in larger river systems. Results of mark-recapture efforts of nonnative fish in 1997 and 1998, however, indicate a low probability that this method would be effective. The feasibility, cost and effectiveness of this approach should be further explored.

3.3.2 Minimize nonnative impacts.

Utilizing information from in-river studies, effective alternatives for reducing nonnative impacts should be implemented. Operation of the permanent fish weir could reduce the impacts migrating common carp and predaceous fish have on June sucker spawning. Provision of a combination of suitable river flows and enhanced instream habitat may help alleviate predation pressure. Management actions within Utah Lake, described in 34, may also reduce predation pressures by nonnative species.

3.3.2.1. Provide flows that minimize nonnative use of the river.

Many of the nonnative fish predators currently found in the river might decrease use of the river with appropriate flows. Many studies have shown that nonnative fish are eliminated or kept at very low localized densities by periodic flushing with high flows.

3.3.2.2 If determined feasible, mechanically control nonnative fish predators within the river.

Control techniques such as barriers to migration, altered fishing regulations or netting and removal of nonnatives should be implemented to control nonnative fish in the Provo river.

3.3.3 Monitor effectiveness of measures implemented.

Monitor effectiveness of implemented actions and amend as necessary to achieve maximum success. Implement new methods should investigations indicate feasibility.

3.4 Restore or provide habitat limiting recruitment of June sucker in Utah Lake.

Utah Lake is utilized by all life stage of June sucker. Historically, riverine inflow to Utah Lake from numerous tributaries was balanced by lake evaporation and outflow from the Jordan River, resulting in smaller lake level fluctuations than currently occurring. Because Utah Lake is used as a water storage facility, the lake elevation cycle has been modified. Alteration of elevation cycles, combined with other human-induced impacts, has altered habitat features believed critical to recovery of the June sucker.

3.4.1 Develop and implement a plan to increase habitat complexity in Utah Lake.

Because of large lake level fluctuations, increased turbidity from runoff and the foraging behavior of introduced carp, aquatic vegetation has largely been eliminated from Utah Lake. Restoring these refugia areas are critical to recovery efforts.

3.4.1.1 Investigate and implement alternatives for increasing habitat complexity.

Artificial macrophyte beds have been successful in terms of providing small patches of habitat. These are invariably utilized by small June suckers. Other methods of increasing habitat complexity should be investigated.

- 3.4.2 Evaluate, develop and implement a plan to manage Utah Lake water elevation to enhance aquatic vegetation for June sucker recruitment.

Water levels in Utah Lake are likely important to the June sucker. Alterations from historic conditions may have reduced stability of aquatic vegetation, thereby reducing refuge for young June sucker.

- 3.4.2.1 Evaluate Utah Lake water elevation instability impacts.

Recent survivability of young June sucker during migrations has been correlated with higher lake elevations. It is hypothesized that higher lake water elevations inundated shoreline terrestrial vegetation, temporarily creating in-lake cover that currently is limited due to reasons delineated above. Evaluation of historic versus current water elevation may indicate benefits to June sucker from certain water operation strategies.

- 3.4.2.2 Evaluate relationship between Utah Lake water elevations and riverine flows.

June sucker evolved under natural river hydrographs and natural lake fluctuations. Both of these important processes have been modified, potentially impacting key June sucker life history activities, such as spawning and larval migration. Utah Lake levels can affect riverine habitat in the lower Provo River, and Provo River flows can affect habitat in Utah Lake. Studies are necessary to determine historic patterns and evaluate the relationship between these two processes, to determine the most beneficial operational scenarios.

- 3.4.2.3 Develop and implement plan to manage Utah Lake water elevations and enhance aquatic vegetation.

Coordinated efforts need to be made to develop and implement feasible operating scenarios to manage the level of Utah Lake to enhance aquatic vegetation.

- 3.4.2.4 Monitor and evaluate effectiveness of plan.

Monitor effectiveness of implemented actions and amend as necessary to achieve maximum success.

- 3.5 Improve water quality in Utah Lake.

Historical information concerning the limnology of Utah Lake needs to be reviewed with reference to the present eutrophic status of the lake. Changes in limnology - physical, chemical, geological, or biological - need to be evaluated with reference to their possible effect on June sucker. A set of hypotheses on the primary factors causing the decline of the species need to be developed.

3.5.1 Determine and reduce or eliminate specific impacts of water quality on June sucker in Utah Lake.

Irrigation withdrawals, diversions from Utah Lake's tributaries, addition of sediments and chemicals via irrigation returns, waste water discharge, as well as general changes in the timing and magnitude of the hydrologic cycle within the tributaries have all affected water quality in the Utah Lake drainage. The impact of these changes on the Utah Lake food web and June sucker need to be evaluated and managed to support the June sucker population.

3.5.1.1 Develop and implement a plan to improve water quality.

Historical records note that Utah Lake was previously less turbid than its present state of advanced eutrophication. Changes in water quality and in the plant community (macrophyte versus algal growth) may have strong effects on the fish of Utah Lake.

Furthermore, water clarity (especially increasing turbidity levels) may decrease feeding efficiency of June suckers and may limit the ability of the fish to visually prey on preferred plankton food types.

An overall Utah Lake Water Quality Plan should be developed to guide future management of actions that impact or benefit Utah Lake water quality. The plan should delineate actions necessary to increase water quality, and time frames to implement those actions.

3.5.1.2 Monitor impacts of water quality changes on June sucker.

Monitor effectiveness of implemented actions and amend as necessary to achieve maximum success.

3.6 Protect June sucker from impacts due to presence of nonnatives in Utah Lake.

Numerous nonnative species have been introduced into the Utah Lake drainage. Currently, nonnative fish competition and predation is believed to be a major, if not the most significant, impact on June sucker recruitment success (Radant et al. 1987). Several methods may be available to reduce impacts of nonnative fishes on June sucker, but will require further evaluation of predation and competition impacts prior to initiation.

3.6.1 Remove nonnative fish predators.

An increase in abundance of white bass, walleye, and channel catfish occurred at the same time a decline in June sucker abundance was noted, indicating that these predatory fish may well limit the abundance of June suckers in Utah Lake. A number of studies completed over the past five years have provided strong evidence that white bass predation could be the main factor in virtually eliminating recruitment.

3.6.1.1 Evaluate feasibility of Utah Lake nonnative fish eradication.

Because of the high fecundity and voracious predation potential of the current white bass population, it may be necessary to eradicate all centrarchids from Utah Lake. Such an activity would require a large effort. However, because of the large scale of such an activity, it may not be feasible. Site specific control may be necessary. If nonnative fish that impact June sucker were completely removed, aquatic vegetation could be restored, June sucker populations could be enhanced, and selective introduction of sportfish species, that have benign impact on June sucker populations, could be considered.

3.6.1.2 Implement appropriate control techniques or removal of nonnative fish.

Removal of nonnative fish may be more feasible on a smaller scale. Because all current spawning activities occur in the Provo River, it may be possible to use netting, semi-permeable cloth or some other means to isolate the mouth of the Provo River and some portion of Utah Lake. This would allow a small-scale removal, via rotenone or mechanical removal of nonnative fish predators from this area.

3.6.2 Investigate other impacts of nonnatives on June sucker.

Common carp, comprising the majority of biomass in Utah Lake, alter the lake bottom through feeding behavior, thereby increasing lake turbidity and decreasing aquatic vegetation. Measures should be evaluated regarding common carp control and eradication in Utah Lake. White bass and other nonnative species may compete with June sucker for zooplankton. June sucker feeding studies, described below, should be coordinated with nonnative food habit studies.

3.6.3 Ascertain alternatives to protect June sucker from predation and other impacts due to nonnatives.

Introduction of a carefully selected, alternative prey for nonnative species has been suggested as an additional mechanism to reduce predation on June sucker. However, careful review of the forage species' life history, feeding habits, habitat use, and potential impacts to the June sucker food base must be completed prior to introduction. Common carp can increase Utah Lake turbidity and reduce aquatic vegetation. Studies should be conducted to determine feasible methods to reduce or eliminate impacts from common carp.

3.6.3.1 Evaluate feasibility of alternative forage as a potential buffer for predation effects.

All proposed Utah Lake fish introductions need to be evaluated for their possible interactions with June sucker. Introduction of forage fish has been proposed to serve as food for nonnative fish.

Introduced forage fishes might serve as a buffer for developing June sucker, reducing predaceous pressures, and thereby enhancing June sucker recruitment. Alternatively, forage fish might act as competitors with June sucker for food resources, with far-reaching food chain ramifications. It is also possible that addition of forage fish into the lake might cause a population expansion and/or size increase in predaceous fishes that would counteract any buffering capacity that the forage species initially offer.

3.6.4 Monitor and evaluate effectiveness of nonnative control strategies.

Monitor effectiveness of implemented actions and amend as necessary to achieve maximum success.

3.7 Evaluate food availability for June sucker in Utah Lake.

To determine if food availability is a limiting factor in June sucker recovery studies within enclosed cages floating in Utah Lake will be carried out to document growth rates and survivorship in the lake. Contrasts will be made between cages located in deep, open water, and shallow, near shore areas. These studies will utilize macrophytes or artificial structures. Zooplankton availabilities will be monitored in all cases.

3.7.1 Determine nutritional needs of June sucker.

Different age and size classes of June suckers will be monitored in limnocorrals through seasonal cycles in Utah Lake, Willard Bay and experimental ponds at USU to determine feeding selectivities. Zooplankton availabilities will be determined and electivity indices will be calculated to determine if June suckers show feeding preferences based on

taxa or are more generalists, preying on the most abundant plankton types. Comparisons will be made across age and size classes to determine if their feeding ecology changes with growth.

3.7.2 Investigate food availability and abundance in Utah Lake.

Historic information concerning plankton in Utah Lake needs to be reviewed with reference to present populations. Any changes in food (plankton) abundance or availability need to be evaluated with reference to their possible effect on June sucker.

4.0 Enhance June sucker population in Utah Lake and its tributaries.

The June sucker population in Utah Lake is threatened by numerous impacts. Currently, without potentially major modifications to habitat, water operations, and nonnative species, June sucker numbers will continue to decrease until the population is no longer viable in the wild. Because major modifications will potentially require a long period of time to implement, June sucker numbers will need to be augmented, both in the short term and, potentially, in the long term.

4.1 Refine and continue to implement procedures augmenting the existing June sucker population in Utah Lake.

Augmentation of the existing June sucker population in Utah Lake should continue and more aggressive efforts will require establishment of a hatchery facility, selection of brood stock, development of propagation procedures and an augmentation plan.

4.1.1 Establish a hatching and rearing facility to propagate June sucker for introduction into Utah Lake.

Natural recruitment is too small to ensure the long term survival of the species without the aid of stocking hatchery reared fish to initially "jump start" the lake population. A new hatchery facility is needed to produce fish for reintroduction into Utah Lake as no current hatcheries within the State are available for June sucker production. Hatchery production would be phased out as the restored habitat and lake population are able to provide sufficient recruitment to maintain the June sucker population.

4.1.1.1 Identify and select potential sites for the facility.

The Utah Reclamation Mitigation and Conservation Commission has committed funds to establish a warm water hatchery facility. They are currently in the site selection stage of development.

4.1.1.2 Procure and secure preferred site.

Conduct necessary negotiations to procure and purchase the facility site.

4.1.1.3 Design and construct the facility.

The facility should be designed and constructed by qualified, experienced personnel. The facility design should embrace production goals, as defined in 4.1.2.1.

4.1.1.4 Secure brood stock at preferred site.

Brood stock selection should be based on taxonomic and stock evaluation, availability of adequate numbers, and genetic considerations. Temporary holding facilities for brood stock have been established at several sites including Camp Creek Reservoir, the Ogden Nature ponds, Red Butte Reservoir, the Millville ponds, the Fisheries Experiment Station, and USU.

4.1.2 Develop propagation procedures for captive brood stock.

Rearing and handling techniques for June suckers are receiving preliminary review at temporary rearing facilities. Feeding regimes and culture protocols are being developed by the UDWR and the Service to meet production goals at permanent facilities.

4.1.2.1 Develop production goals and augmentation plan.

Biologists need to determine, through knowledge of the Utah Lake ecosystem, appropriate numbers and sizes of June sucker for augmentation purposes. The augmentation plan will establish criteria and methods to be used in the program for evaluating effectiveness of the effort.

4.1.3 Propagate and stock June sucker into Utah Lake.

Utilizing the information, guidelines, and plans from 413 above, utilize the propagation facility to produce target sizes and numbers of June sucker for augmentation purposes. All fish stocked should be marked for evaluation of stocking methods and success.

4.2 Establish and maintain spawning stocks in other viable tributaries to Utah Lake.

In order to reduce chances for catastrophic losses of June sucker spawners, a spawning run should be developed in at least one additional tributary of Utah Lake, the most likely candidates being Hobble Creek or the Spanish Fork River. Given the likelihood of an historic run up the Spanish Fork River, this river should be assessed for the feasibility of re-establishing a spawning run. However, Hobble Creek may provide more suitable spawning and nursery habitat without the potential conflicts of reestablishing a run up the Spanish Fork River. If feasible, a run should be developed and protected within the same legal framework as that outlined for the Provo River population.

4.2.1 Investigate potential for establishing spawning stocks in other tributaries.

It is possible that June suckers historically spawned in the Spanish Fork River, as well as other smaller tributaries to Utah Lake. Establishment of spawning stocks in other tributaries or artificial spawning channels would diminish the likelihood of a catastrophic event destroying the wild population in the Provo River. Restoration of potential historic spawning sites beyond Fort Fields Diversion in the Provo River and in other tributaries should be given priority in order to establish resilience of the June sucker population.

4.2.1.1 Analyze past and present habitat characteristics and complexity of other tributaries.

Historic accounts indicate June sucker spawned in tributaries other than the Provo River. A thorough review of historic and current tributary hydrology and instream habitat characteristics of candidate tributaries is necessary to prioritize potential reintroduction sites.

4.2.1.2 Determine barriers to establishing a spawning stock in other tributaries.

Numerous barriers, including water rights, diversion dams, private land ownership, and dewatered habitat, currently preclude spawning from occurring in other tributaries. Identification and evaluation of feasibility in addressing these barriers is important in prioritizing future reintroduction efforts.

4.2.1.3 Develop and implement habitat rehabilitation program to improve suitability of other tributaries for spawning stock.

Following procedures for protection of habitat and instream flows during spawning season, as described in 3 above, develop and implement a habitat rehabilitation program.

4.2.2 Develop guidelines for introduction of June sucker in other tributaries.

Following guidelines established in 4.1 above, develop a set of guidelines for reintroduction of June sucker into suitable tributary waters. These guidelines should include timing of introductions, number of fish, size at stocking, and future monitoring efforts.

4.2.3 Establish spawning stocks in other tributaries.

Utilize guidelines developed in 4.2.2 above to establish spawning populations of June sucker in selected waters.

4.2.4 Monitor and evaluate effectiveness of establishing tributary spawning stocks.

Monitor effectiveness of implemented actions and amend as necessary to achieve maximum success.

5.0 Develop and conduct interpretation and education highlighting the value of the Utah Lake ecosystem and the June sucker and associated recovery efforts.

By educating the public to the values of protecting ecosystems and recovering threatened and endangered species, public support for recovery is strengthened and vandalism reduced. Educational information should be made available to the public at large and fishermen, specifically, to educate them as to the needs of the species and the adverse impacts of certain activities, such as illegal introductions of nonnative fish like the gizzard shad.

6.0 Implement measures to protect the June sucker during their spawning run.

June sucker, because of their limited numbers and localized activity, are very vulnerable during their spawning run up the Provo River. To protect the species from catastrophic loss during this vulnerable life stage, and to ensure maximum survival, reproduction, and recruitment, the June sucker and its habitat, including flows, in the Provo River should be protected.

6.1 Maintain presence of law enforcement officials and biologists in the Provo River to protect the June sucker during the spawning run.

Federal and State Wildlife officers and biologists should maintain their presence in the Lower Provo River during June sucker spawning activities. The law enforcement presence, as well as increase in public contacts, will be important in reducing illegal activities related to June sucker.

7.0 Further define criteria necessary for the recovery of June sucker.

At present, there are still many uncertainties about the life history of the June sucker. As more information becomes available, additional criteria necessary for the successful recovery of the species should be developed.

- 7.1 Conduct an analysis to refine quantified objectives for June sucker recovery including a definition of a self-sustaining June sucker population.

Additional information is needed to be able to quantify specific numbers of fish and/or age-class structure necessary to ensure the long-term survival of the species while maximizing genetic variability.

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PART III

IMPLEMENTATION SCHEDULE

The table that follows is a summary of scheduled actions and costs for this recovery program. It is a guide to meet the objectives of the recovery plan for the endangered June sucker. This table indicates the priority in scheduling tasks to meet the objectives, which agencies are responsible to perform these tasks, a time-table for accomplishing these tasks, and the estimated costs to perform them. Implementing Part III is the action of the recovery plan, that when accomplished, will satisfy the recovery objective. Initiation of these actions is subject to the availability of funds.

Definition of Priorities

Priorities in column one of the implementation schedule are assigned as follows:

Priority 1 - An action that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future.

Priority 2 - An action that must be taken to prevent a significant decline in species population/habitat quality or some other significant negative impact short of extinction.

Priority 3 - All other actions necessary to meet the recovery objectives.

Abbreviations

FWS	Fish and Wildlife Service
UDWR	Utah Division of Wildlife Resources
BR	Bureau of Reclamation
PRWUA	Provo River Water Users Association
CUWCD	Central Utah Water Conservancy District
DNR	Utah Department of Natural Resources
URMCC	Utah Reclamation Mitigation and Conservation Commission
DOI	Central Utah Project Completion Action Office

Other Definitions

Ongoing:	Task which is now being implemented, and should be continued on an annual basis.
Unknown:	The cost and/or duration of this task is yet to be determined and may require completion of other tasks to determine amount of effort required.

Chasmistes liorus (June sucker) Recovery Implementation Schedule

Priority	Task	Task Description	Task Duration	Responsible Party	FY-01	Cost Estimates FY-02	FY-03	Comments
1	1.1.1.1	Determine a genetic baseline for June sucker using historic samples	ongoing	UDWR	—*	—	—	
1	1.1.1.2	Determine degree of hybridization with Utah sucker	ongoing	UDWR	—	—	—	
1	1.1.1.3	Determine genetic variability within existing populations and year-classes	3 years	UDWR	—	30,000	30,000	
1	1.1.1.4	Determine genetic integrity and variability of existing refugia populations	3 years	UDWR	30,000	30,000	—	
1	1.1.2	Develop protocols to protect optimal genetic integrity of captive stock	1 year	UDWR	—	—	30,000	
2	1.1.3	Synthesize existing information to maximize genetic diversity in a management plan	1 year	UDWR	—	—	—	
1	1.2.1.1	Identify and select potential primary refuge site	ongoing	FWS, UDWR, FS, BR	—	—	—	Tentative site is Red Butte Reservoir
1	1.2.1.2	Secure selected primary refuge site	ongoing	FWS, FS, DOI, BR, URMCC, UDWR	unknown	unknown	unknown	Minimum costs to repair Red Butte Dam to State stds. are estimated at \$5 Million
1	1.2.1.3	Introduce June sucker into selected primary refuge site	ongoing	FWS, UDWR, FS	—	—	—	3200 June sucker have been stocked into Red Butte Reservoir, but additional stocking will be necessary to enhance the genetics

Chasmistes liorus (June sucker) Recovery Implementation Schedule

Priority	Task	Task Description	Task Duration	Responsible Party	Cost Estimates			Comments
					FY-01	FY-02	FY-03	
1	1.2.1.4	Monitor and maintain the refuge population in selected primary refuge site	ongoing	UDWR, FWS, FS	25,000	25,000	25,000	Costs of maintaining the dam will continue until the June sucker is recovered
2	1.2.2.1	Identify and select secondary refuge sites, with at least one located within the historic drainage of Utah Lake	unknown	FWS, UDWR, CUWCD, DOI	—	—	—	Tentative sites include Mona Reservoir, Camp Creek Reservoir, the Millville Ponds, and Ogden Nature Center Ponds
2	1.2.2.2	Secure secondary refuge sites		FWS, UDWR, CUWCD, DOI	unknown	unknown	unknown	
2	1.2.2.3	Introduce June sucker to secondary refuge sites	1 year	UDWR, FWS	—	—	—	
2	1.2.2.4	Monitor and maintain June sucker introduced into secondary refuge sites	ongoing	UDWR	5,000	5,000	5,000	All occupied sites are monitored by the UDWR
2	2.1.1	Refine and implement protocols for monitoring YOY production in Utah Lake tributaries	ongoing	UDWR	5,000	5,000	5,000	
2	2.1.2	Refine and implement protocols for monitoring the adult spawning population in Utah Lake tributaries	ongoing	UDWR	7,500	7,500	7,500	
3	2.3.1	Develop methods and implement a plan for monitoring June sucker in Utah Lake	ongoing	UDWR, URMCC	unknown	unknown	unknown	

Chasmistes liorus (June sucker) Recovery Implementation Schedule

Priority	Task	Task Description	Task Duration	Responsible Party	FY-01	Cost Estimates FY-02	FY-03	Comments
1	3.1.1	Refine flow requirements including timing, magnitude, and duration to maintain and enhance June sucker spawning and recruitment in the Provo River	ongoing	CUWCD, UDWR, FWS, DOI	unknown	unknown	unknown	
1	3.1.2	Identify flexibility in current flow operations in the Provo River and determine strategies and mechanisms for acquiring June sucker spawning and nursery flows	ongoing	CUWCD, PRWUA, BR, FWS, DOI	unknown	unknown	unknown	
1	3.1.3	Acquire and protect flows in the Provo River	ongoing	DNR, DOI, URMCC, BR, UDWR	unknown	unknown	unknown	\$15 Million has been authorized by Section 302(a) of CUPCA, URMCC has acquired about 1100 AF and additional acquisitions are being pursued
1	3.2.1	Analyze past and present habitat characteristics in the Provo River	ongoing	CUWCD, UDWR, FWS	unknown	unknown	unknown	
1	3.2.2.1	Provide low velocity habitats in the Provo River to enhance and maintain habitat limiting recruitment		UDWR, FWS	unknown	unknown	unknown	
1	3.2.2.2	Provide structural refugia in the Provo River to enhance and maintain habitat limiting recruitment	unknown	UDWR, FWS	unknown	unknown	unknown	
2	3.2.3	Monitor effectiveness of habitat management plan for Provo River	unknown	UDWR	unknown	unknown	unknown	

Chasmistes liorus (June sucker) Recovery Implementation Schedule

Priority	Task	Task Description	Task Duration	Responsible Party	FY-01	Cost Estimates FY-02	FY-03	Comments
1	3.3.1.1	Investigate Provo River-Utah Lake interactions to determine measures and alternatives necessary to protect June sucker from nonnative impacts	ongoing	UDWR	5,000	—	—	
1	3.3.1.2	Investigate feasibility of mechanically controlling nonnative fish predators within the Provo River	ongoing	UDWR	—	—	—	
1	3.3.2.1	Provide flows that minimize nonnative use of the Provo River	ongoing	BR, CUWCD, PRWUA, DOI, FWS, URMCC	unknown	unknown	unknown	
1	3.3.2.2	If determined feasible, mechanically control nonnative fish predators in the Provo River		UDWR, FWS	—	—	—	
2	3.3.3	Monitor effectiveness of nonnative control methods in the Provo River	ongoing	UDWR	unknown	unknown	unknown	
1	3.4.1.1	Investigate and implement alternatives for increasing habitat complexity in Utah Lake	Unknown	UDWR, FWS	unknown	unknown	unknown	
2	3.4.2.1	Evaluate Utah Lake water elevation instability impacts on aquatic vegetation	1 year	UDWR, URMCC	20,000	—	—	
2	3.4.2.2	Evaluate relationship between Utah Lake water elevations, riverine flows and aquatic vegetation	1 year	UDWR, URMCC, CUWCD	—	20,000	—	
2	3.4.2.3	Develop and implement plan to manage Utah Lake water elevations to enhance aquatic vegetation	unknown	UDWR, BR, CUWCD, PRWUA	unknown	unknown	unknown	

Chasmistes liorus (June sucker) Recovery Implementation Schedule

Priority	Task	Task Description	Task Duration	Responsible Party	FY-01	Cost Estimates FY-02	FY-03	Comments
3	3.4.2.4	Monitor and evaluate effectiveness of plan to manage Utah Lake water elevations to enhance aquatic vegetation	unknown	UDWR, BR, CUWCD, URMCC	unknown	unknown	unknown	
3	3.5.1.1	Develop and implement a plan to improve Utah Lake water quality	unknown	DNR	unknown	unknown	unknown	
3	3.5.1.2	Monitor impacts of Utah Lake water quality changes on June sucker	unknown	DNR	unknown	unknown	unknown	
1	3.6.1.1	Evaluate feasibility of Utah Lake nonnative fish eradication	1 year	UDWR, URMCC	30,000	—	—	
1	3.6.1.2	Implement appropriate control techniques or removal of nonnative fish in Utah Lake	unknown	UDWR	to be determined in 3611	to be determined in 3611	to be determined in 3611	
2	3.6.2	Investigate other impacts of nonnatives in Utah Lake on June sucker	ongoing	UDWR	unknown	unknown	unknown	
1	3.6.3.1	Evaluate feasibility of alternative forage in Utah Lake as a potential buffer for predation effects	1 year	UDWR	—	20,000	20,000	
2	3.6.4	Monitor and evaluate effectiveness of nonnative control strategies in Utah Lake	unknown	UDWR, FWS, URMCC	—	—	—	
2	3.7.1	Determine nutritional needs of June sucker	1 year	UDWR	20,000	—	—	
2	3.7.2	Investigate food availability and abundance in Utah Lake	2 years	UDWR	—	20,000	20,000	

Chasmistes liorus (June sucker) Recovery Implementation Schedule

Priority	Task	Task Description	Task Duration	Responsible Party	FY-01	Cost Estimates FY-02	FY-03	Comments
1	4.1.1.1	Identify and select potential site for hatching and rearing facility to propagate June sucker for introduction into Utah Lake	1 years	URMCC, UDWR, FWS	30,000	—	—	
1	4.1.1.2	Procure and secure preferred hatchery and rearing facility site	1 year	URMCC, UDWR	unknown	unknown	unknown	
1	4.1.1.3	Design and construct hatchery and rearing facility	3 years	URMCC, UDWR, FWS	3.5 million	3.5 million	3 million	
1	4.1.1.4	Secure brood stock at hatchery and rearing facility	1 year	UDWR	—	—	—	
2	4.1.2.1	Develop production goals and augmentation plan for captive brood stock	1 year	UDWR, FWS	—	—	—	
1	4.1.3	Propagate and stock June sucker into Utah Lake	unknown	UDWR, URMCC	unknown	unknown	unknown	
3	4.2.1.1	Analyze past and present habitat characteristics and complexity of other tributaries to Utah Lake for potential to establish a spawning run	1 year	CUWCD, UDWR	—	—	—	
3	4.2.1.2	Determine barriers to establishing a spawning stock in other tributaries	1 year	CUWCD, FWS UDWR, DOI, BR	—	—	—	
3	4.2.1.3	Develop and implement habitat rehabilitation program to improve suitability of other tributaries for spawning stock	unknown	UDWR, BE, FWS, CUWCD, DOI	unknown	unknown	unknown	

3	4.2.2	Develop guidelines for introduction of June sucker into other tributaries	1 year	UDWR, FWS	—	—	—
3	4.2.3	Establish spawning stocks in other tributaries	unknown	UDWR, FWS	—	—	—
3	4.2.4	Monitor and evaluate effectiveness of establishing other tributary spawning stocks	unknown	UDWR, FWS	—	—	—
3	5.0	Develop and conduct interpretation and education highlighting the value of the Utah Lake ecosystem and the June sucker and associated recovery efforts.	ongoing	all parties	unknown	unknown	unknown
1	6.1	Maintain presence of law enforcement officials and biologists in the Provo River to protect June sucker during the spawning run	ongoing	FWS, UDWR	—	—	—
3	7.1	Conduct an analysis to refine quantified objectives for June sucker recovery including a definition of a self-sustaining June sucker population	1 year	CUWCD, UDWR, FWS	10,000	—	—

* This task has either been completed or there are no direct costs associated with it.

PUBLIC COMMENT

This recovery plan was made available to the public for comment as required by the 1988 amendments to the Endangered Species Act of 1973. The public comment period was announced in the Federal Register (60 FR 29711) on June 5, 1995 and closed on August 4, 1995. During the public comment period seven letters of comment were received. The comments provided in these letters have been considered and incorporated as appropriate. Comments are maintained at the Services Utah Ecological Services Field Office and are available for public inspection, by appointment.

A Draft Final Recovery Plan was prepared and distributed to the following technical reviewers for comment prior to finalization and publication of this final plan.

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