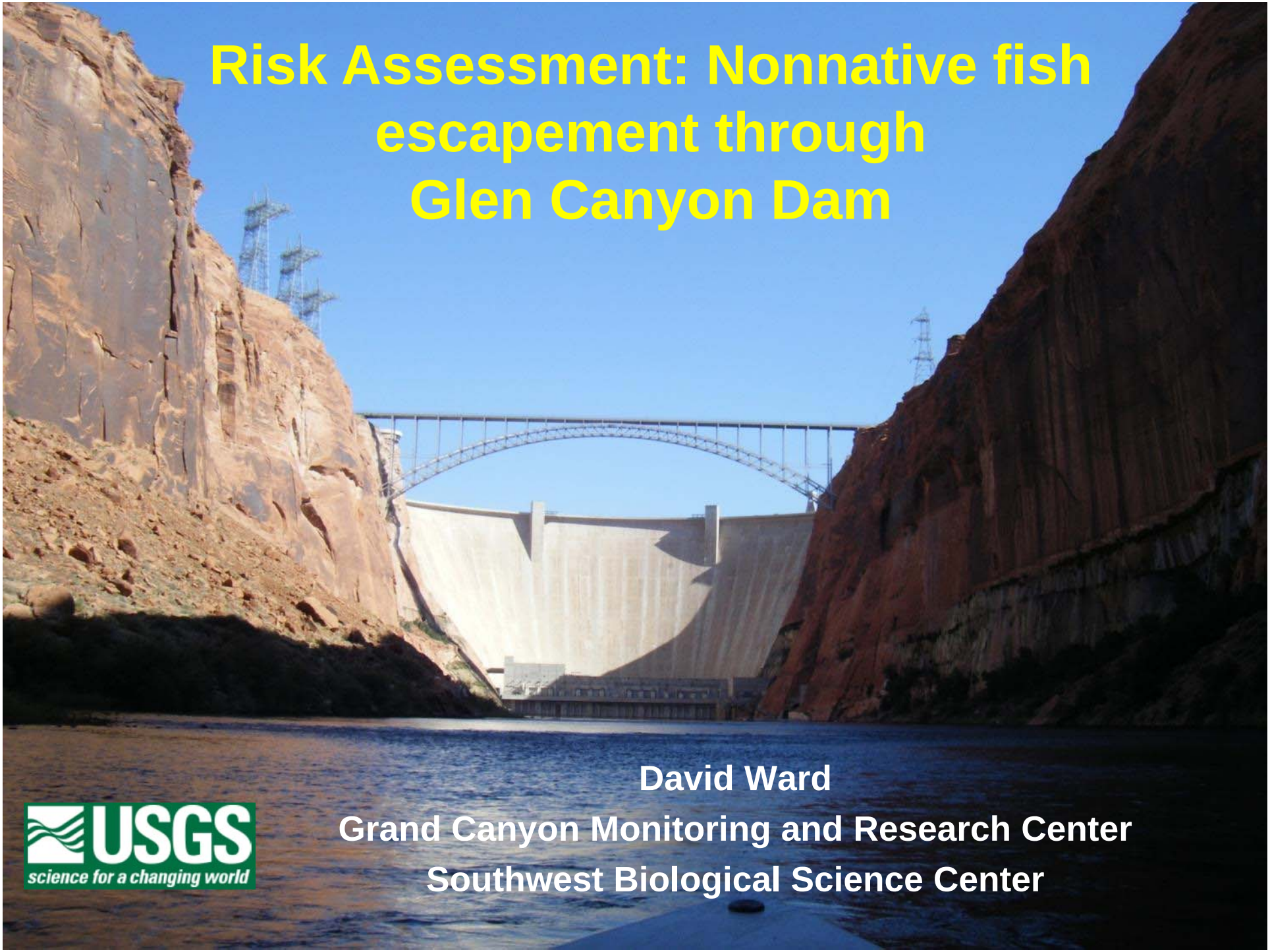


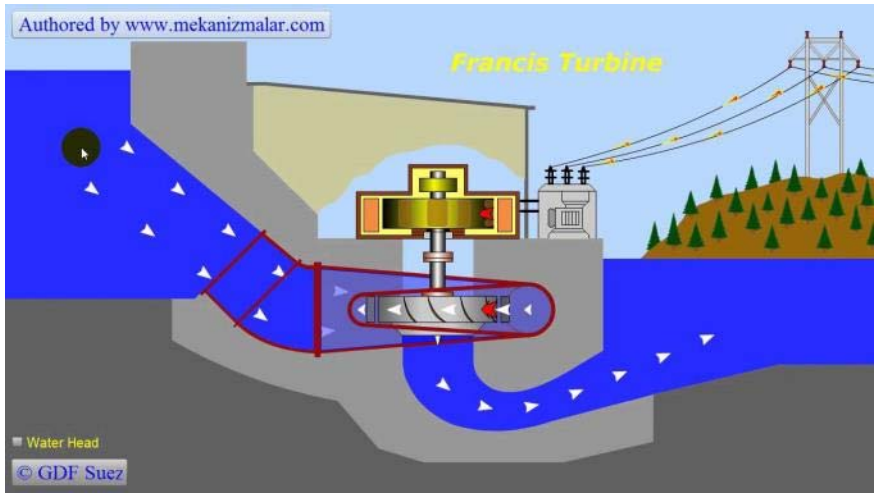
Risk Assessment: Nonnative fish escapement through Glen Canyon Dam

David Ward
Grand Canyon Monitoring and Research Center
Southwest Biological Science Center

USGS
science for a changing world

What is the risk of nonnative fish passage?

Francis Style Turbines



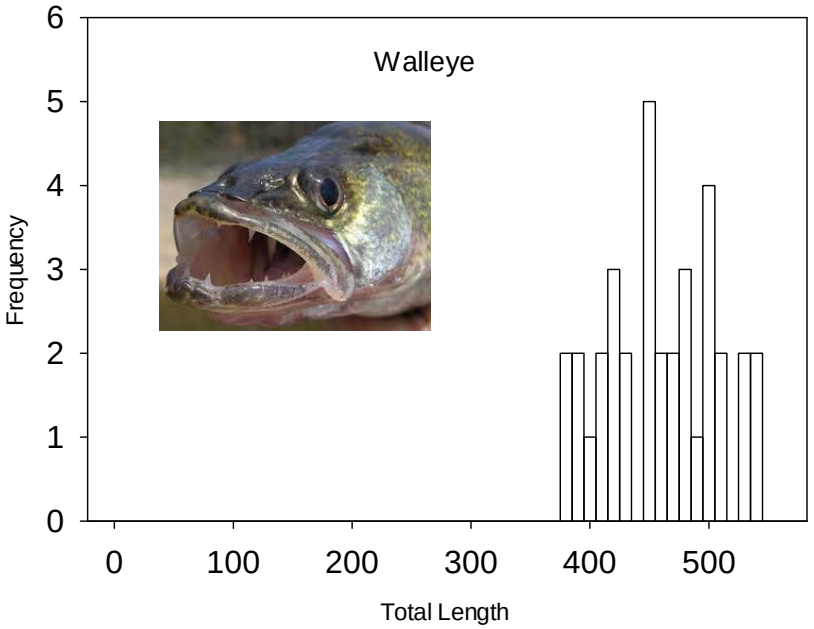
USGS
science for a changing world

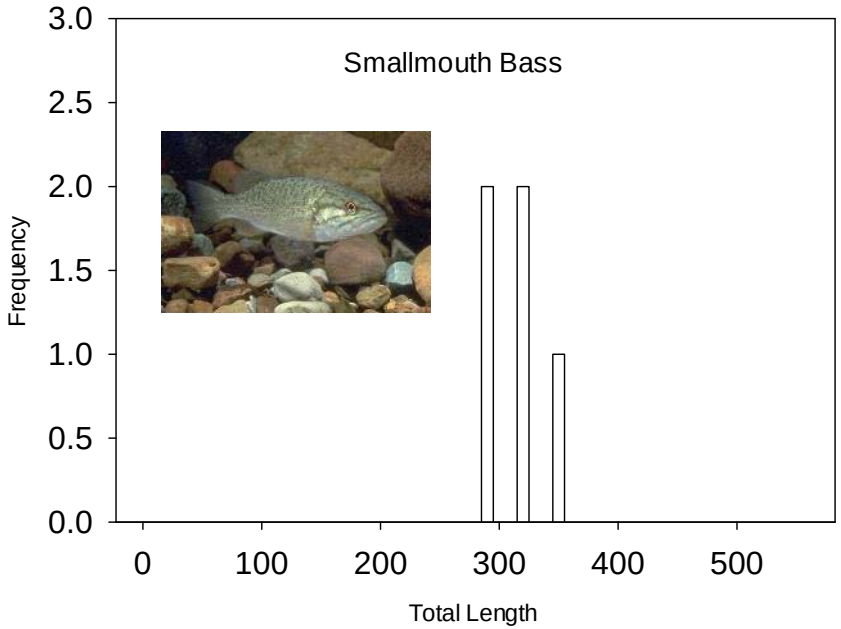
What data do we have ?

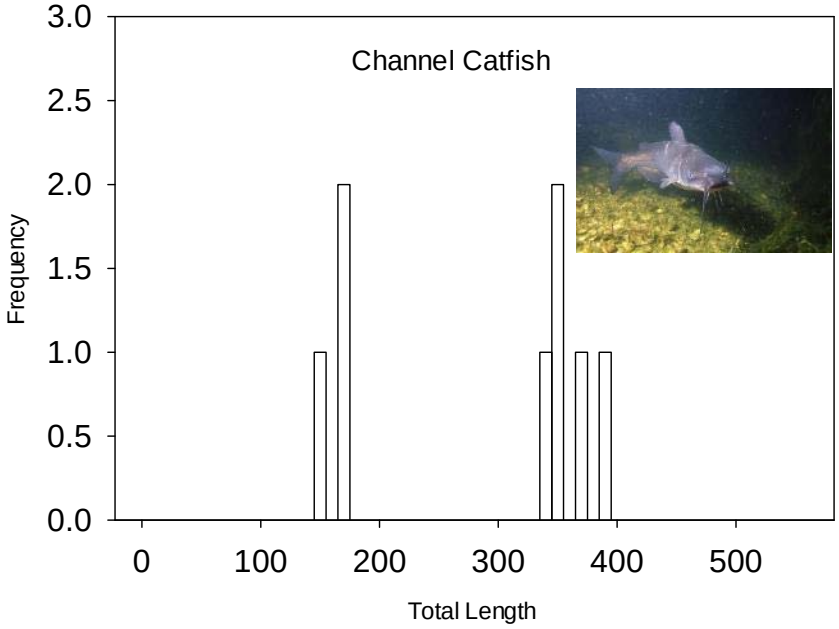
- **Data from Davis Dam**

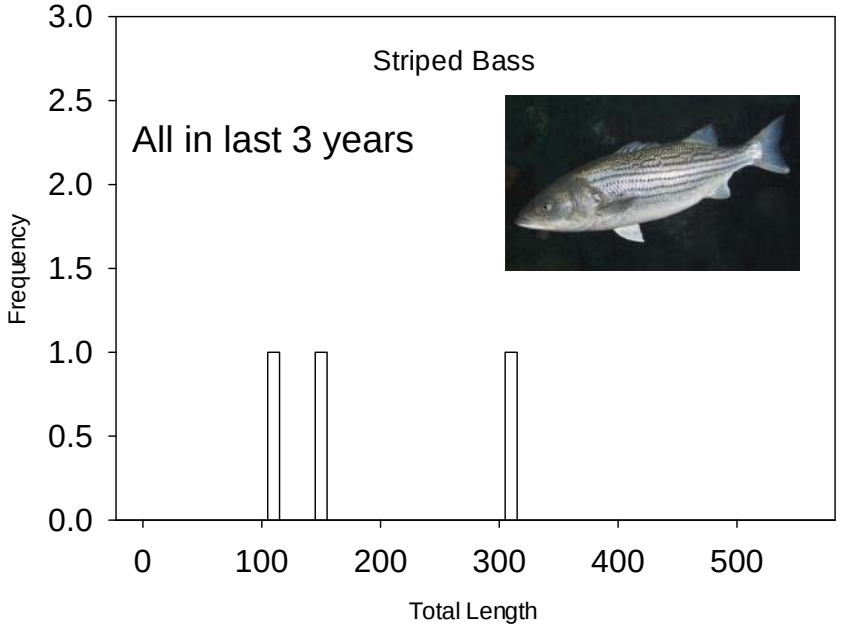
7 repatriated Razorback suckers went from Lake Mohave to Lake Havasu via Davis Dam

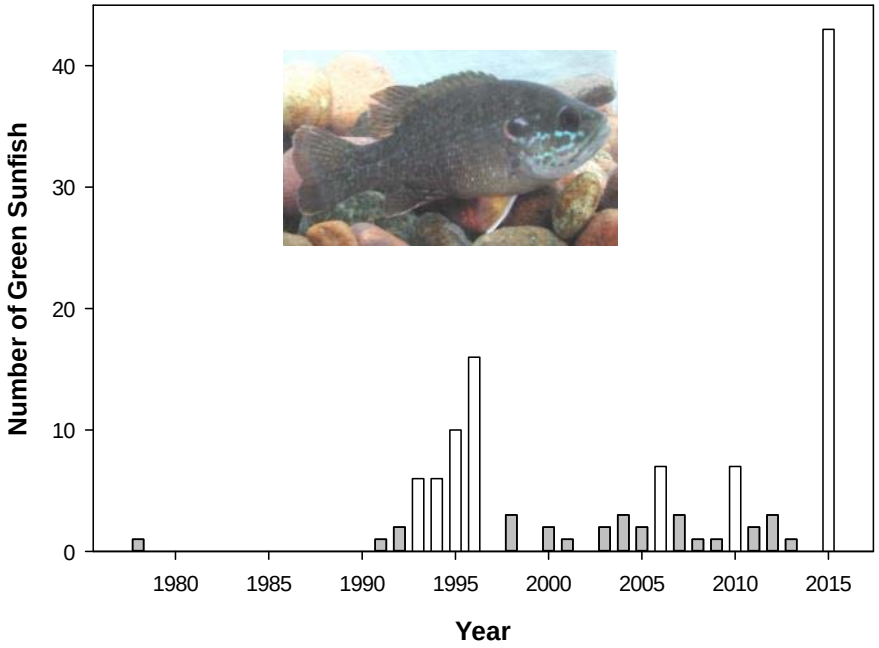
- **Capture Data from Below Glen Canyon Dam**


Walleye
Frequency
Total Length
0
1
2
3
4
5
6
0
100
200
300
400
500


Smallmouth Bass
Frequency
Total Length
0.0
0.5
1.0
1.5
2.0
2.5
3.0
0
100
200
300
400
500

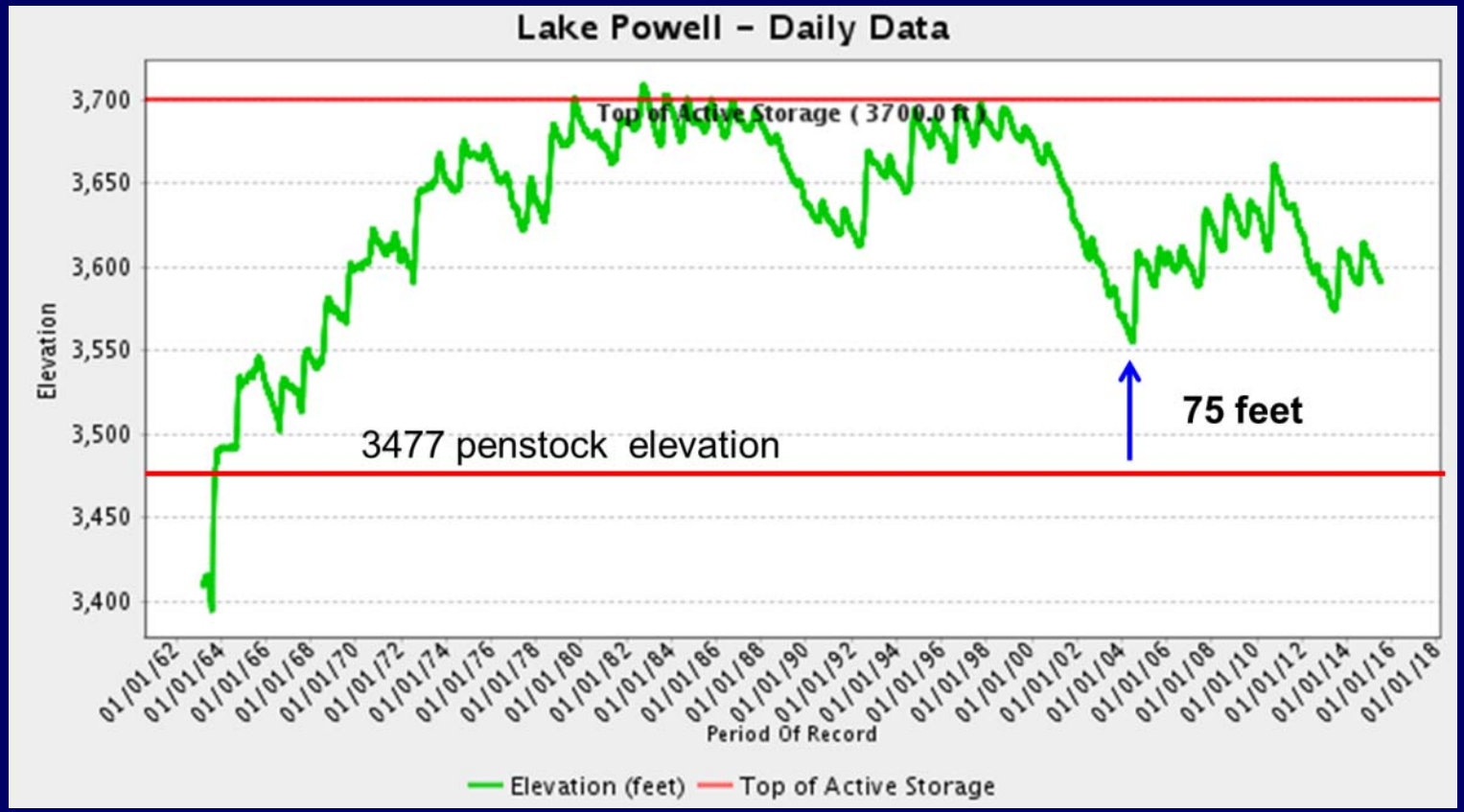

Channel Catfish
Frequency
Total Length
0.0
0.5
1.0
1.5
2.0
2.5
3.0
0
100
200
300
400
500


Striped Bass
All in last 3 years
Frequency
Total Length
0.0
0.5
1.0
1.5
2.0
2.5
3.0
0
100
200
300
400
500


Number of Green Sunfish
0
10
20
30
40
1980
1985
1990
1995
2000
2005
2010
2015
Year

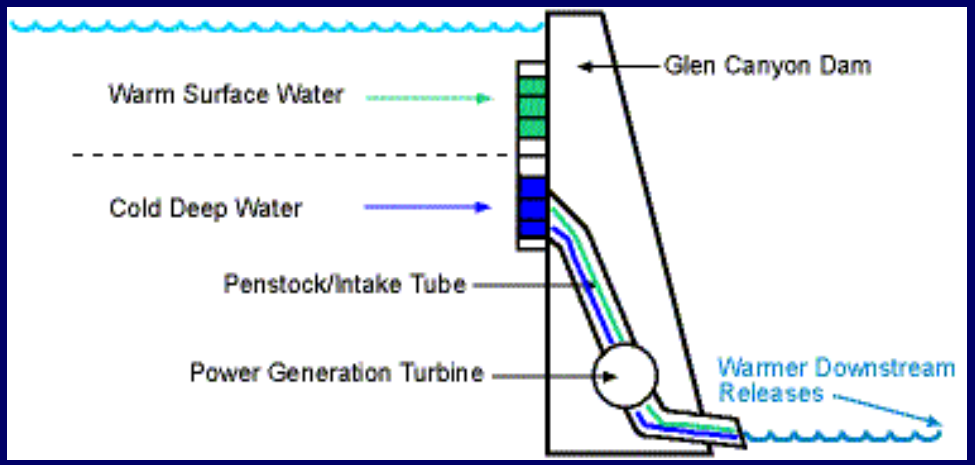
What keeps fish from moving through GC Dam?

- Depth of penstocks



What keeps fish from moving through GC Dam?

- Depth of penstocks
- Water temperature/quality at those depths



U.S. Bureau of Reclamation

Lake mixing during the spring and fall “turnover”

What keeps fish from establishing downstream?

- Its not currently habitat for those lake species

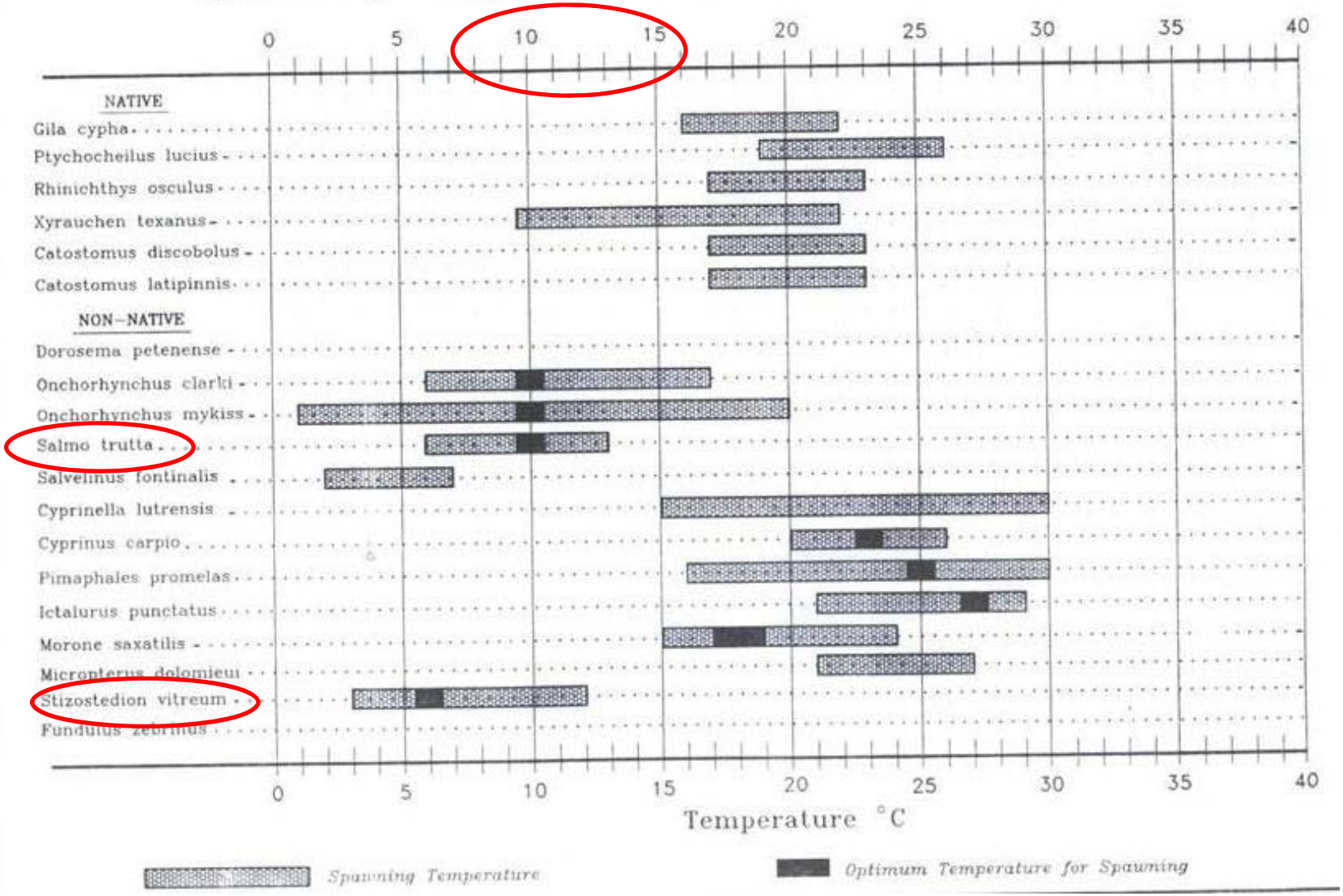
What is habitat?

- Wildlife Management/Ecology definition:

An environment that contains all of the resources that an animal needs to complete its life cycle (survive, grow to maturity and reproduce)

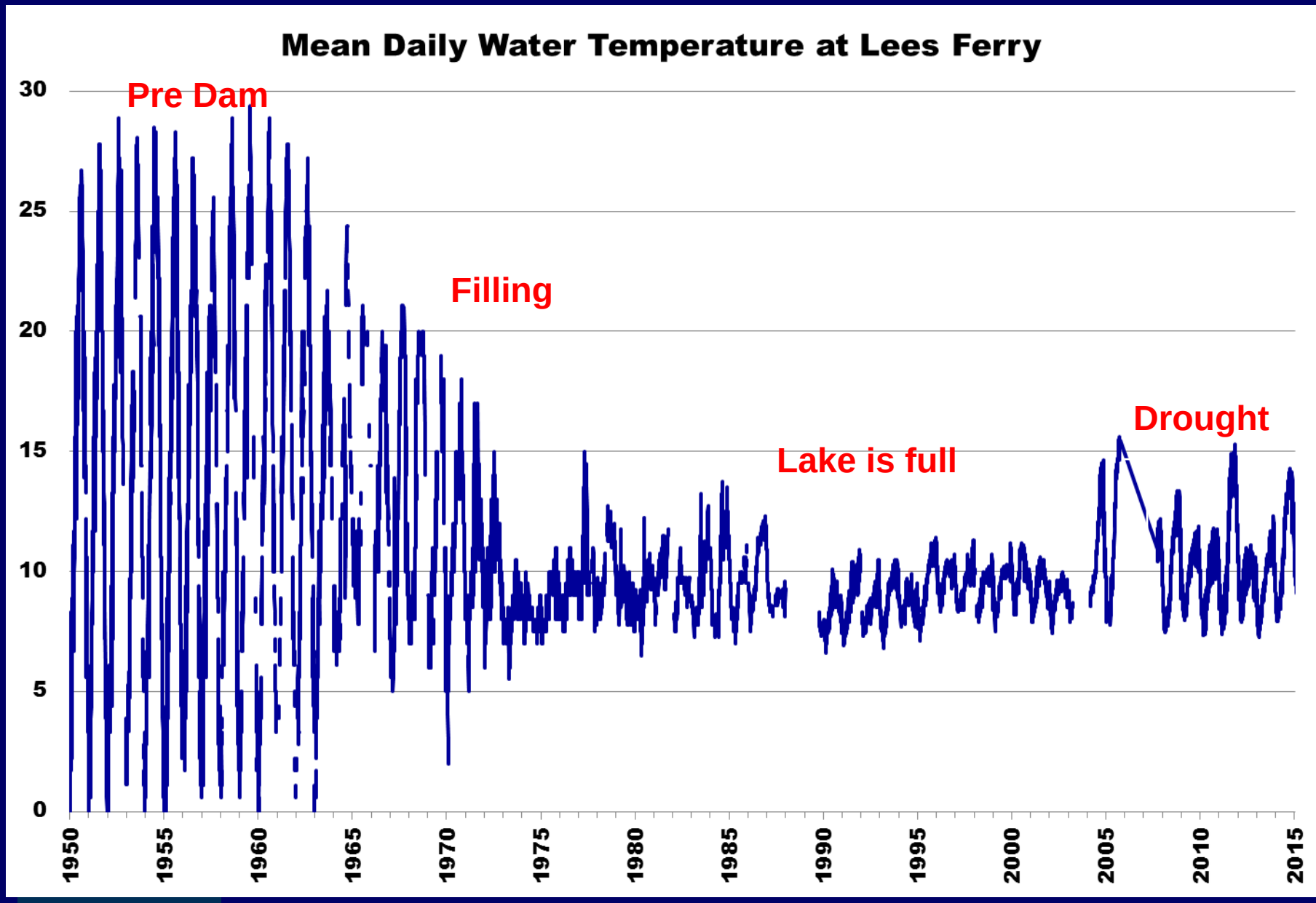
Question then becomes what is limiting?

Figure 2: Spawning Temperature for Colorado River Fishes



Species	Code	Spawning			Incubation				Growth			Lethal	
		Minimum	Maximum	Optimum	Minimum	Maximum	Optimum	Days	Minimum	Maximum	Optimum	Low	High
Black bullhead	BB	19	22	20	21	24	23	6	20	22	21	3	35
Black crappie	BC	14	18	16	15	22	17	4	24	30	27	0	34
Bluehead sucker	BH	15	25	18	17	23	20	7	15	21	18	0	29
Bluegill	BG	19	27	20	20	26	20	3	15	25	23	0	35
Brown trout	BR	7	14	10	8	20	10	41	12	20	15	0	27
Bonytail	BT	18	22	20	18	28	21	4	18	24	20	0	35
Common Carp	CP	18	30	23	20	30	24	4	15	30	27	0	38
Channel catfish	CC	21	29	27	20	30	27	7	21	30	28	3	38
Colorado pikeminnow	CM	16	24	22	19	25	22	5	18	23	25	0	35
Flathead catfish	FC	22	29	26	22	29	27	8	24	30	26	5	40
Fathead minnow	FH	16	30	25	16	29	25	5	18	27	25	2	33
Flannelmouth sucker	FM	14	25	19	14	23	18	6	16	22	20	0	35
Grass carp	GC	18	24	19	18	24	19	1	18	22	20	0	35
Green sunfish	GS	19	31	22	19	24	23	5	26	31	30	0	35
Golden shiner	GD	15	27	20	17	27	24	4	16	26	21	5	35
Gizzard shad	GZ	18	22	20	19	22	21	3	20	28	24	7	35
Humpback chub	HB	16	22	18	16	27	19	3	16	22	18	0	35
Little Colorado spinedace	LD	13	17	15	14	18	16	6	16	23	18	3	34
Largemouth bass	LM	16	20	18	16	20	18	6	16	30	27	3	35
Mosquitofish	MF	18	30	22	20	24	22	25	14	28	22	4	43
Plains killifish	PK	20	30	28	20	30	28	21	20	30	25	5	40
Razorback sucker	RZ	14	22	18	14	25	19	7	18	24	20	0	30
Rainbow trout	RB	8	13	10	7	15	10	31	12	21	16	0	25
Redside shiner	RD	10	18	15	12	20	18	8	15	22	18	0	24
Red shiner	RS	15	30	23	15	25	24	4	18	28	24	0	40
Roundtail chub	RT	14	22	16	16	22	18	5	18	24	18	0	35
Smallmouth bass	SM	13	18	17	14	18	15	9	20	26	23	0	35
Speckled dace	SD	18	25	20	18	23	20	6	18	22	20	0	35
Sand shiner	SS	16	30	24	18	26	24	4	18	28	24	0	38
Striped bass	SB	14	24	18	16	26	18	3	23	30	24	5	33
Threadfin shad	TF	20	25	21	20	27	20	5	22	34	25	5	37
Blue tilapia	TL	21	28	23	21	28	26	5	25	32	27	8	46
Utah chub	UC	12	20	16	14	20	18	6	16	30	23	0	35
Walleye	WE	6	13	7	6	14	13	7	18	23	21	0	33
Yellow bullhead	YB	19	24	20	21	24	23	7	21	23	22	3	35
Zuni bluehead sucker	ZB	10	15	13	10	15	13	6	15	21	20	0	29

Valdez 2007



Adapted from Voichick and Wright 2007


Little Colorado River

What we know

- Continuous cold water is detrimental to native fish! 

- Continuous cold water is also detrimental to warm water invasive fish

Temperature Conundrum for Colorado River Native Fishes

Cold Water is Bad (physiological effects) VS **Warm Water is Bad (Invasive fish effects)**

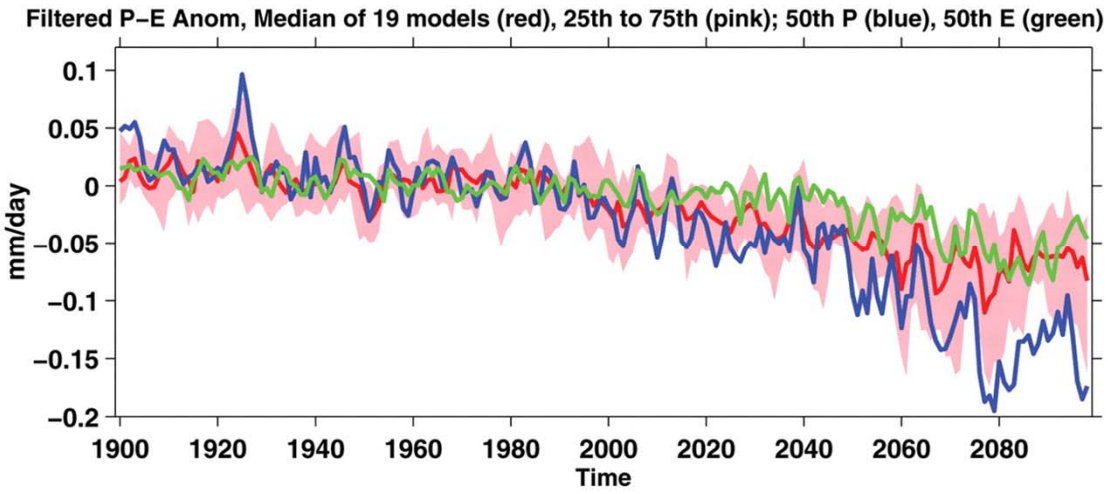
We currently appear to be in a "Sweet Spot"

Will it last?

But what about climate change and drought induced warming?

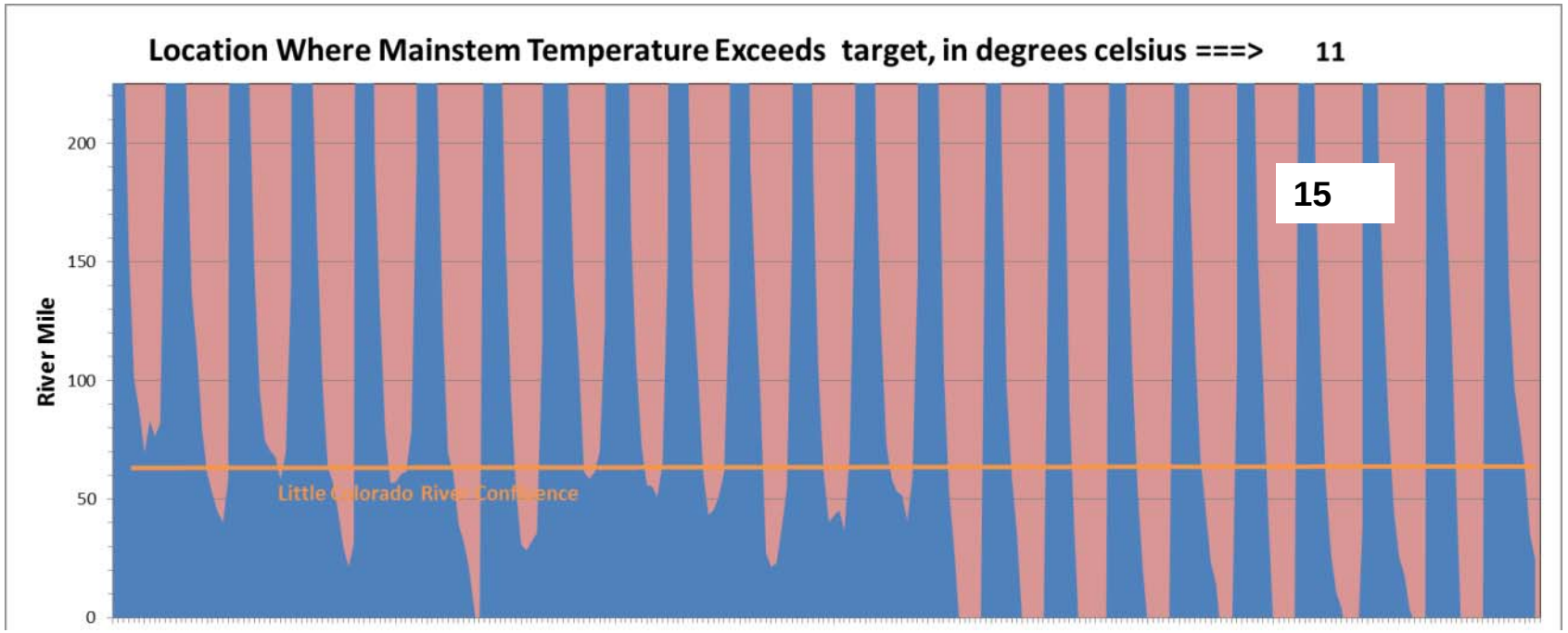
- Climate forecasts indicate: Continued drying in the southwest

Fig. 1. Modeled changes in annual mean precipitation minus evaporation over the American Southwest (125°W to 95°W and 25°N to 40°N, land areas only), averaged over ensemble members for each of the 19 models.



R Seager et al. Science 2007;316:1181-1184

Published by AAAS



Wright, S. A., C. R. Anderson, and N. Voichick (2008),
A simplified water temperature model for the Colorado River
below Glen Canyon Dam, *River Research and Applications*, *25*(6), 675-686.

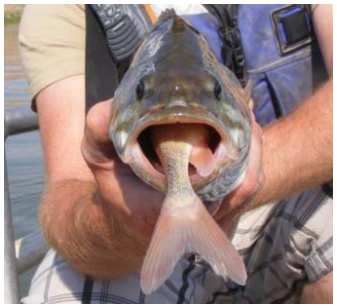
Time

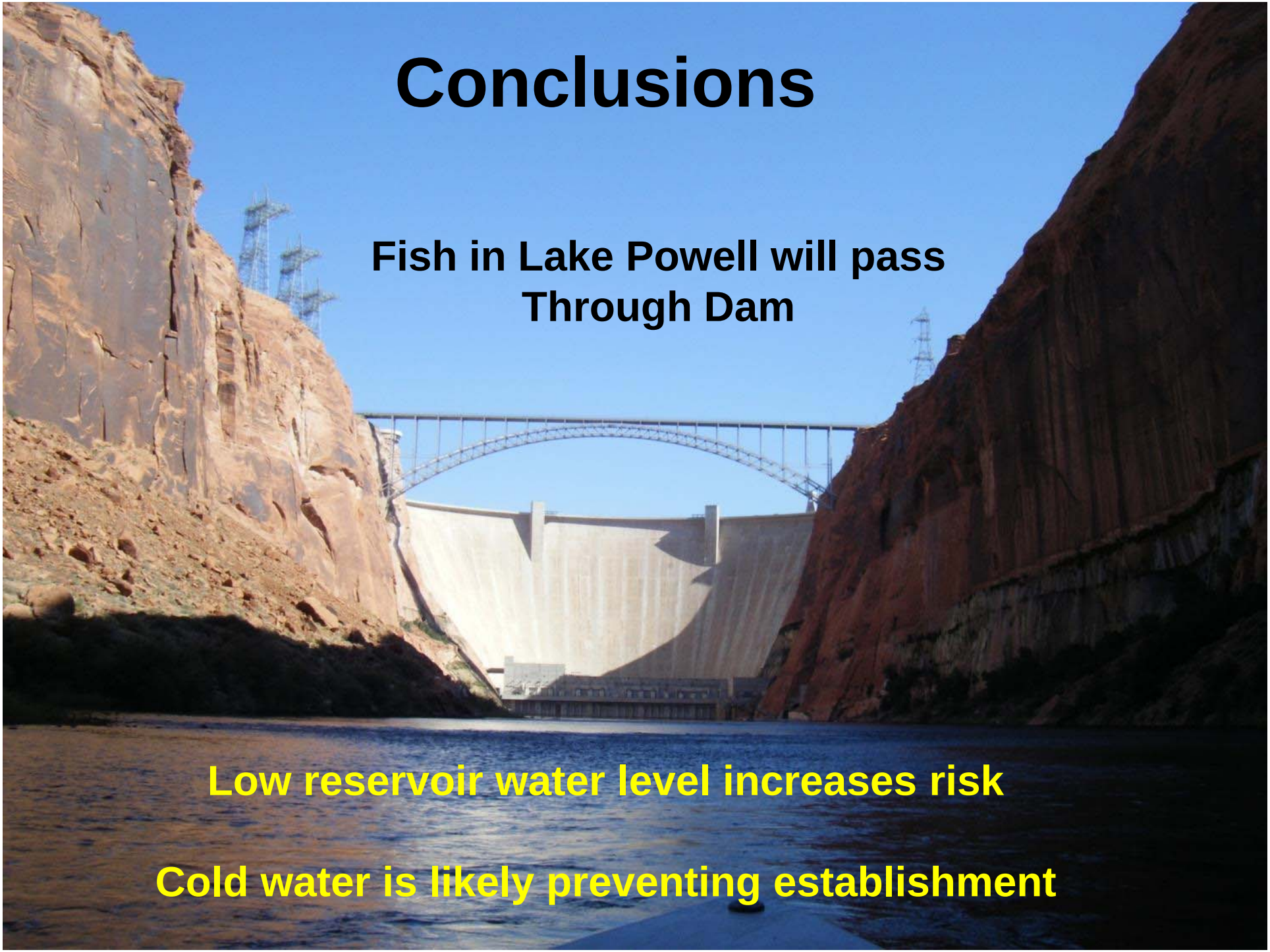







My Ranking of Threats





Conclusions

Fish in Lake Powell will pass Through Dam

Low reservoir water level increases risk

Cold water is likely preventing establishment

Conclusions

- **Interval of drought induced warming may play a critical role in whether or not new species of warm water non native fish establish in Grand Canyon**

- **Cold water most of the time - although detrimental to Grand Canyon native fishes, may be the best way to conserve them**

Conclusions

- **Annual invasive species monitoring and mechanical removal below the dam may be warranted**

- **Removing areas that are habitat for warm water invasive fishes seems like a good idea**