GCMRC PROJECTS

1) A Program of Experimental Flows
2) A Plan to Establish a Second Population of Humpback Chub

SWCA TEAM

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- David L. Wegner – Principal, EMI
- Dorothy House – Editor, SWCA
- Marlis Douglas, Ph.D. – ASU

Table 1. Schedule for developing a Research and Implementation Plan for Experimental Flows from Glen Canyon Dam.

TASKS	Mar 1999	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan 2000	Feb
OBJECTIVE 1: DEVELOP R&I PLAN												
1A. Kickoff Meeting	5th											
1B. Develop Scope of Work	12th											
1C. Initiate/Maintain Agency Coordination												
1D. SWCA Workshops		13-16th		16-18th								
1E. Develop Internal Review Draft Report				15th								
1F. Preliminary Draft Report					15th							
1G. Review of Prelim Draft by GCMRC												
1H. Meet With TWG							7th					
1I. Draft Report To Scientific Review/TWG								1st				
1J. Scientific Review of Draft Final												
1K. Develop Prelim Final Report												
1L. Agency Review of Prelim Final Report												
1M. Final Report												28th
1N. Professional Meetings a/												Aug 2001
OBJECTIVE 2: PROVIDE JUSTIFICATION												
2A. Develop Supporting Data												
OBJECTIVE 3: DEVELOP HYPOTHESES												
3A. Develop Primary Hypotheses												
3B. Address Native/Non-Native Concerns												
OBJECTIVE 4: DEVELOP OUTLINE												
4A. Identify Needs & Requirements												

a/ 131st AFS Annual Meeting will be held August 19-23, 2001 in Phoenix, Arizona

REQUEST FOR PROPOSALS
ISSUED JULY 31, 1998

A REQUEST FOR PROPOSALS TO DESIGN A RESEARCH AND IMPLEMENTATION PLAN FOR ENDANGERED FISH RESEARCH

- **PROJECT OBJECTIVES**
  - **Develop a research and implementation plan for one or more experimental flows, consistent with the Biological Opinion.**
  - **Each proposed flow should be accompanied with supporting data and soundly justified based on these data.**
  - **Each proposed flow should be accompanied with testable hypotheses that relate to the Biological Opinion and to concerns between native/non-native fish interactions.**
  - **Each proposed plan should be accompanied with an outline describing the steps required for implementation and estimated costs for each plan**

EVOLUTION OF EXPERIMENTAL FLOWS

- Concept first presented as Element 1a of the RPA of Draft BO of 19 May 1993 "...to facilitate natural ecosystem processes which include accomodating the needs of endangered and other native fishes..."

- Element 1A of RPA of Final BO of 21 December 1994 "A program of experimental flows will be carried out to include high steady flows in the spring and low steady flows in summer and fall during low water years (releases of approximately 8.23 maf) to verify an effective flow regime and to quantify...effects on endangered and native fish."

PURPOSE AND OBJECTIVES OF PROPOSED PROGRAM OF EXPERIMENTAL FLOWS

PURPOSE: To benefit the endangered and native fishes by providing high spring releases and low steady summer flows during low water years (approximately 8.23 maf)

- **OBJECTIVES**
  - **Enhance survival and growth of young native fishes by providing stable, warm, productive shoreline nursery habitats**
  - **Increase recruitment of native fishes**
  - **Minimize adverse effects of non-native fishes**
  - **Contribute toward recovery of endangered humpback chub and razorback sucker**

PRIMARY HYPOTHESES

No significant differences in life history parameters for LSSF compared to MLFF (native & non-native)

- Growth
- Survival
- Condition
- Density
- Distribution
- Recruitment

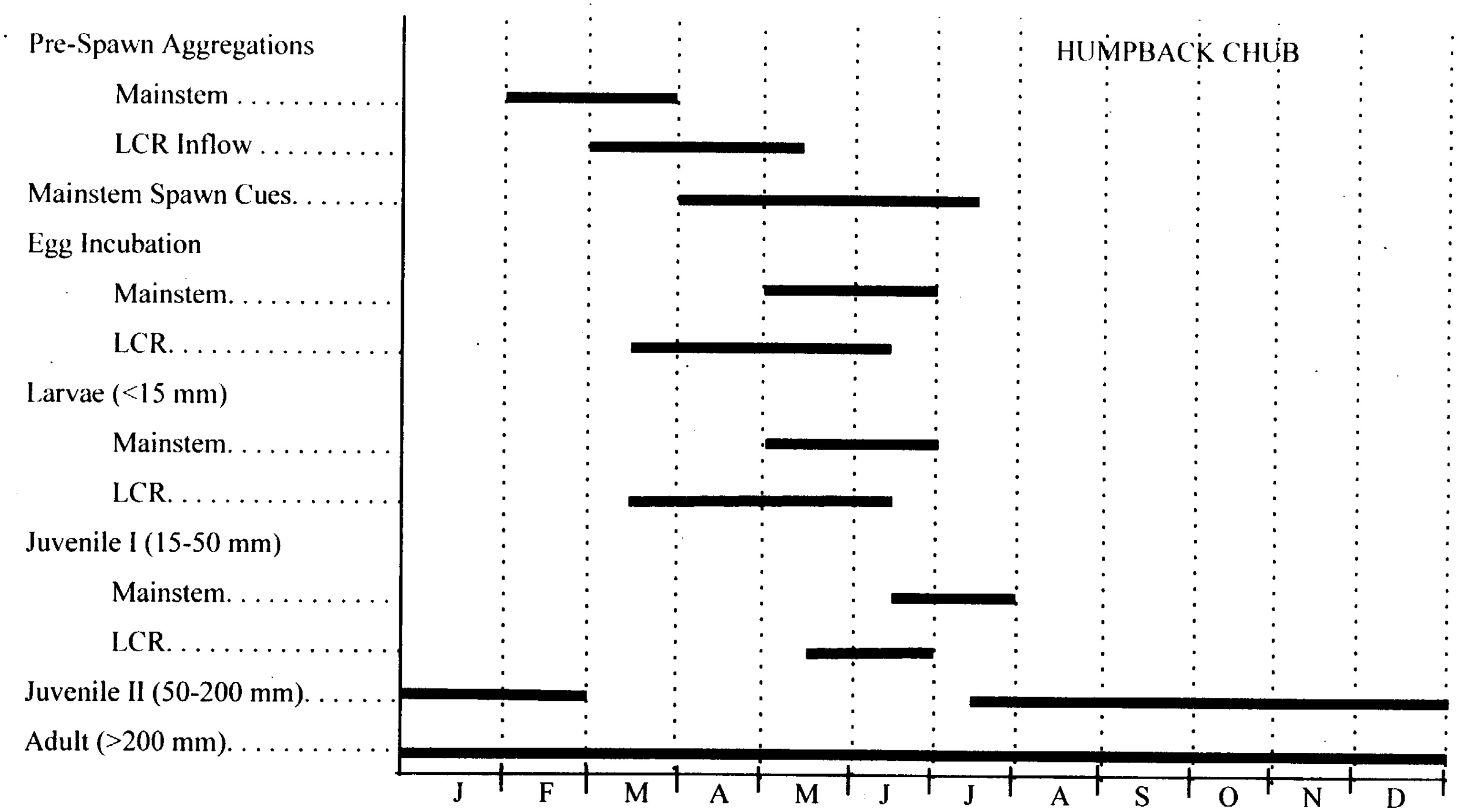


Figure 3a. Life history phenologies for the native fishes in the mainstem Colorado River and the Little Colorado River (LCR) in Grand Canyon.

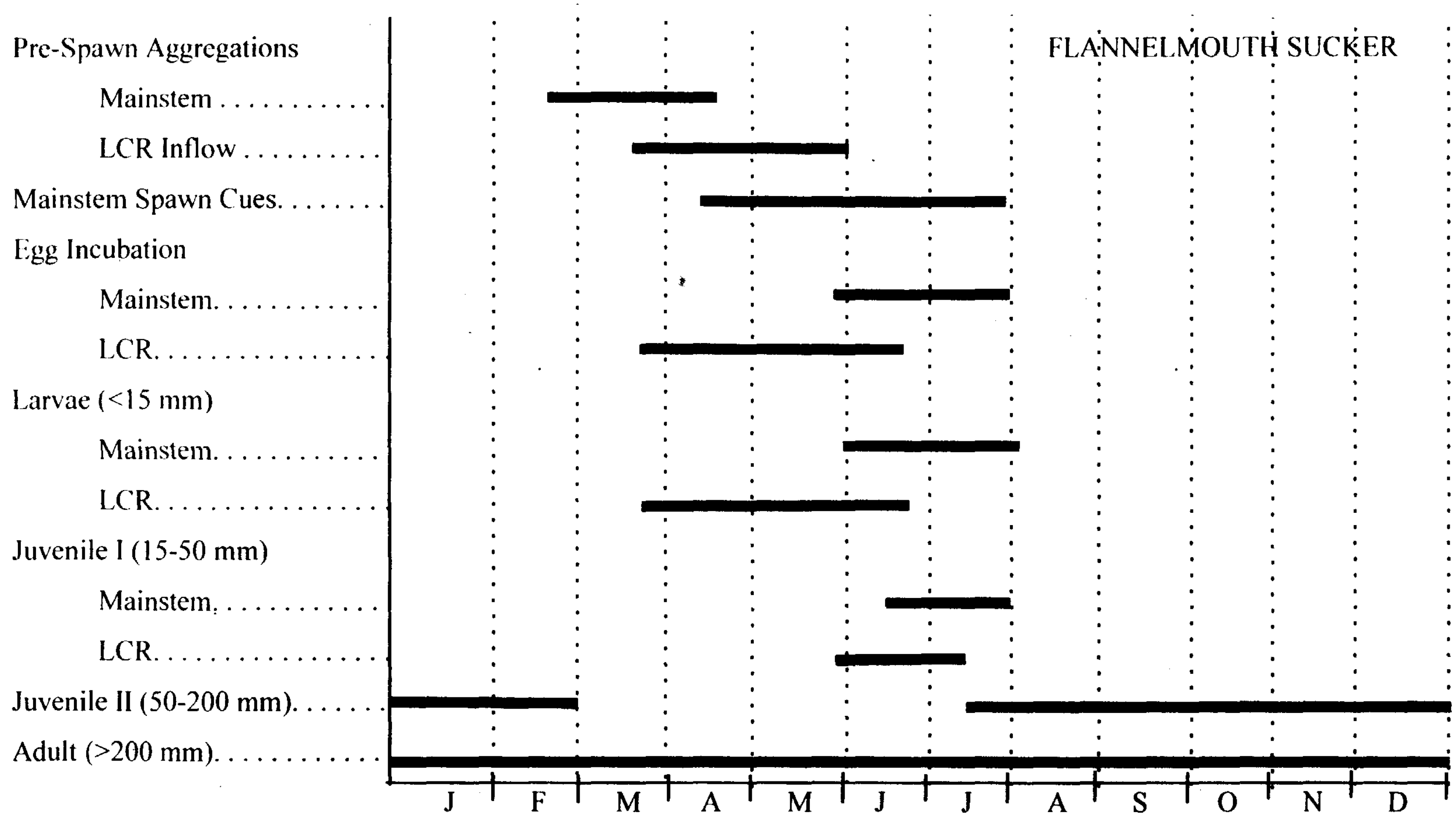


Figure 3b. Life history phenologies for the native fishes in the mainstem Colorado River and the Little Colorado River (LCR) in Grand Canyon.

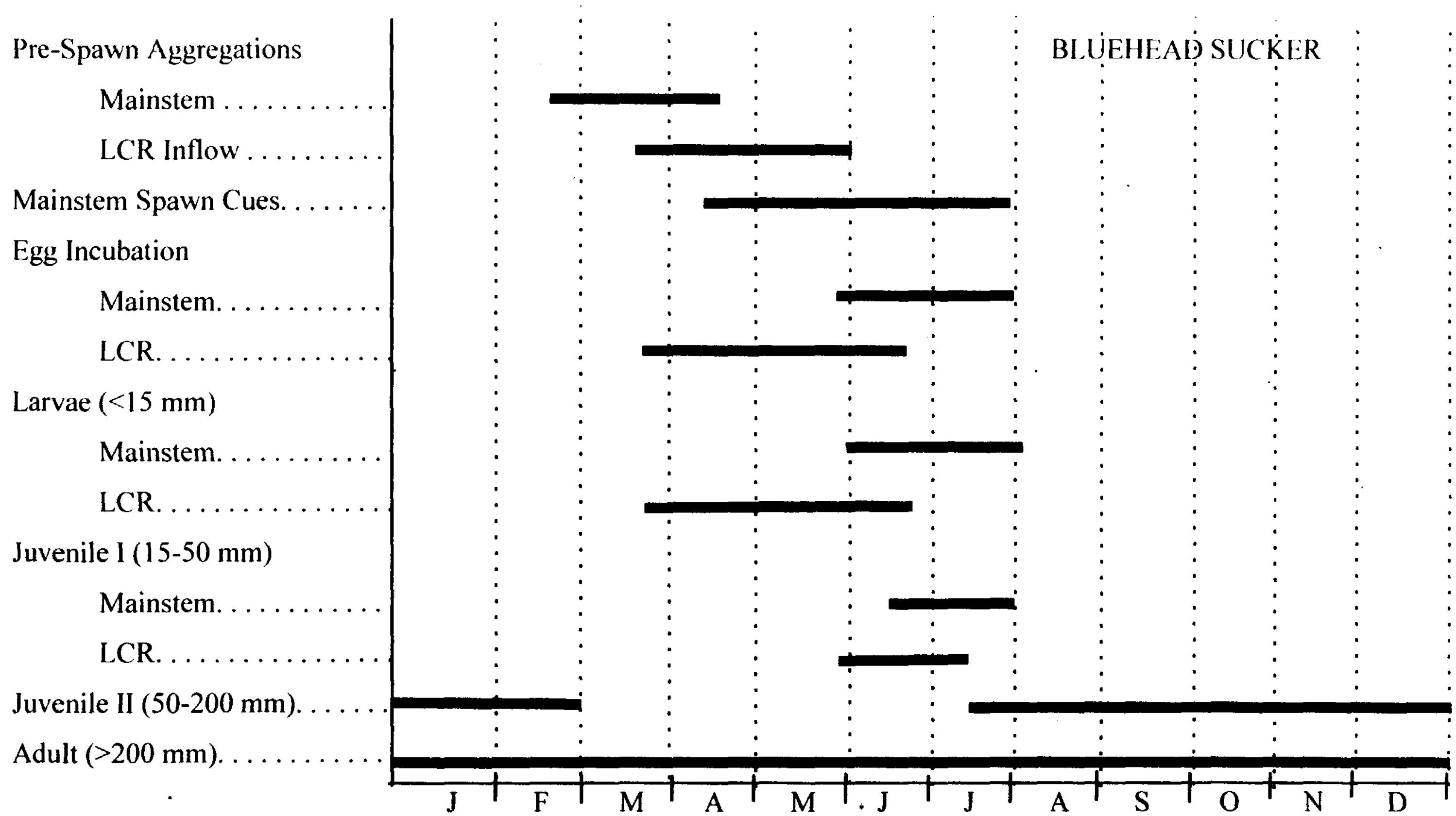


Figure 3c. Life history phenologies for the native fishes in the mainstem Colorado River and the Little Colorado River (LCR) in Grand Canyon.

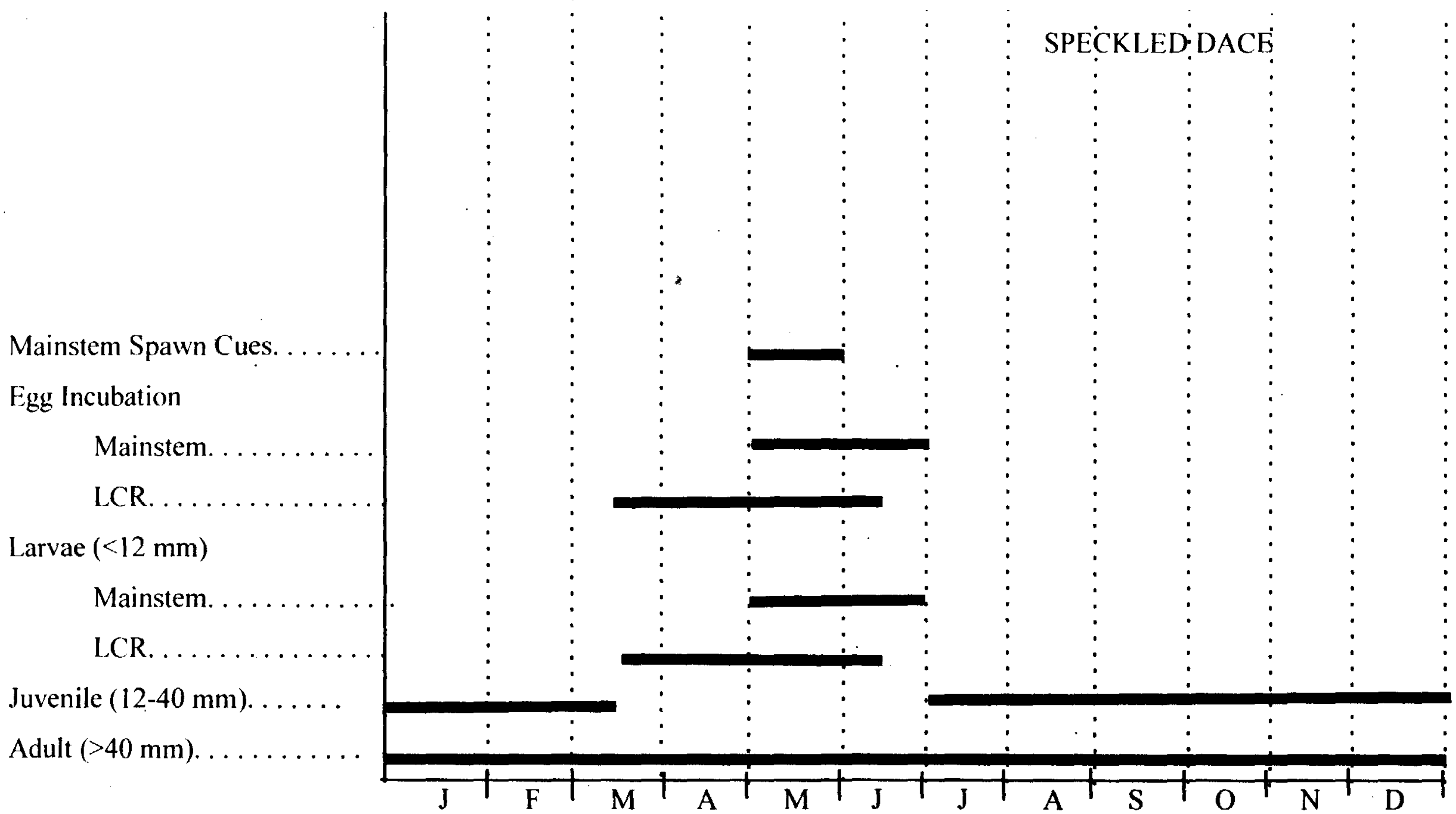


Figure 3d. Life history phenologies for the native fishes in the mainstem Colorado River and the Little Colorado River (LCR) in Grand Canyon.

Table 2. Important life stages of the four native fishes by hydrographic period.

Fish Species	Period I: March-May	Period II: June-September	Period III: October-February
humpback chub	–pre-spawning aggregations at mouth of LCR –adults ascend LCR for spawning –spawning in LCR and drift of larvae to mainstem –larvae and early juveniles rearing along shallow shorelines and backwaters	–juvenile I rearing along shallow shorelines and backwaters –adults in mainstem eddies	–need food resources for maximum accumulation of fats leading to spawning –adults in pre-spawning aggregations in mainstem eddies –juvenile II rearing along deep shorelines and backwaters
flannelmouth sucker	–adults in pre-spawning aggregations at tributary inflows –adults ascend tributaries for spawning –larvae drift into mainstem –larvae and early juveniles rearing along shallow shorelines and backwaters	–juvenile I rearing along shallow shorelines and backwaters –adults disperse through mainstem	–need food resources for maximum accumulation of fats leading to spawning –adults in pre-spawning aggregations at tributary inflows in March –juvenile II rearing along deep shorelines and backwaters
bluehead sucker	–adults in loose pre-spawning aggregations at tributary inflows in April –adults ascend tributaries for spawning –larvae drift into mainstem –larvae and early juveniles rearing along shallow shorelines and backwaters	–juvenile I rearing along shallow shorelines and backwaters –adults disperse through mainstem, mainly near tributary inflows	–need food resources for maximum accumulation of fats leading to spawning –adults in tributary inflows in March –juvenile II rearing along deep shorelines and backwaters
speckled dace	–adults in loose pre-spawning aggregations at tributary inflows in April-May –adults use tributary inflows and mainstem shorelines for spawning –larvae drift in mainstem –larvae and early juveniles rearing along shallow shorelines and backwaters	–juveniles rearing along shallow shorelines and backwaters –adults dispersed along shorelines and in tributary inflows	–need food resources for maximum accumulation of fats leading to spawning –adults dispersed along shorelines and in tributary inflows

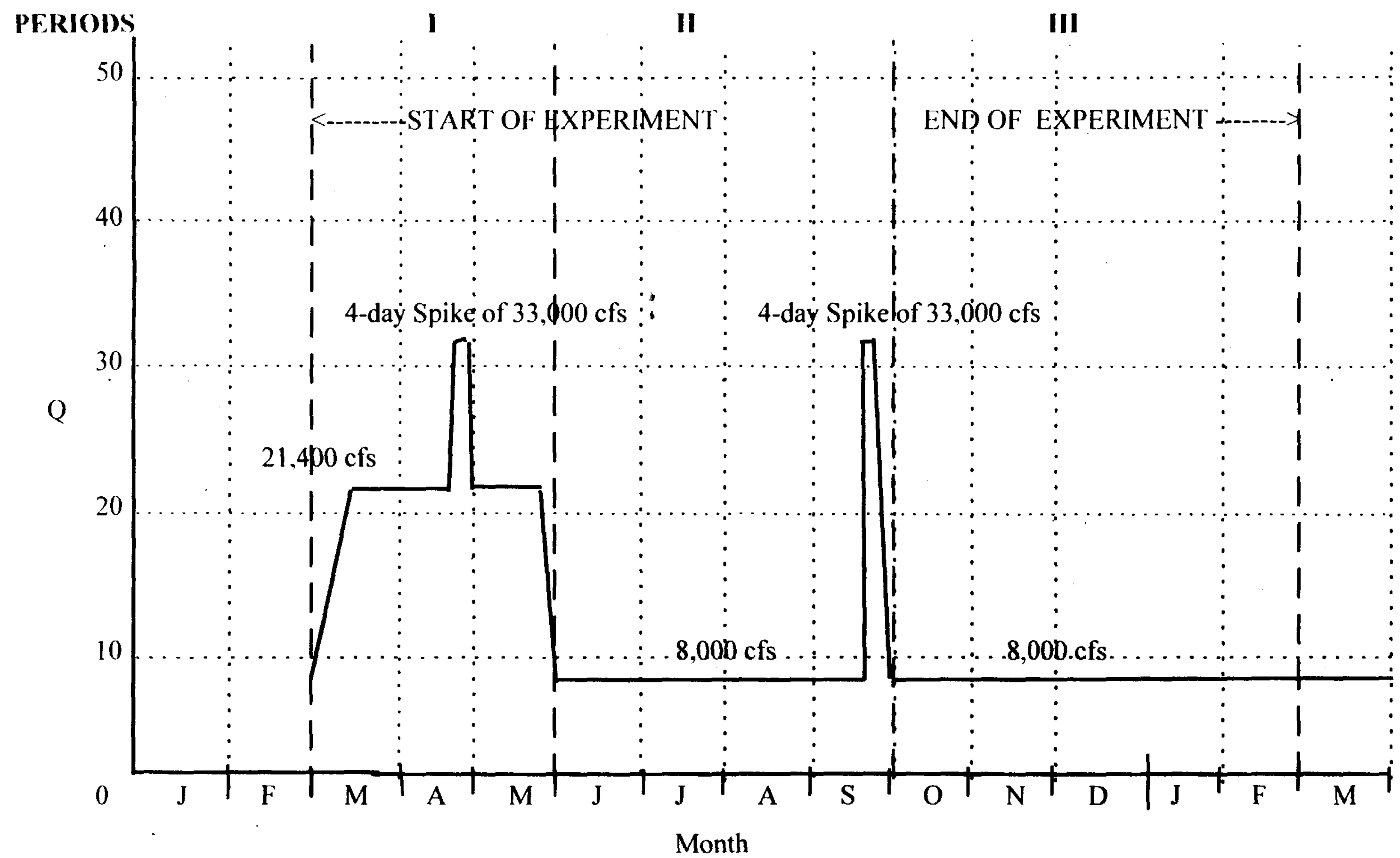
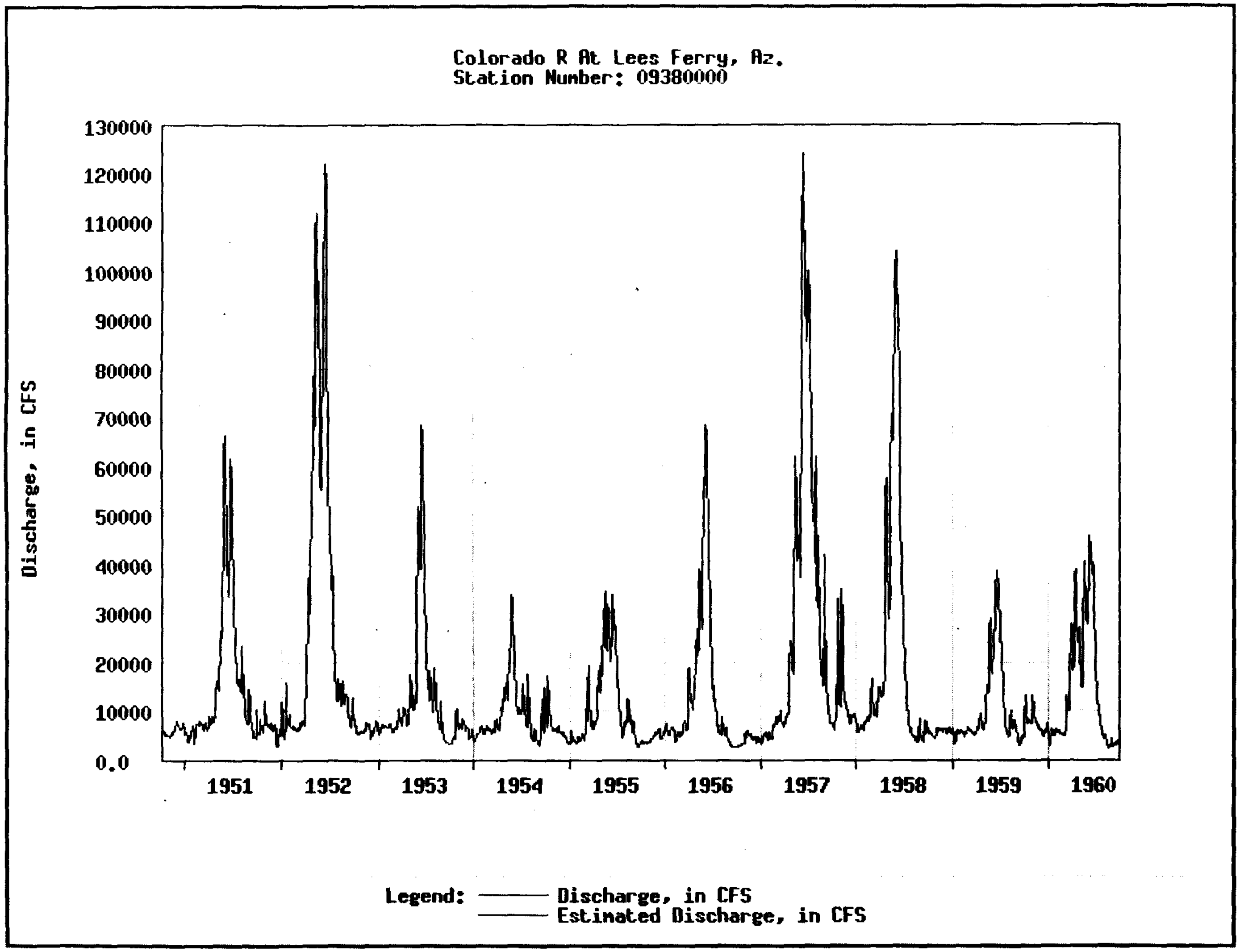


Figure 5. Hydrograph of experimental flows (Q = cubic feet per second x 1,000) designed to release a volume of approximately 8.23 maf.

Table 1. Release characteristics of the GCDEIS No Action, MLFF, and SASF Alternatives[1], compared to the Experimental Flow (EF).

Alternative	Minimum Release (cfs)	Maximum Release (cfs)	Daily Fluctuations (cfs/24 hrs)	Ramp Rate
No Action	1.000 Labor Day to Easter 3.000 Easter to Labor Day	31.5000	30,500 Labor Day to Easter 28,500 Easter to Labor Day	Unrestricted
Modified Low Fluctuating Flow (MLFF: Preferred Alternative)	8.000 7 a.m. to 7 p.m. 5.000 7 p.m. to 7 a.m.	25.000	5.000; 6.000; or 8.000 depending on monthly release volume	4,000 cfs/hr up 1,500 cfs/hr down
Seasonally Adjusted Steady Flow (SASF)	8.000 Oct–Nov 8.500 Dec 11.000 Jan-Mar 12.500 Apr 18.000 May–Jun 12.500 Jul 9.000 Aug–Sep	18.000 same same same same same same	± 1,000 same same same same same same	2.000 cfs/day when releases are changed between steady flow periods
Experimental Flow (EF): High Steady Spring. Low Steady Summer Flow	8.000 Jun-Feb 21.400 March 15-May 25	33.000 spike for 4 days last week Apr 33.000 spike for 4 days last week Sep	±1.000 same same same	Ramp 8.000 to 21.400 cfs during March 1-15 Ramp 21,400 to 8.000 during May 25-31 Ramp spikes at 4.000 cfs/hr up 1.500 cfs/hr down

[1]Source: U.S. Department of Interior (1995)


Colorado R At Lees Ferry, Az.
Station Number: 09380000
Discharge, in CFS
130000
120000
110000
100000
90000
80000
70000
60000
50000
40000
30000
20000
10000
0.0
1951
1952
1953
1954
1955
1956
1957
1958
1959
1960
Legend:
Discharge, in CFS
Estimated Discharge, in CFS

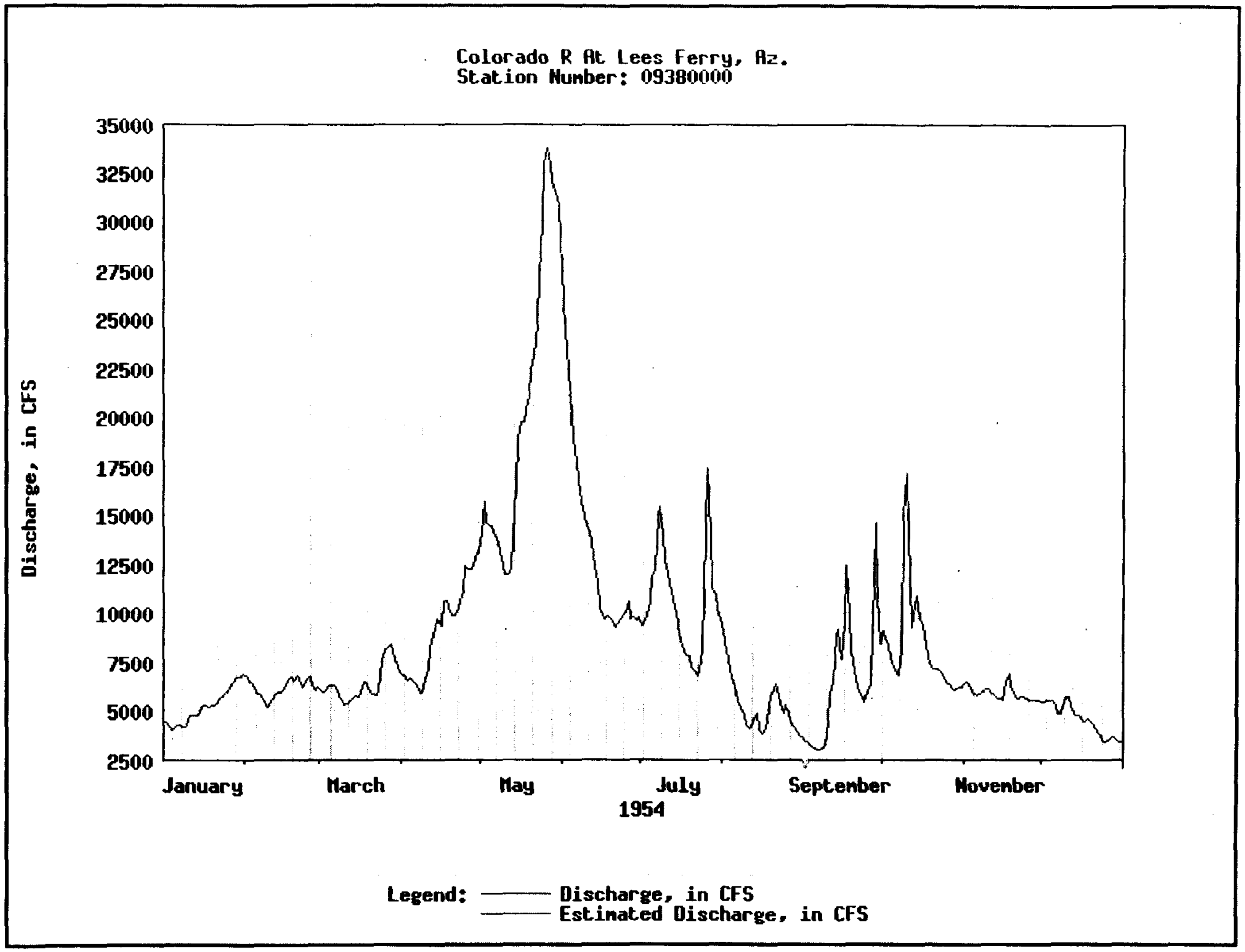

Colorado R At Lees Ferry, Az.
Station Number: 09380000
Discharge, in CFS
35000
32500
30000
27500
25000
22500
20000
17500
15000
12500
10000
7500
5000
2500
January
March
May
July
September
November
1954
Legend: Discharge, in CFS
Estimated Discharge, in CFS

Table 3. Anticipated benefits and risks for resources by hydrographic period.

Fish Species	Period I: March-May	Period II: June-September	Period III: October-February
Abiotic Resources Benefits	–scour and maintain backwater –flush sediments from spawning areas –mobilize and store some sands and sediments	–stabilize nearshore habitats and backwaters –enhance longitudinal warming of mainstem river –warm nearshore habitats and backwaters –spike may resuspend and store sand and sediment from tributary monsoonal floods	No significant benefits
Abiotic Resources Risks	No significant risks	–minimize thermal plume at 30-mile –reduce tributary inflow habitats	No significant risks
Biotic Resources Benefits	–ponded tributary inflows provide thermal refuges for drifting larvae and young fish –ponded tributary inflows provide access for spawning runs of native fish –destabilize habitats to disadvantage non-native fishes –redistribute nutrients –reset community production –cue mainstem spawning	–increase growth rate of juvenile native fishes –increase survival of larvae and young in the mainstem –increase autotrophic algal and macroinvertebrate production –maximize mainstem egg incubation and hatching success –spike flow flushes non-native fish from backwaters and shorelines	–maintain stable winter conditions to minimize energy expenditure –maintain overwinter autotrophic production in mainstem, shorelines, backwaters
Biotic Resources Risks	--warm ponded tributary inflows attract non-native fish predators –disrupt reproductive cues for native fish ascending to spawn in LCR	–mainstem reproduction by non-native fishes --increase growth and survival of non-native fishes –increase infestation rate of parasites and diseases –decrease drift of food for fish –minimize thermal plume at 30-mile may increase predation –increased water clarity may lead to increased predation of native fish by sight feeders	–overwinter survival and expansion of non-native fishes –enhance spawning success of downstream populations of trout –decrease drift of food for fish –increased water clarity may lead to increased predation of native fish by sight feeders

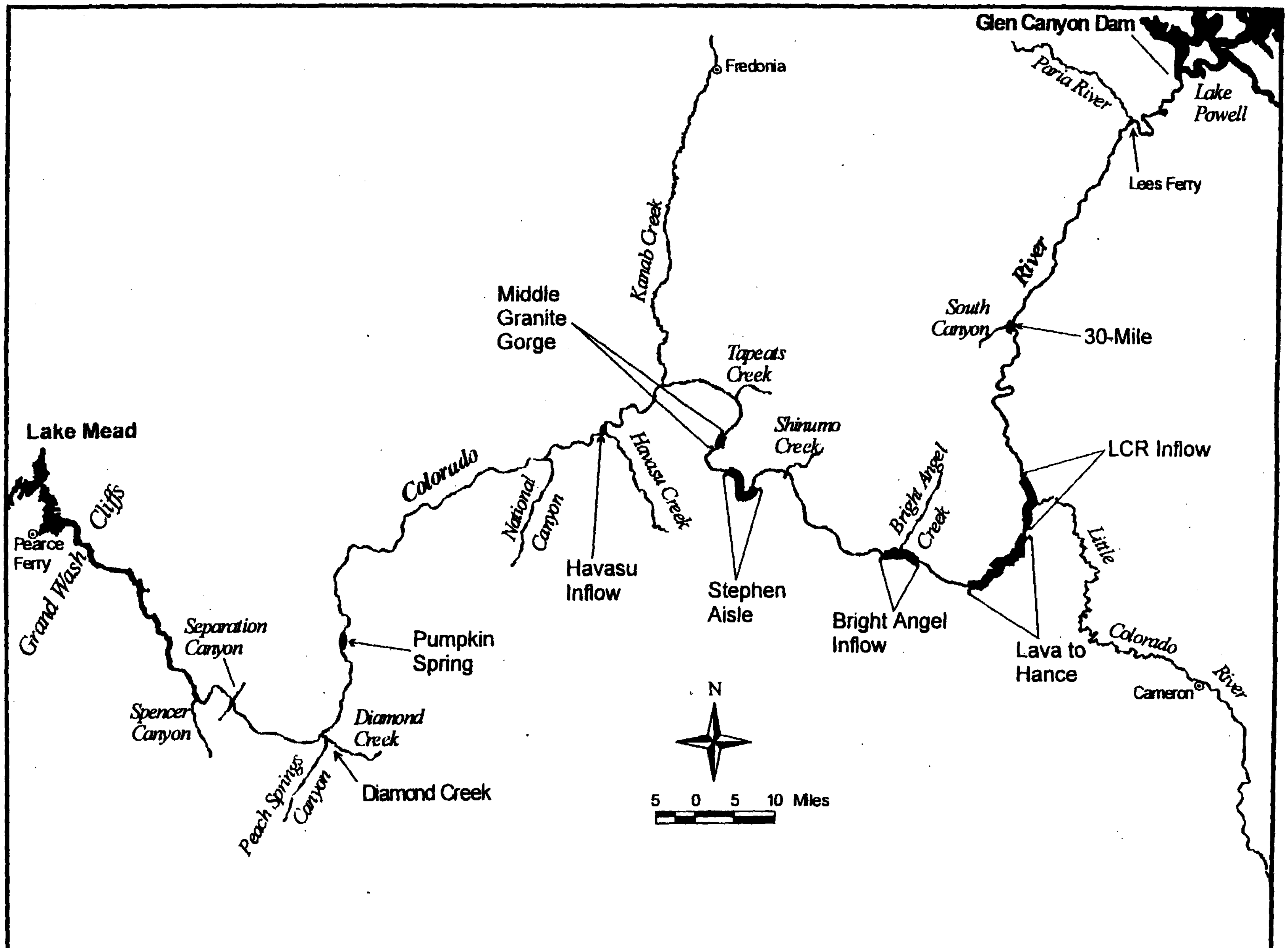
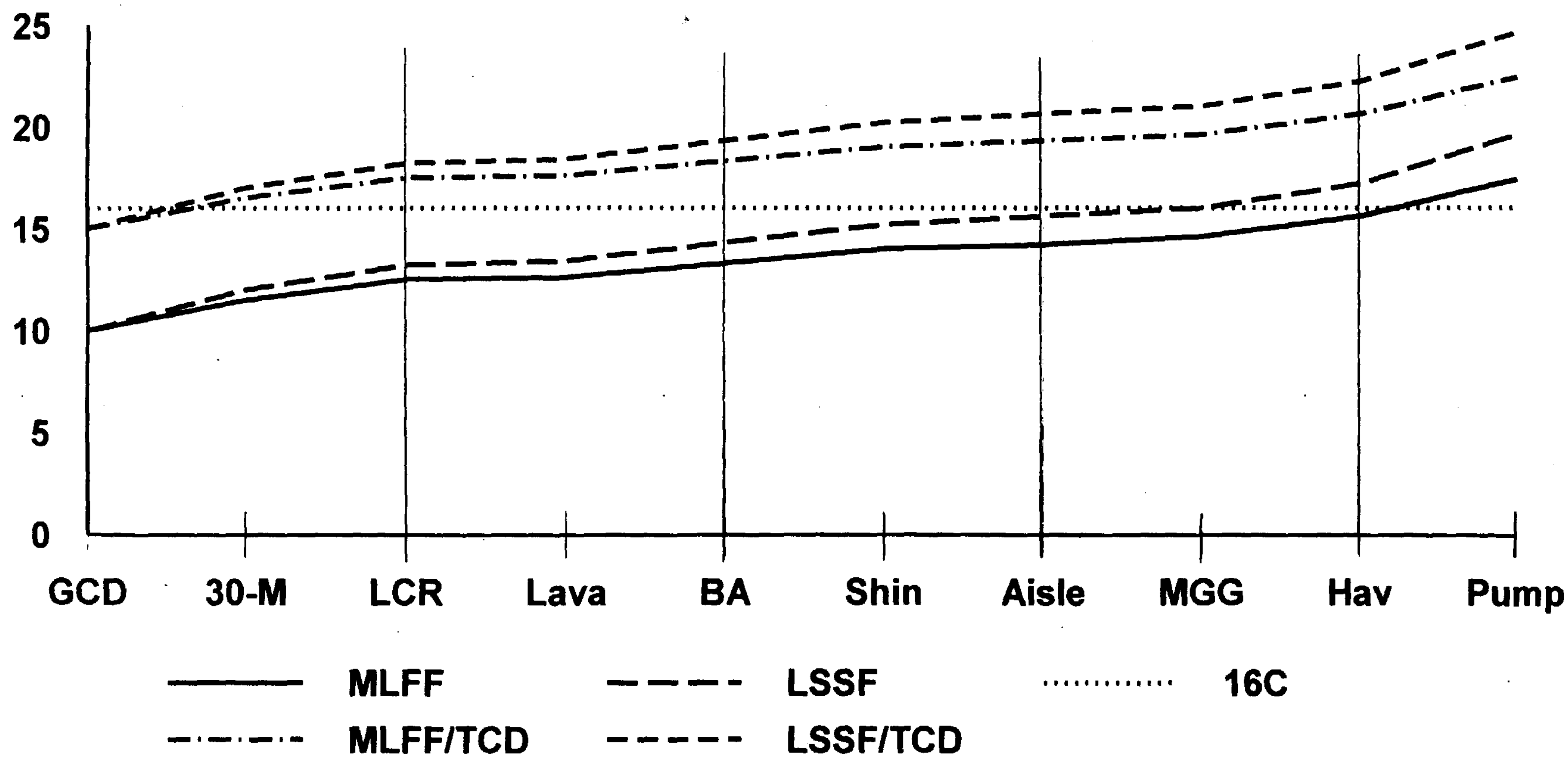
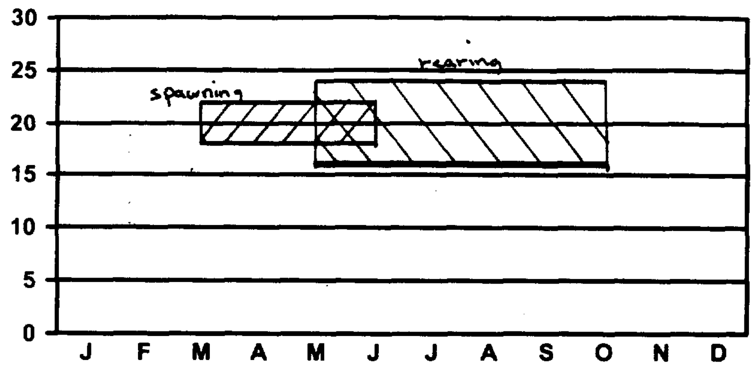


Figure 1. Locations of nine aggregations of humpback chub in the Colorado River though Glen and Grand Canyons. (From Valdez and Rycl 1995)

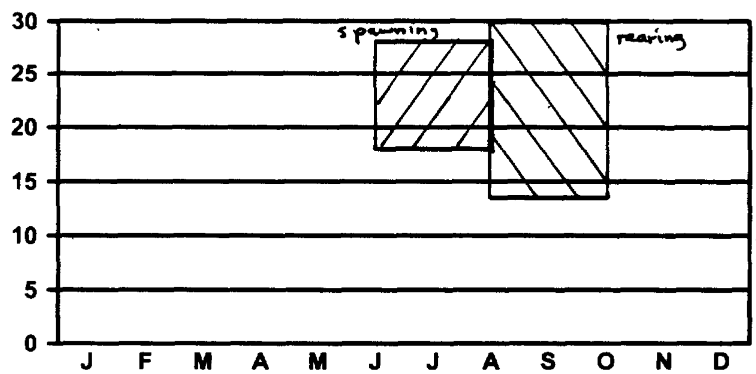
PREDICTED MAXIMUM RIVER TEMPERATURE AT HUMPBACK CHUB AGGREGATIONS



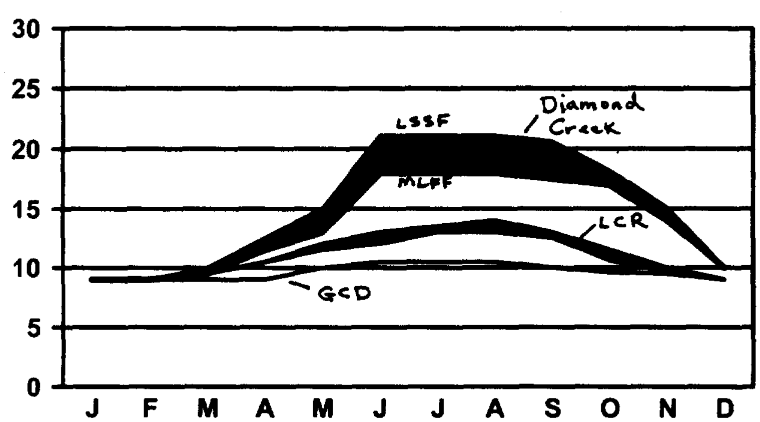
NATIVE FISH



NON-NATIVE FISH



TEMPERATURE



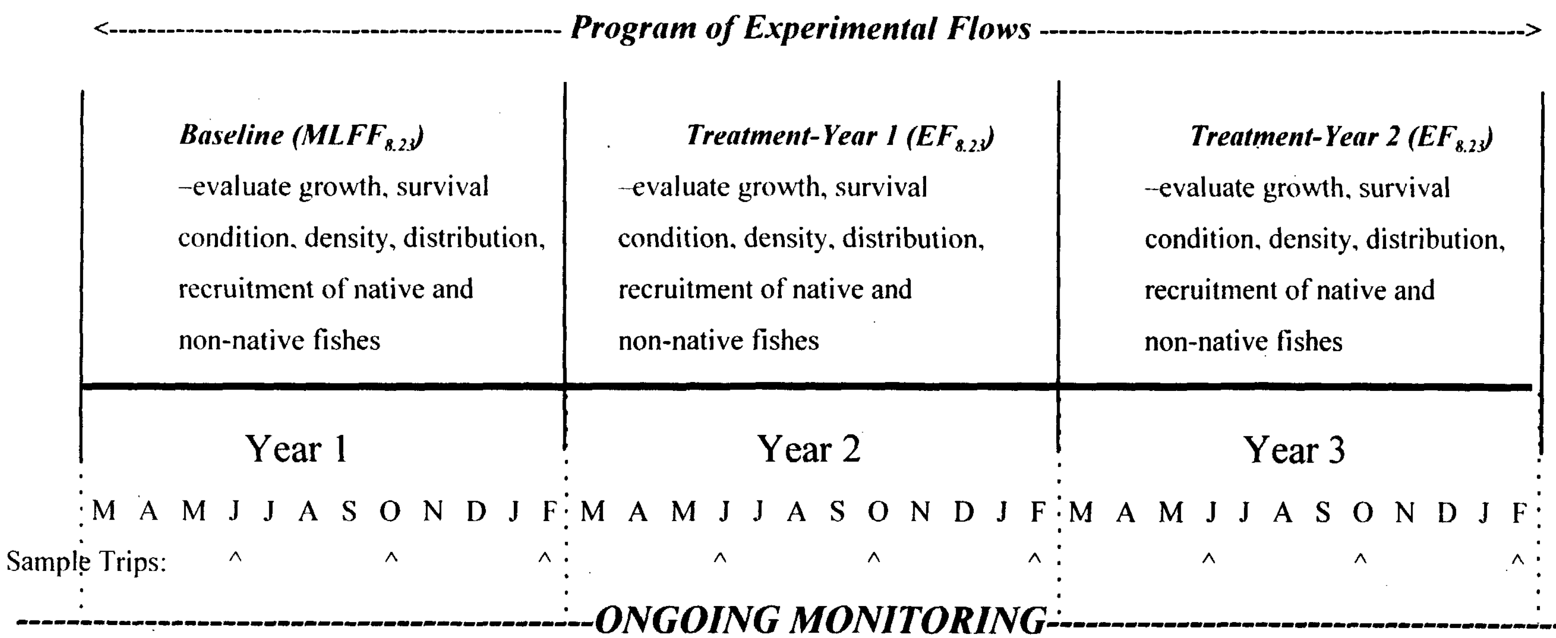


Figure 6. Study design to evaluate the program of experimental flows. Baseline ($MLFF_{8.23}$ = modified low fluctuating flows at 8.23 maf) and Treatments ($EF_{8.23}$ = experimental flows at 8.23 maf) may not occur in consecutive years, depending on the annual hydrology.

CRITERIA FOR IMMEDIATE TERMINATION

- Unacceptable risks to human safety from rafting incidents
- Unacceptable human health risks from water quality
- Invasion/expansion of large numbers of predatory fishes
- Large outbreaks of fish diseases with substantial deaths
- Significant losses of the food base

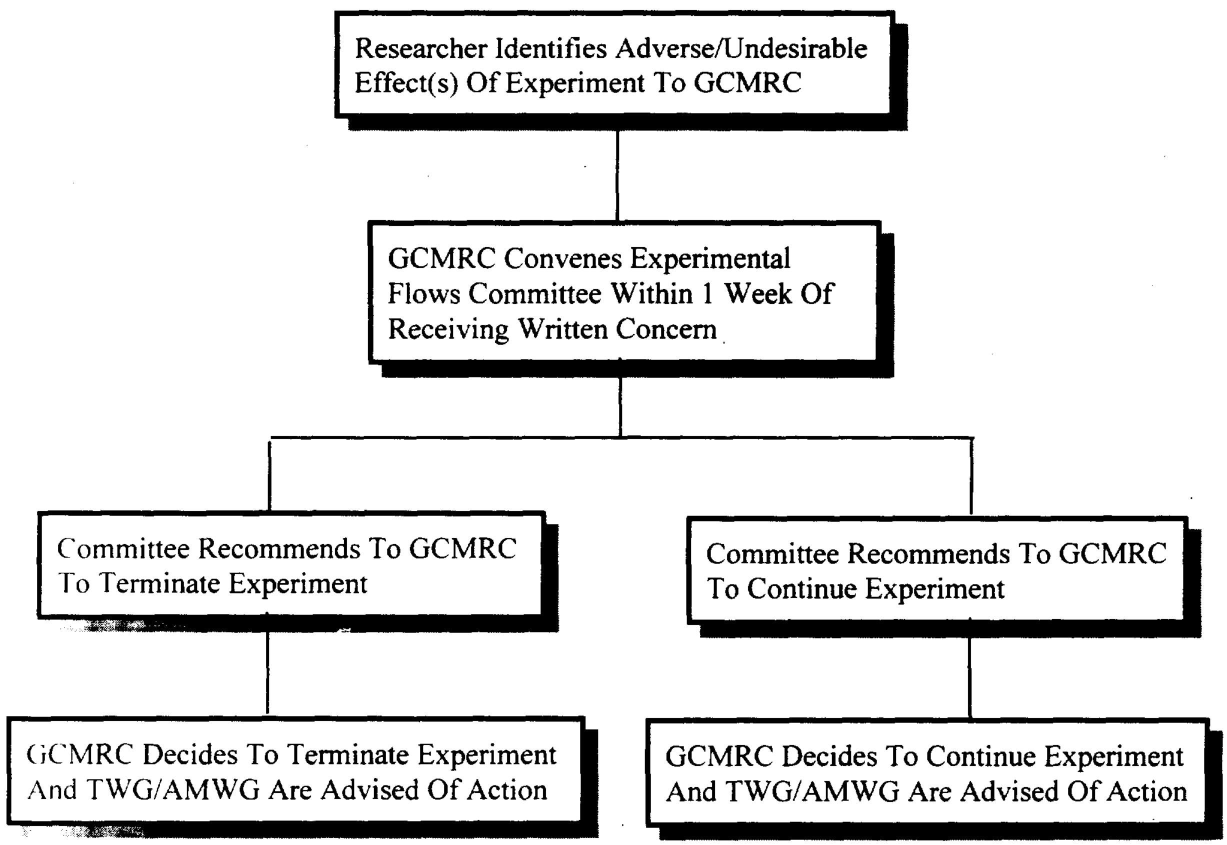


Figure 7. Decision chart for immediate termination of a treatment.

CRITERIA FOR DISCONTINUATION

- **The majority of primary hypotheses do not result in desirable resource responses, or**
- **Possible irreversible deleterious effects or observed damage to the aquatic ecosystem outweigh the benefits or positive effects.**

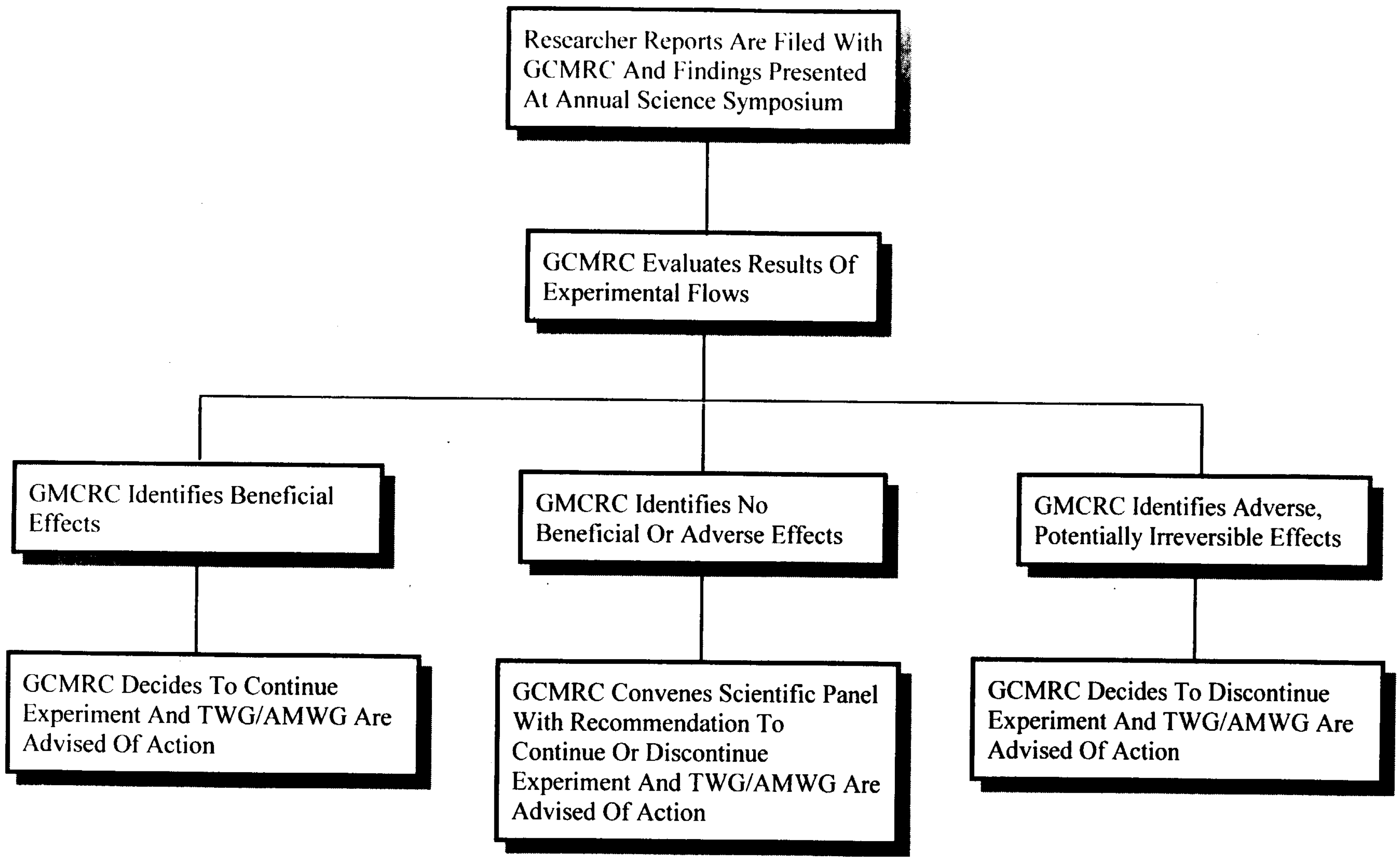


Figure 9. Decision chart for discontinuing the experimental flows program.