



— BUREAU OF —
RECLAMATION

Glen Canyon Dam Adaptive Management Program: Temperature Control and Entrainment Prevention

Bureau of Reclamation

Where do we start?

- Priorities
 - Temperature
 - Entrainment
- Diverse Think Tank
- Focused Facilitation



— BUREAU OF —
RECLAMATION

CONTROLLED

Value Program

Value Planning Study – Final Report
Not for Distribution Outside Reclamation

Glen Canyon Dam Fish Control Value Planning Study

Interior Region 7 – Upper Colorado Basin



Controlled by: Bureau of Reclamation, Interior Region 7 – Upper Colorado Basin, Regional Office
Decontrol by: Do not Decontrol

U.S. Department of the Interior

January 2025

CONTROLLED



CONTROLLED

Value Planning Study – Final Report
 Glen Canyon Dam Fish Control Value Planning Study

Criteria Weighting

The criteria weighting method used was the Combinex® matrix system developed in the early 1960s by value manager Carlos Fallon. The first step in the decision-making process consists of constructing a Criteria Scoring Matrix, which compares each criterion side-by-side.

The criterion having the greatest perceived importance is chosen and the degree of difference between the two criteria is placed in the corresponding cell below. When two criterion tie, a zero value is entered in either box. The number range used for the Criteria Matrix is 1 through 3 (1 being a minor preference and 3 being a major preference). If any criterion has a raw score of zero, it is given a rating of one. The lettering of the Criteria Matrix corresponds to the lettering shown above. Refer to figure 4.

Criteria	Preference	Preference	Preference	Preference	Preference	Preference	Preference	Preference	Raw Score	Weighted by 20	Normalized to 2	Normalized Percentage
A. Amount of Dam Safety Mitigation	A or B	A or C	A or D	A or E	A or F	A or G	A or H	A or I	1	1.4	0.04	4%
B. Flexibility in release temperature	B or C	B or D	B or E	B or F	B or G	B or H	B or I	B or J	3	4.4	0.12	12%
C. Effectiveness to limit entrainment	C or D	C or E	C or F	C or G	C or H	C or I	C or J	C or K	15	7.4	0.21	21%
D. Hydropower impacts	D or E	D or F	D or G	D or H	D or I	D or J	D or K	D or L	3	4.4	0.12	12%
E. Water Quality Impact	E or F	E or G	E or H	E or I	E or J	E or K	E or L	E or M	0	1.0	0.03	3%
F. O&M Considerations	F or G	F or H	F or I	F or J	F or K	F or L	F or M	F or N	4	2.7	0.08	8%
G. Constructability/Time to Implement	G or H	G or I	G or J	G or K	G or L	G or M	G or N	G or O	10	5.3	0.15	15%
H. Ability to sustain temp. below 15.5C at LCR	H or I	H or J	H or K	H or L	H or M	H or N	H or O	H or P	10	5.1	0.20	20%
									Sum	35.9	1.0	100%

Note: Important: Major Preference = 3, Medium Preference = 2, Minor Preference = 1, No Preference Each = 0.

Figure 4 – Project Criteria Scoring Matrix. (Reclamation)

Ranking Matrix

The study team determined the appropriate project criteria as a group, using their project expertise and knowledge. After the alternatives development, each alternative was evaluated based on the criteria matrix results and given a score ranging from one to five, one representing the least favorable (or poor) and five representing the most favorable outcome (or excellent). These scores were multiplied by the criteria weightings, and scores were summed for each alternative.

The results are shown in the following figure, along with the relative ranking of the Alternatives. In summary, the Alternatives were ranked as follow:

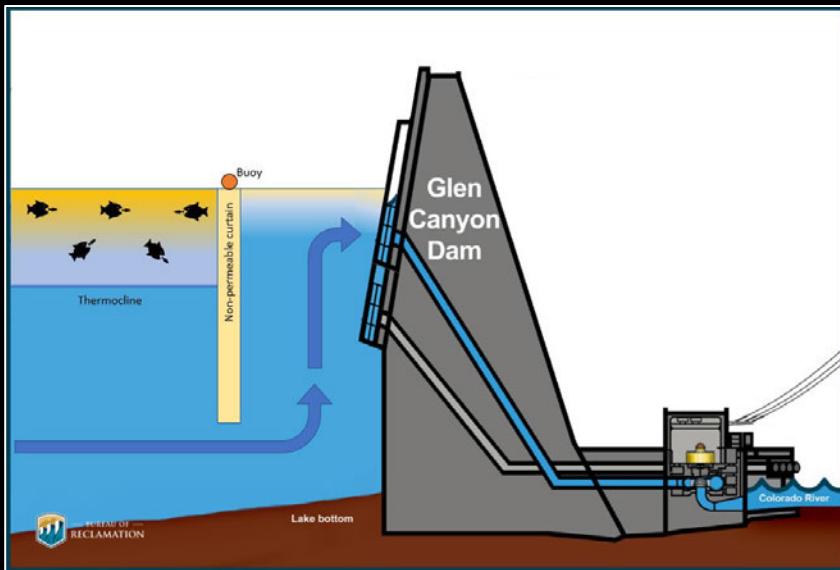
1. Alternative 1A – Thermal Curtain with Stimulus Barrier
2. Alternative 1B – Thermal Curtain without Stimulus Barrier
3. Alternative 3B – Destratification with Air Bubbles
4. Alternative 7 – Continued Bypass
5. Alternative 2 – Selective Withdrawal
6. Alternative 4 – Straw Selective Withdrawal

With continued progress and Project data collection, the criteria, criteria weighting, and scoring for each Alternative may change. This decision matrix can be updated, modified, and adjusted as the VP Study is developed. Refer to Figure 5.

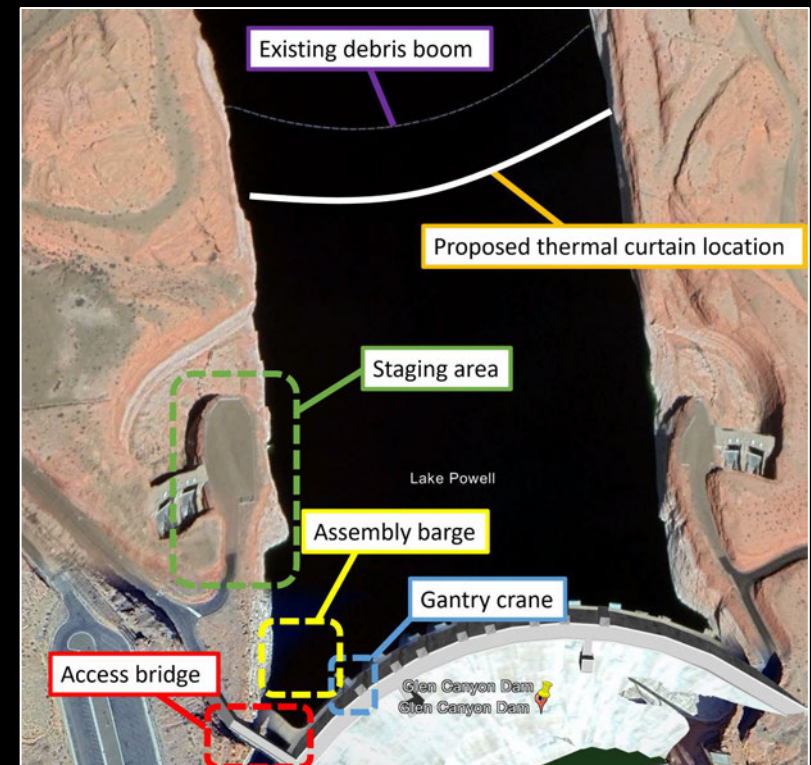
Criteria	Weight	%	Alternative										Raw Score	Normalized Score	Normalized Percentage				
			A	B	C	D	E	F	G	H	I	J							
1. Thermal Curtain	4	0.12	4	0.5	3	0.8	5	0.8	2	0.5	3	0.2	3	0.4	1.0	28	304	2	
2. Selective Withdrawal	3	0.1	3	0.4	2	0.4	4	0.5	4	0.5	3	0.2	3	0.3	4	1.0	25	305	4
3b. Destratification with air bubbles	2	0.2	3	0.4	2	0.4	5	0.8	3	0.1	4	0.3	5	0.7	3	0.6	30	348	3
3c. Destratification with surge	2	0.2	3	0.4	2	0.4	5	0.8	3	0.1	2	0.2	3	0.4	3	0.6	28	304	7
4. Straw Selective Withdrawal	2	0.1	3	0.4	2	0.4	5	0.8	3	0.1	1	0.1	3	0.4	3	0.8	22	285	8
5a. Pulse Generator at Penstock	2	0.1	1	0.1	4	0.8	5	0.8	5	0.1	4	0.5	4	0.8	1	0.3	28	284	8
5b. Thermal Curtain with Stimulus Barrier	4	0.2	4	0.5	4	0.8	5	0.8	2	0.1	3	0.2	4	0.8	4	1.0	30	360	1
6. Flared Selective Withdrawal	3	0.1	4	0.5	2	0.4	4	0.5	4	0.1	4	0.5	1	0.1	4	1.0	28	310	8
7. Continued Bypass	2	0.1	4	0.5	2	0.4	1	0.1	3	0.1	3	0.2	5	0.7	4	1.0	24	310	8

Score: Excellent = 5, Very Good = 4, Good = 3, Fair = 2, Poor = 1
 Total Possible Score = 5

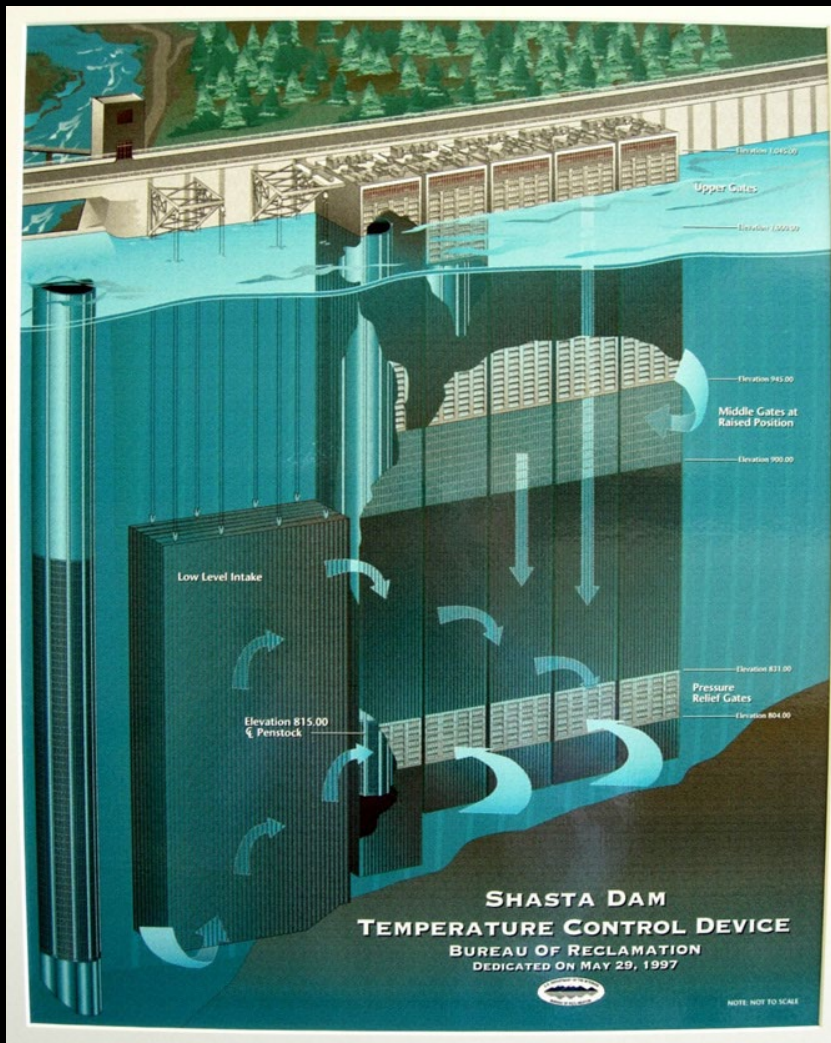
Figure 5 – Alternatives Ranking. (Reclamation)



Source: C. Ellsworth, WAPA



Source: C. Ellsworth, WAPA





Temperature Control Devices

- Examples
 - Whiskeytown - Curtain
 - Iron Gate - Curtain
 - Shasta Dam – Selective Withdrawal
 - Folsom Dam – Selective Withdrawal



Photo taken by Watercourse Engineering, Inc.

- Biofouling Study – Mussel Challenges
 - Pilot study complete
 - Field experiment – 2026

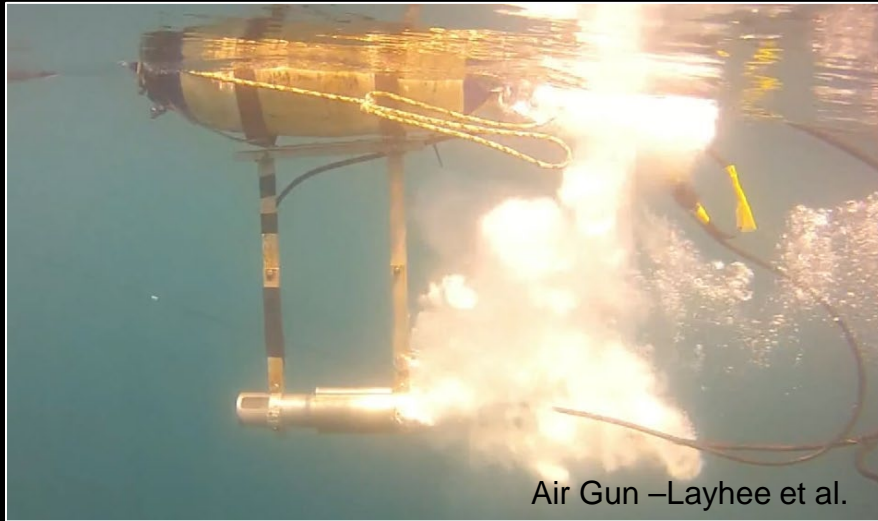
- Need - Feasibility
 - Data Collection
 - Design
 - Technical Model
 - Safety
 - Compliance



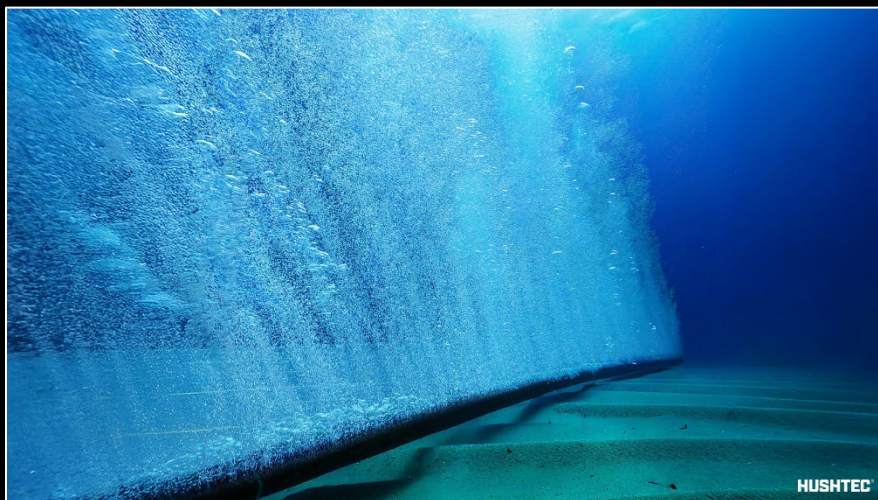
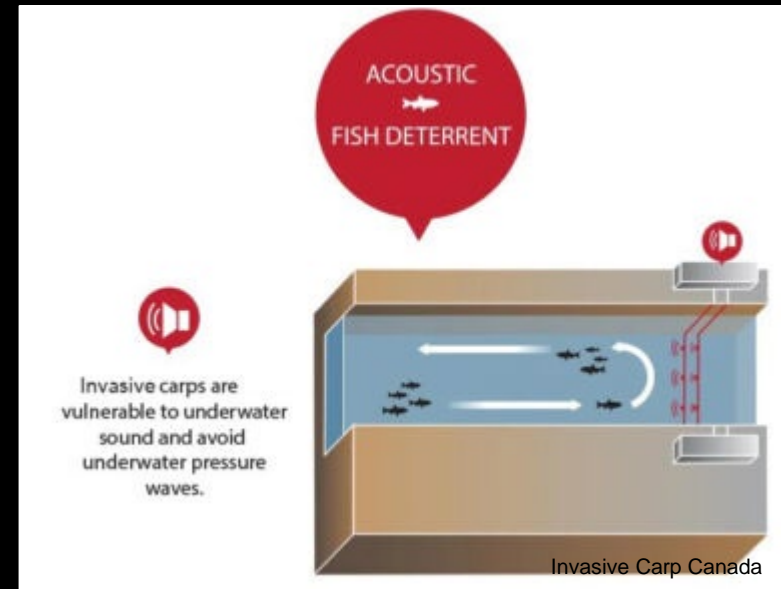
Photo taken by GLCA NRA



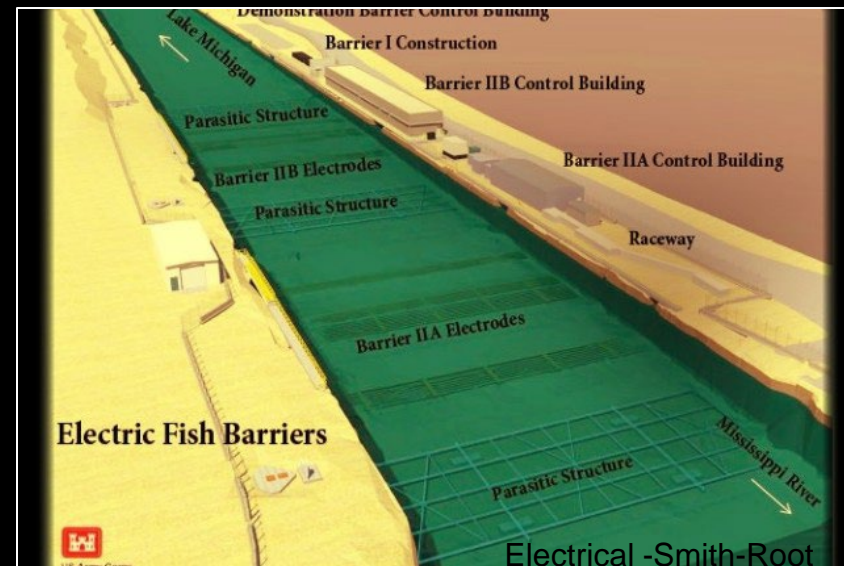
Deterrent Barriers



Air Gun –Layhee et al.



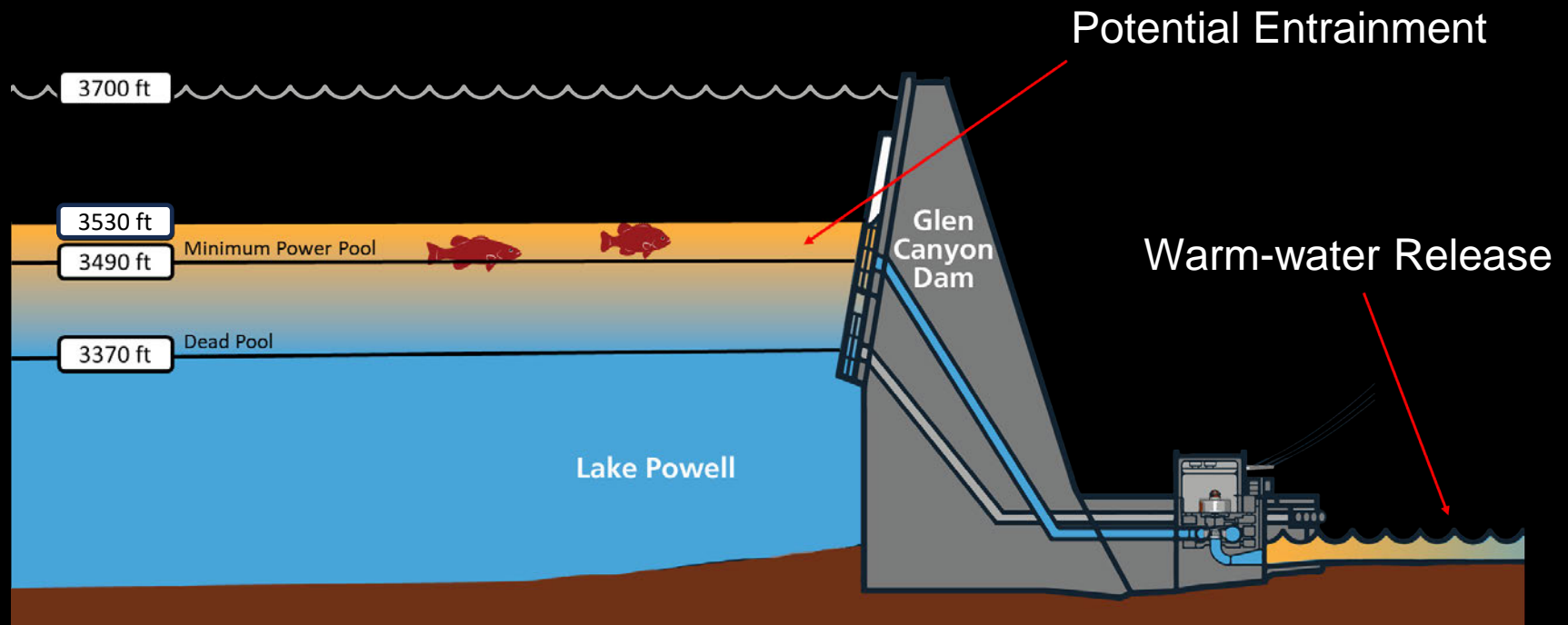
HUSHTEC



Jeremy Hammen
Bureau of Reclamation
jhammen@usbr.gov



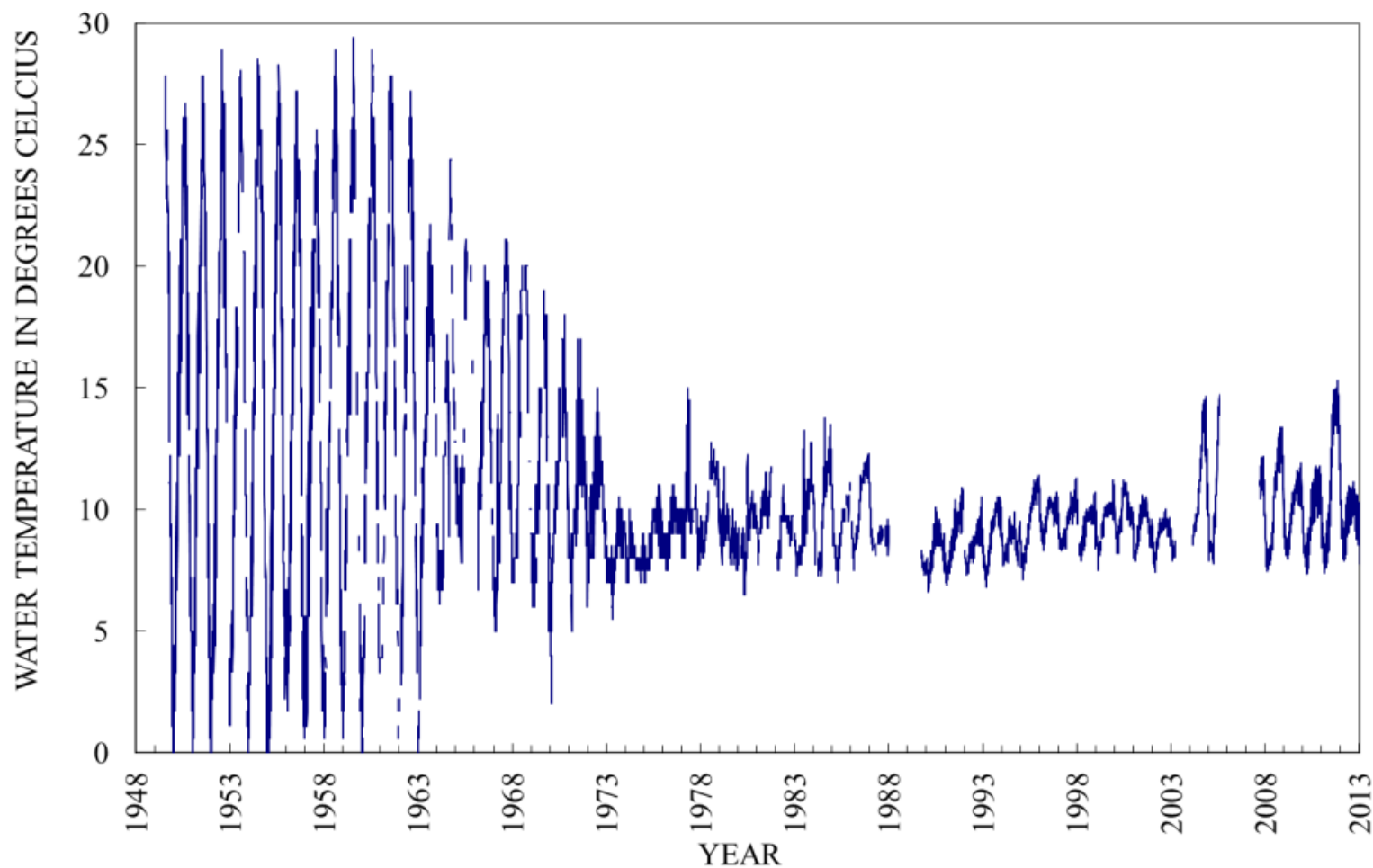
— BUREAU OF —
RECLAMATION



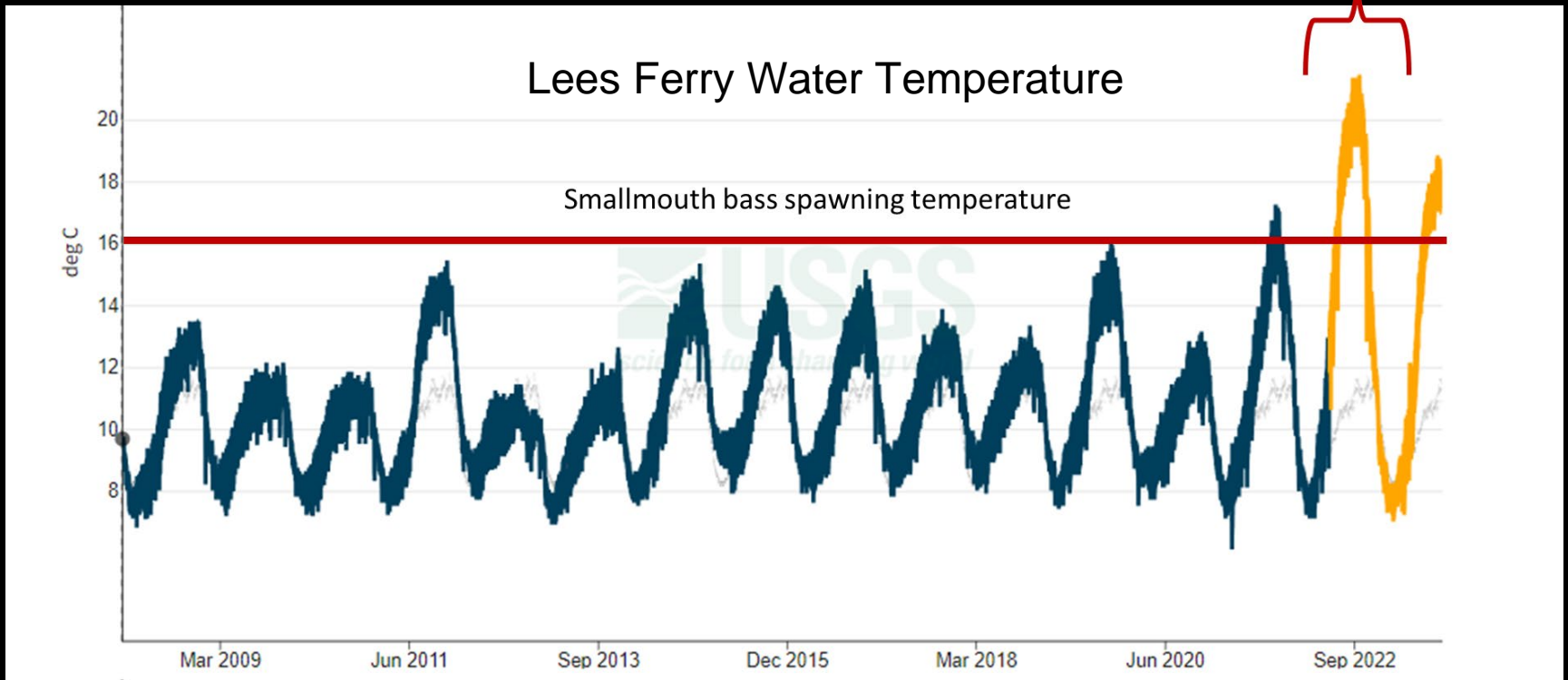
Source: Reclamation and USGS



Lees Ferry Water temperature



Potential SMB Spawning Temp.



USGS Guage: 09380000