Modelling Effects of Discharge from Glen Canyon Dam on Habitat Quality and Dispersal of Juvenile Humpback Chub

Josh Korman – Ecometric Research

Stephen Wiele – USGS

Margaret Torizzo – USGS

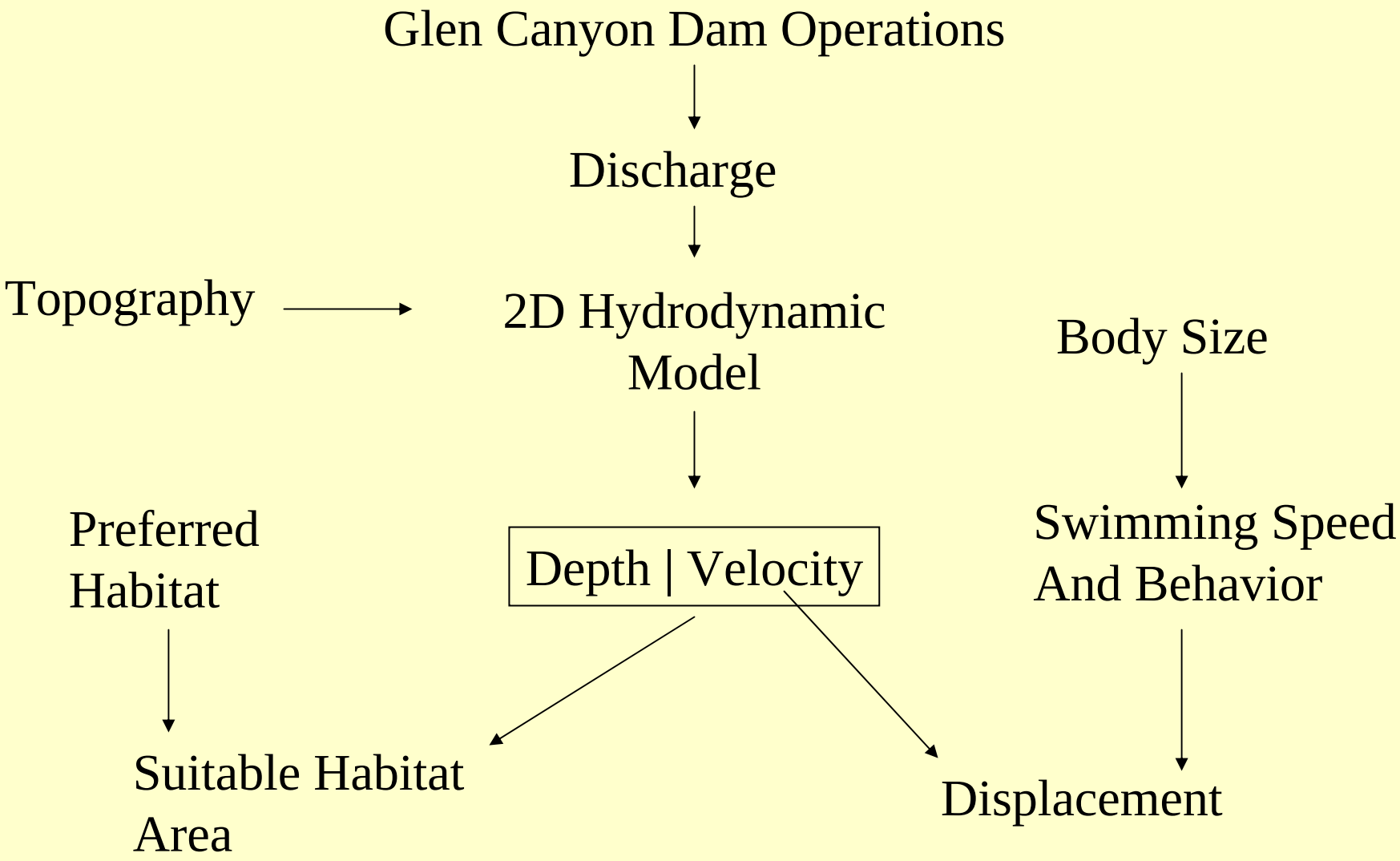
Funded by GCMRC

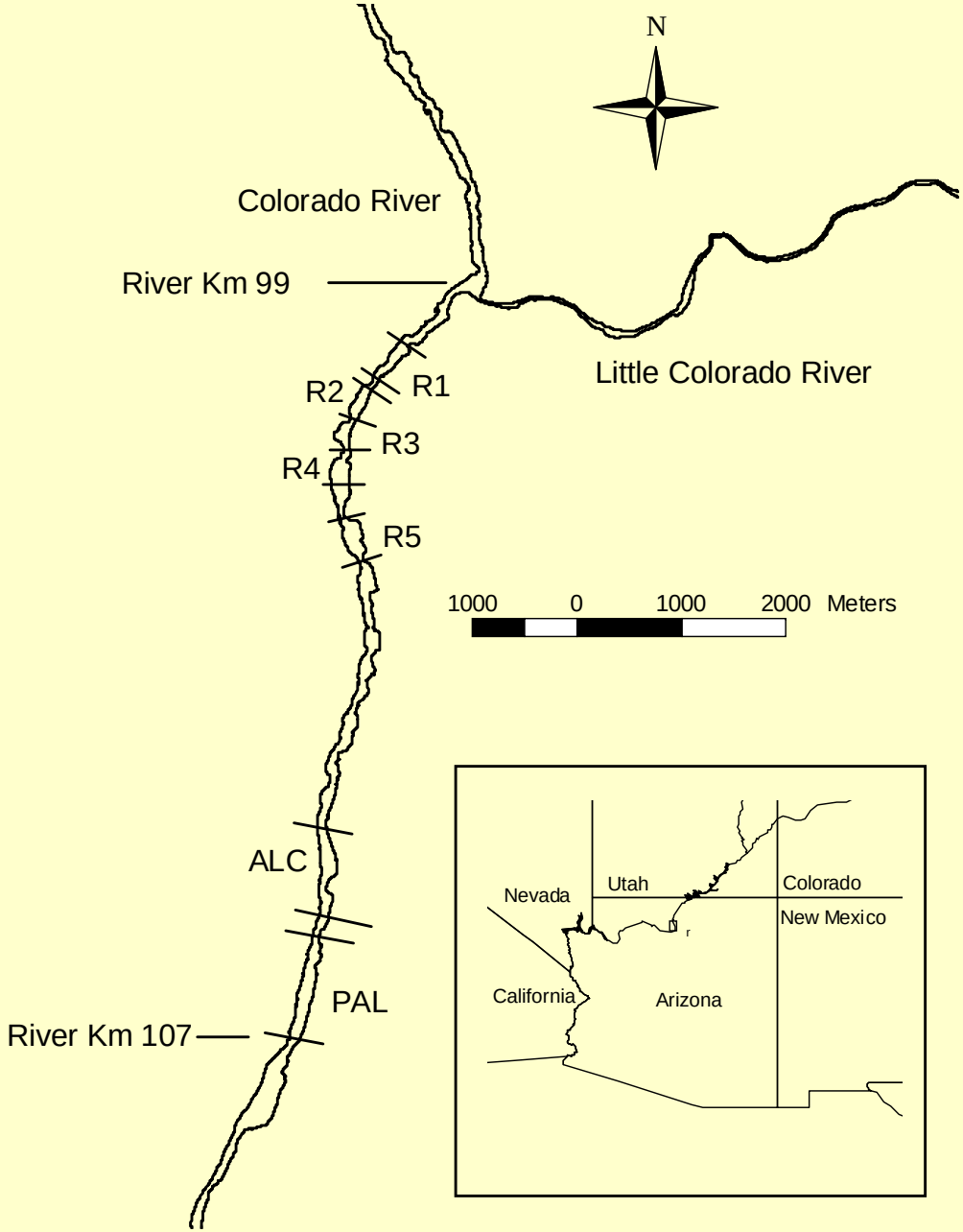
Korman et al., 2003. River Research and Applications 19:1-22

Hypotheses of GCD Impacts

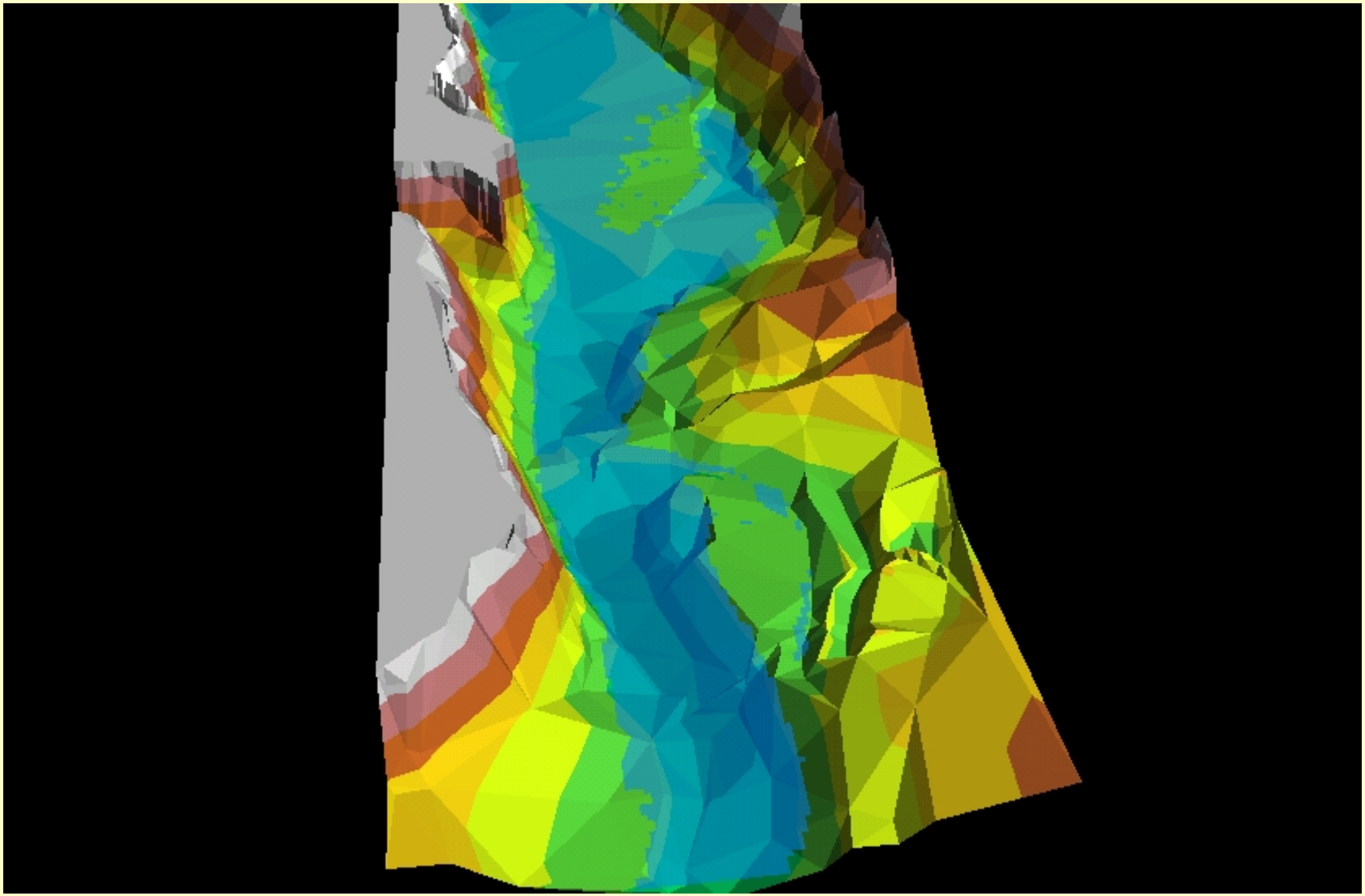
- Decreases in the frequency of low flow periods has reduced suitable habitat availability for HBC *(Converse, Hawkins, and Valdez, 1998)*.
- Recruitment of young HBC may depend on their ability to remain and mature in habitats required by adults *(Valdez and Ryel 1995)*.
- Hourly variation in discharge destabilizes nearshore habitats used by native fish *(Valdez and Ryel 1995)*.
- Higher discharges from GCD will displace small-bodied non-native fish *(8 kcfs Low Summer Steady Flow experiment in 2000).*

Methods

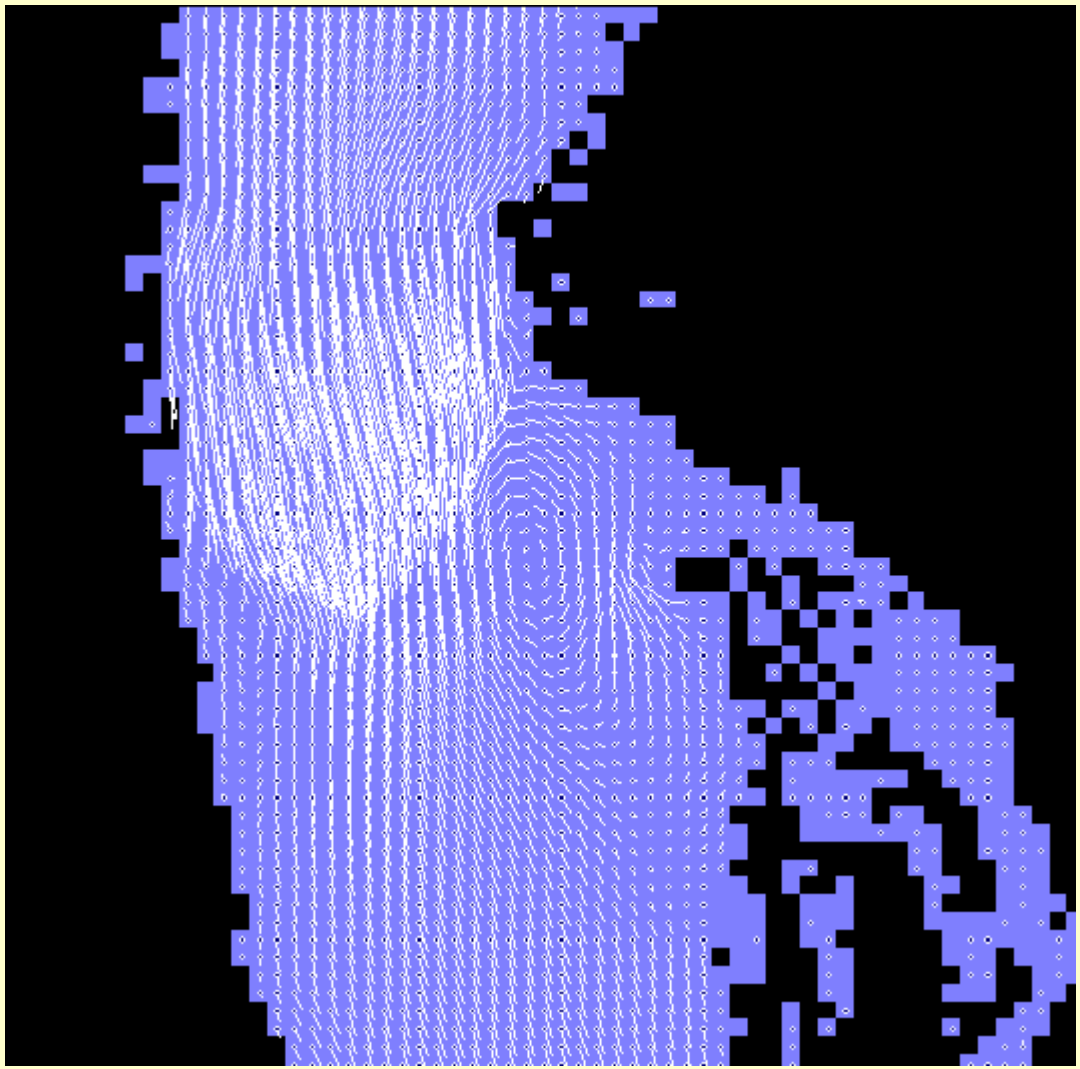

Glen Canyon Dam Operations
Discharge
Topography
2D Hydrodynamic Model
Body Size
Preferred Habitat
Depth | Velocity
Swimming Speed And Behavior
Suitable Habitat Area
Displacement


N
Colorado River
River Km 99
Little Colorado River
R2
R1
R3
R4
R5
1000 0 1000 2000 Meters
ALC
PAL
River Km 107
Nevada
Utah
Colorado
New Mexico
California
Arizona

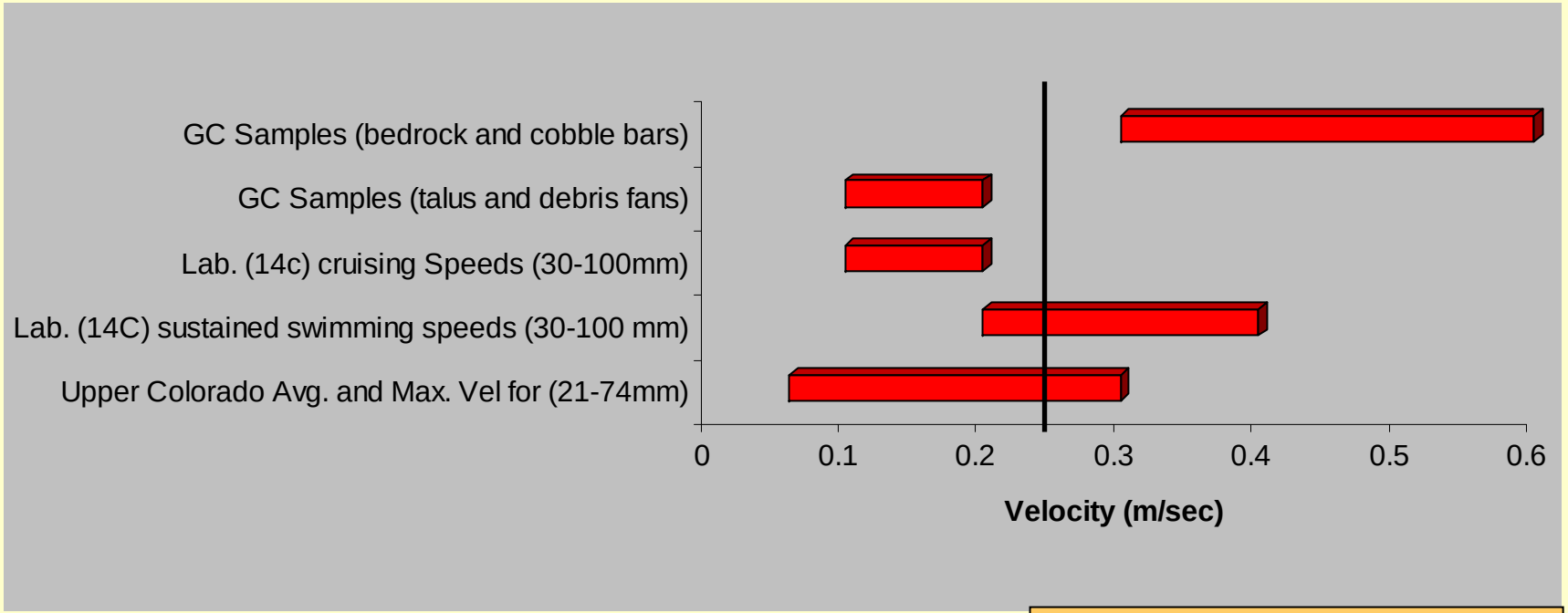
Site Characteristics (ALC)



2D Model Predicts Depth and Velocity Fields (grid = 2.5m)



Habitat Preference Criteria



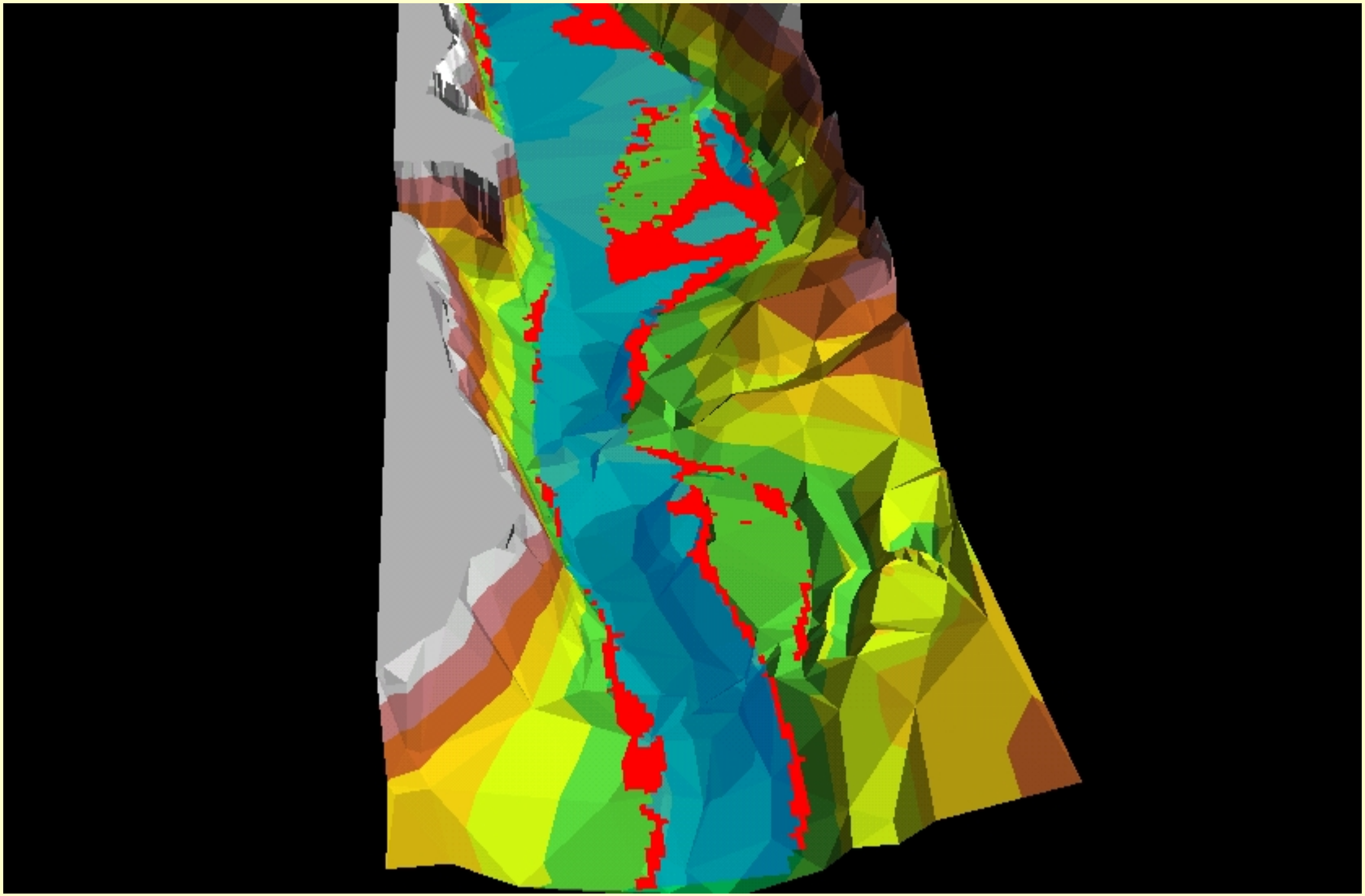
Sources:

Valdez et al. 1990
Bulkley et al. 1982
Converse et al. 1998

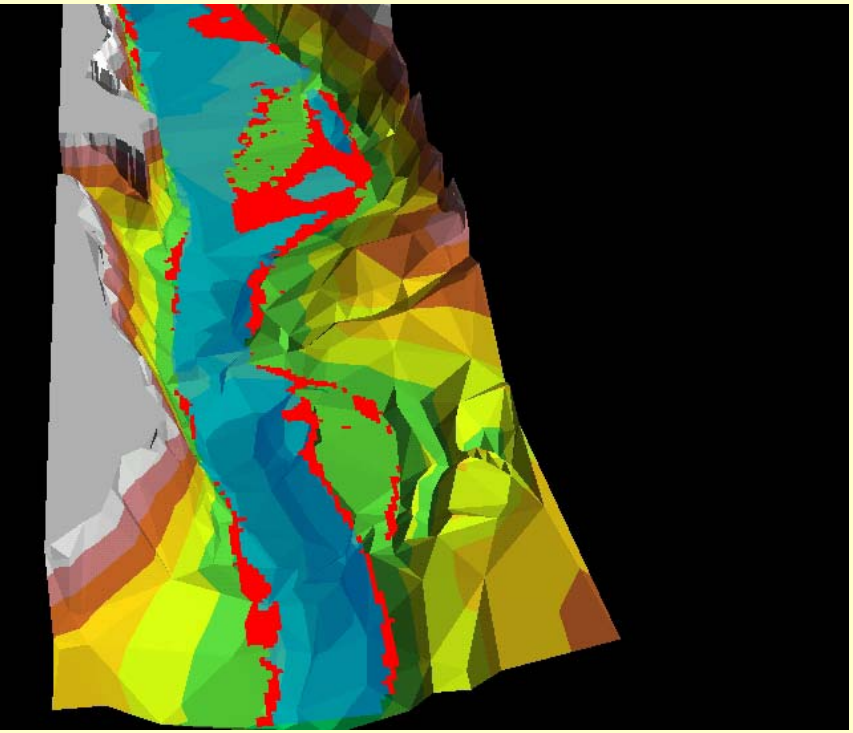
Shoreline habitats important for juvenile fish

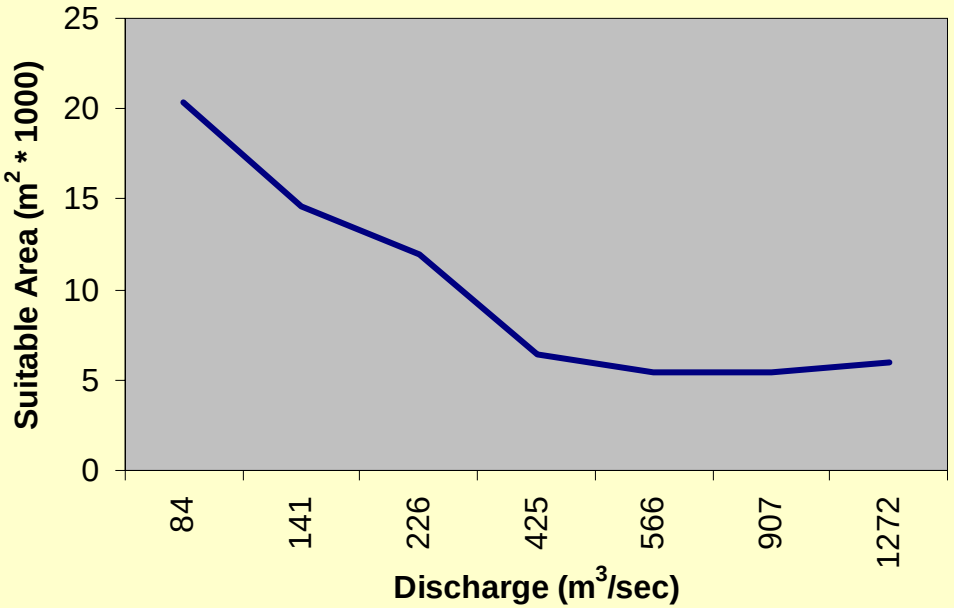
(depth <=1m)

Suitable Habitat (ALC-141 m^3/s)



ALC Suitable Shoreline Habitat Area as a Function of Discharge





Pre-dam avg. min.

Daytime minimum

High Q post-dam

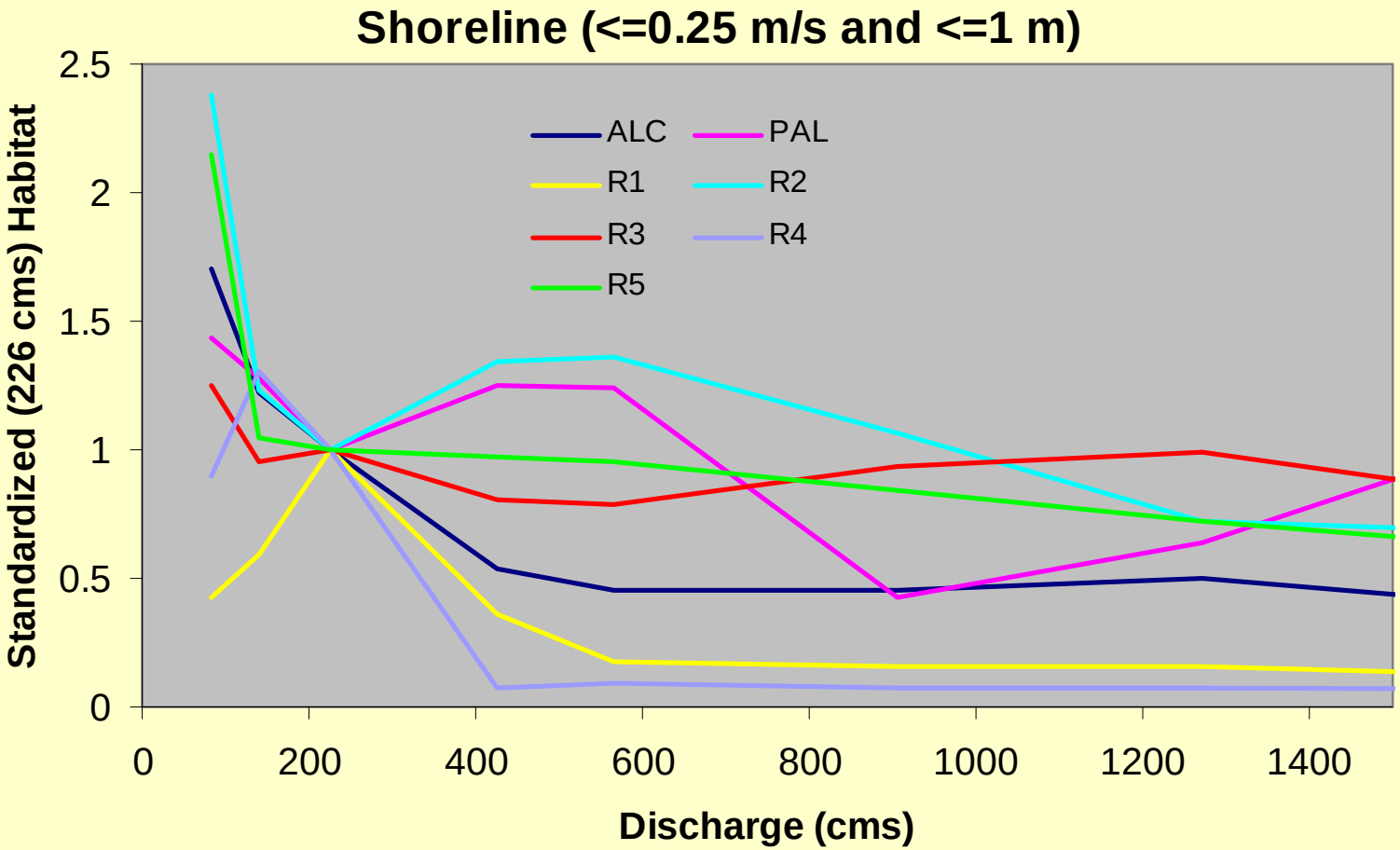
1996 flood

Nightime minimum

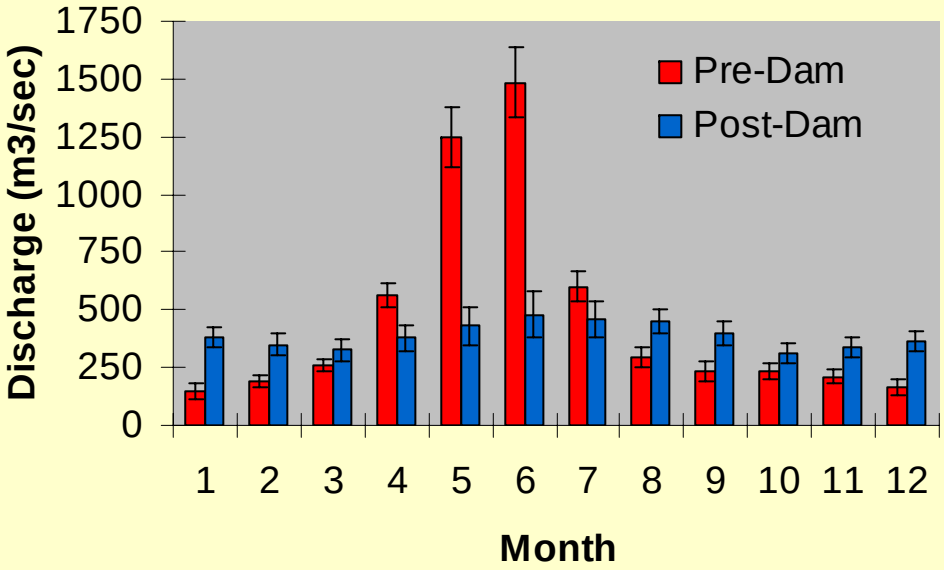
Avg. post-dam

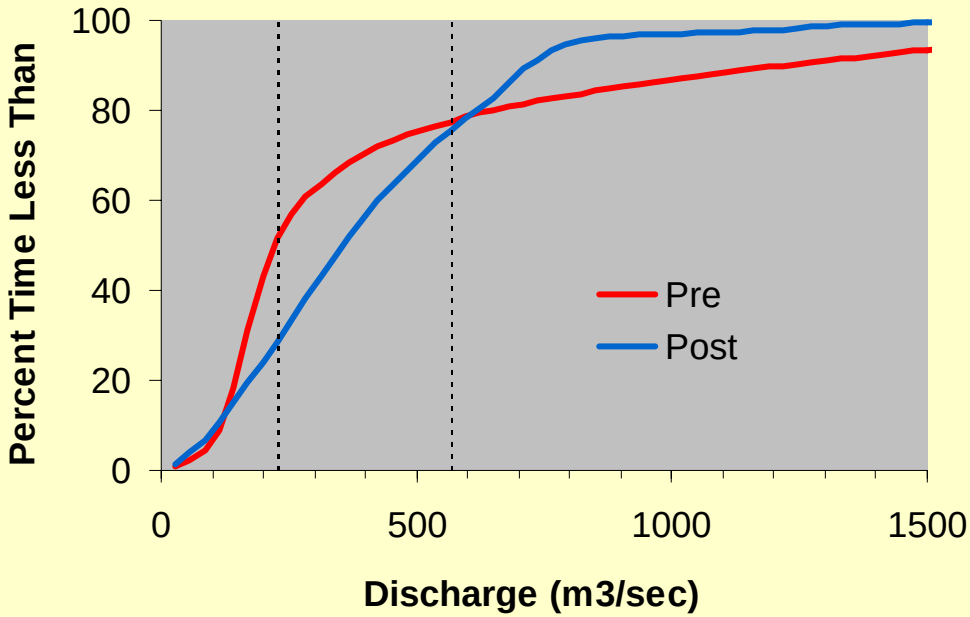
Powerplant capacity

Variable Response of Suitable Shoreline Habitat to Discharge

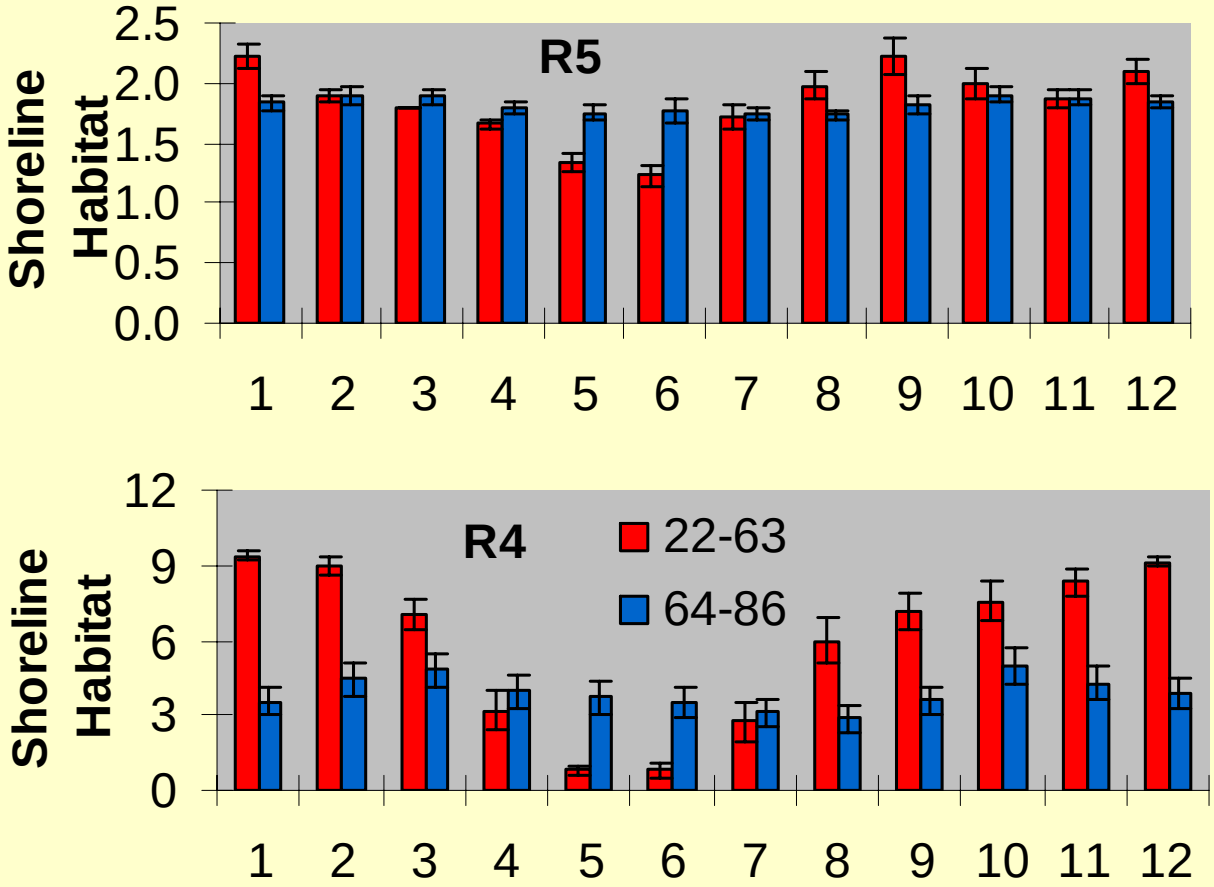


Effects of GCD on Seasonal Patterns and Frequency of Discharge





Reach and Seasonal Variation in Suitable Shoreline Habitat



Summary of GCD Effects on Suitable Shoreline Habitat Availability

Post-Dam > Pre-Dam

+++ <=0.001

++ <=0.01

+ <=0.05

Post-Dam < Pre-Dam

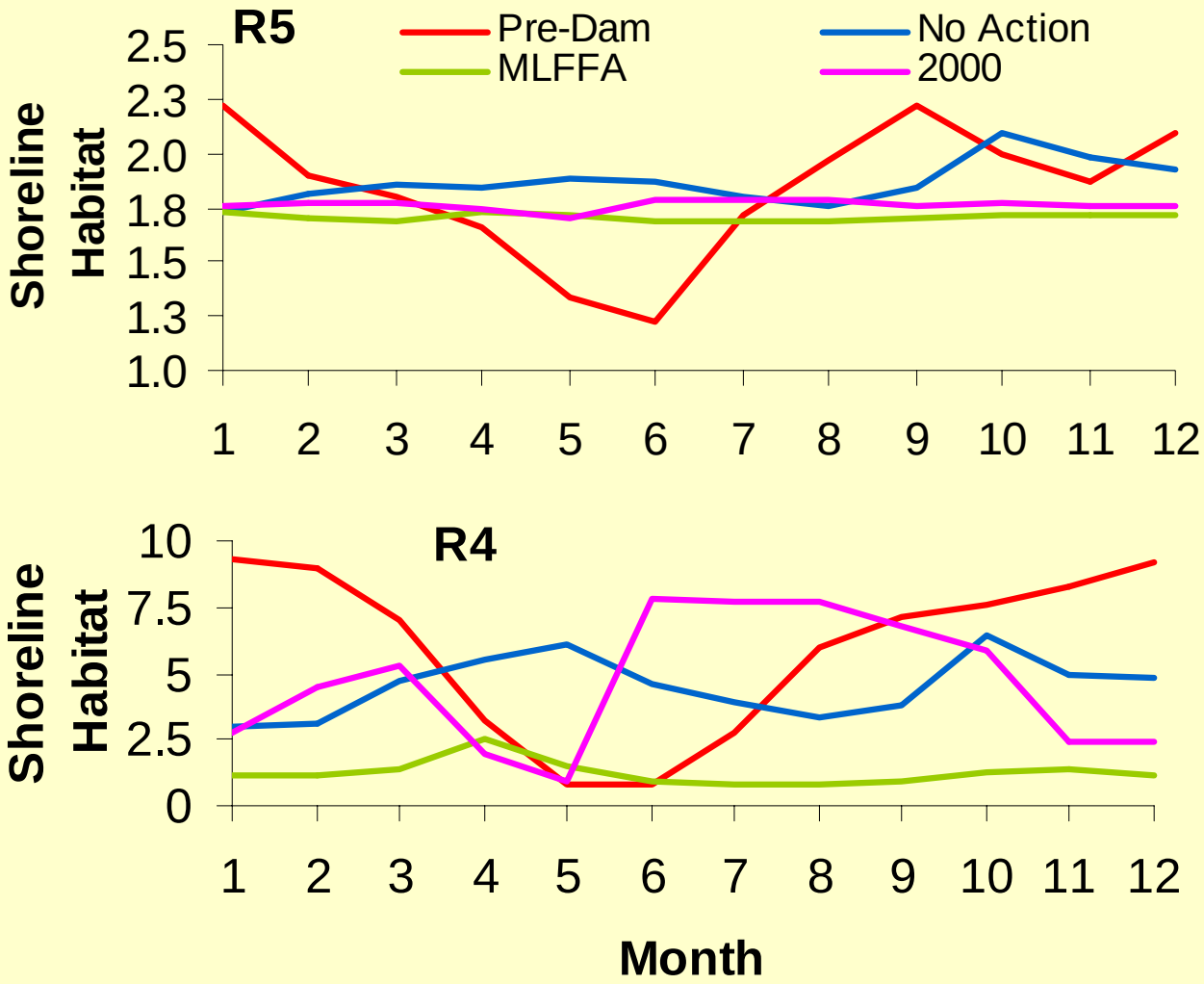
--- <=0.001

-- <=0.01

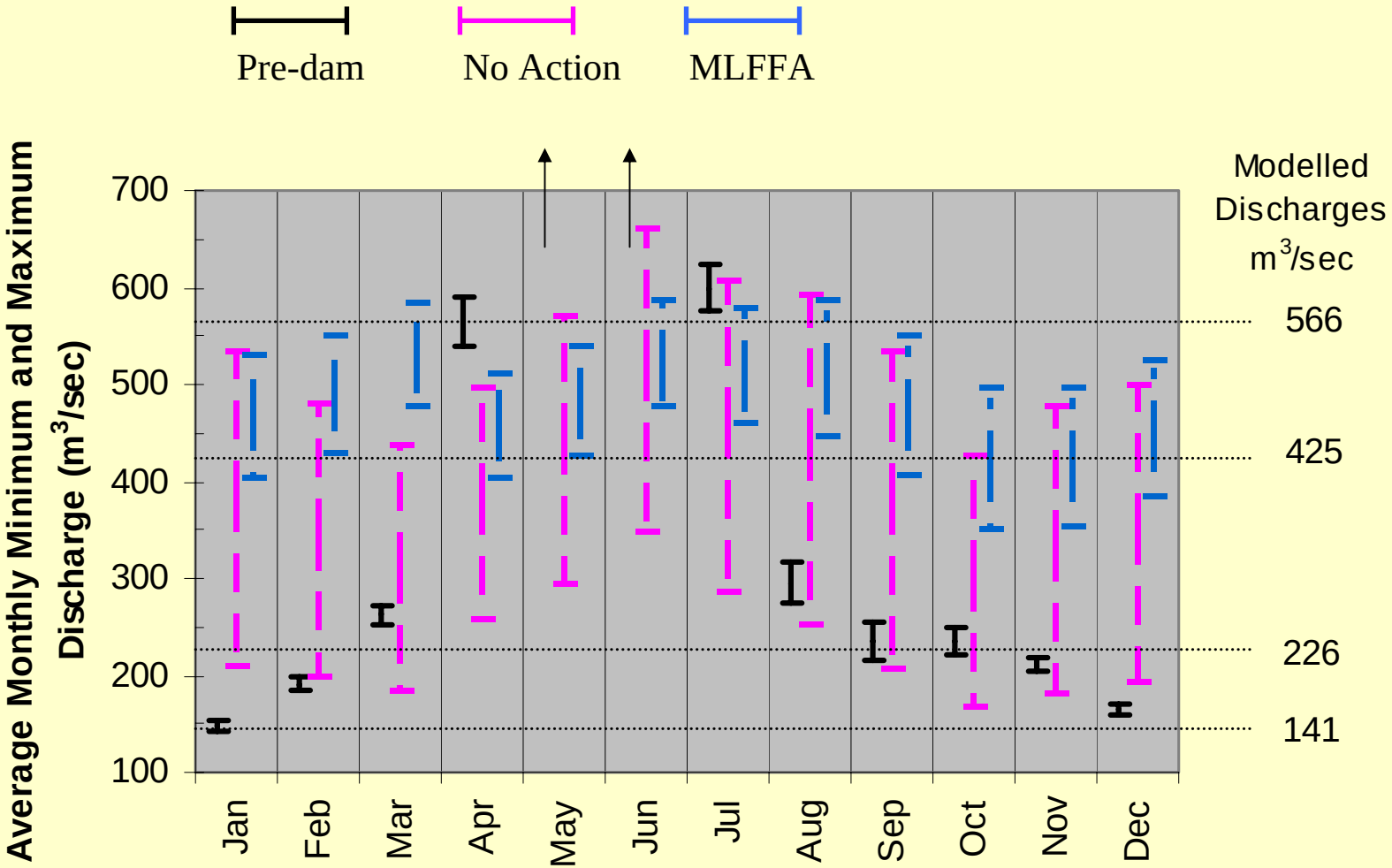
- <=0.05

	R1	R2	R3	R4	R5	ALC	PAL
Jan	---	--	---	---	---	---	---
Feb	---	+++	---	---		---	
Mar	---	+++	---	---	++	-	
Apr		+++			+++	+	+
May	+++	+++	+	+++	+++	+++	++
Jun	+++	+++	++	+++	+++	+++	
Jul							
Aug	---		---	---	---	---	
Sep	---	--	---	---	---	---	--
Oct	-		--	---		---	
Nov	---	++	---	---		---	
Dec	---		---	---	---	---	--
Post>Pre	2	6	2	2	4	3	2
Post<Pre	8	2	8	8	4	8	3

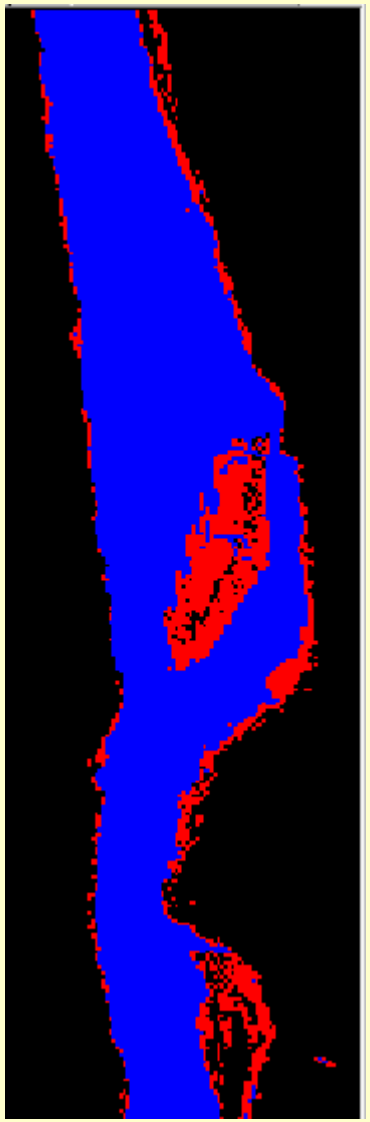
Operational Effects on Habitat



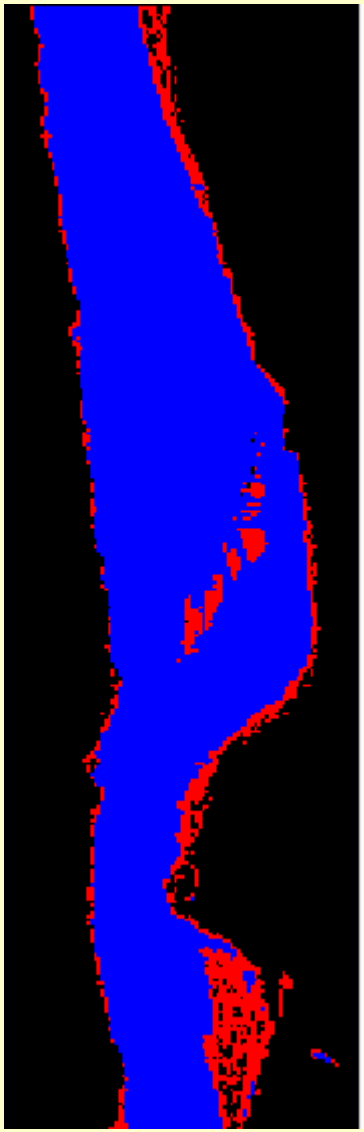
Daily Variation in Discharge



141 m^3/s



226 m^3/s

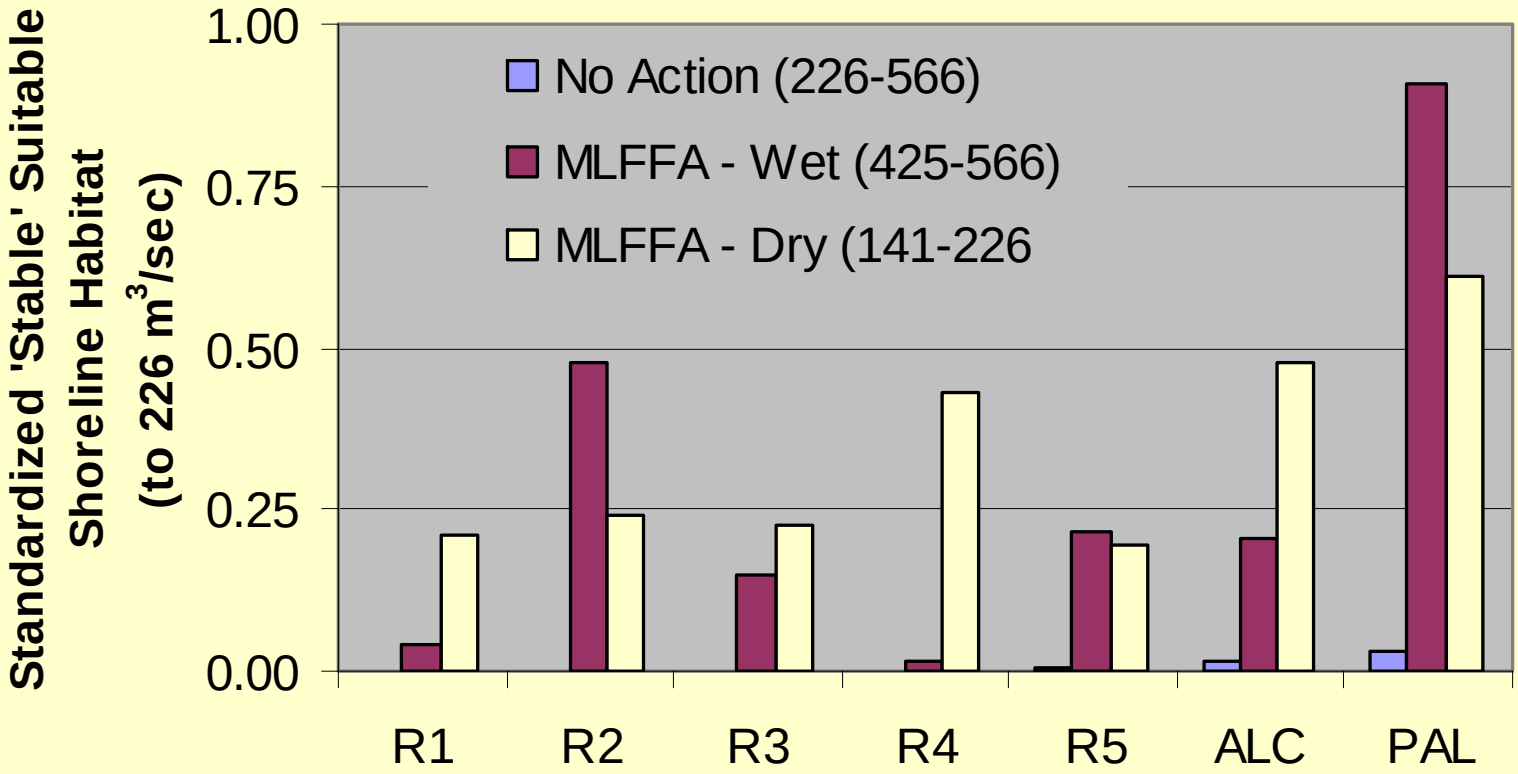


Computation of Stable Suitable Habitat Area

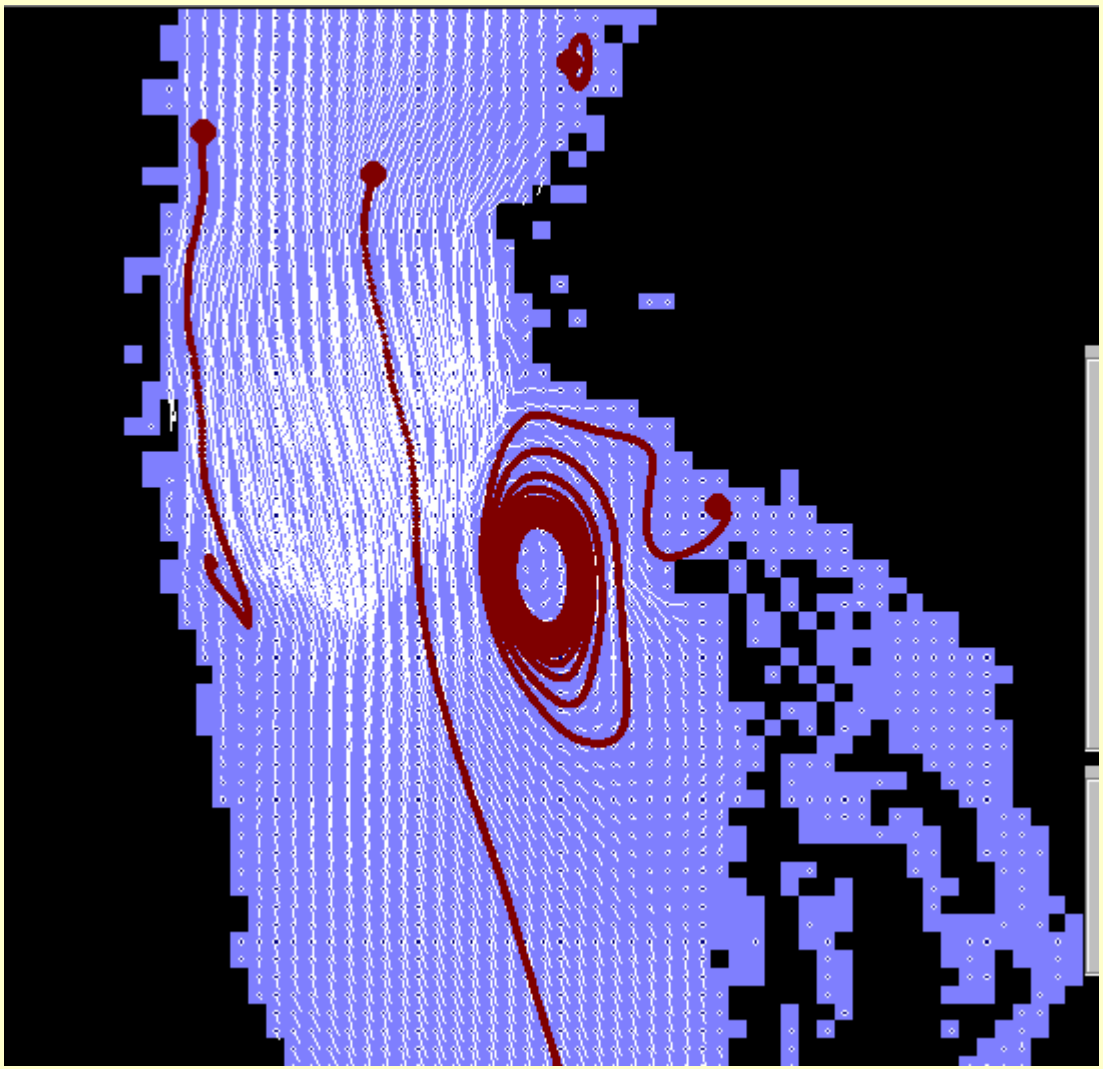
Intersection of suitable habitat areas across typical high and low flow for day

226 – pre-dam
226-566: No Action
425-566: Wet – MLFF
141-226: Dry - MLFF

Effects of Operations on Stable Suitable Habitat

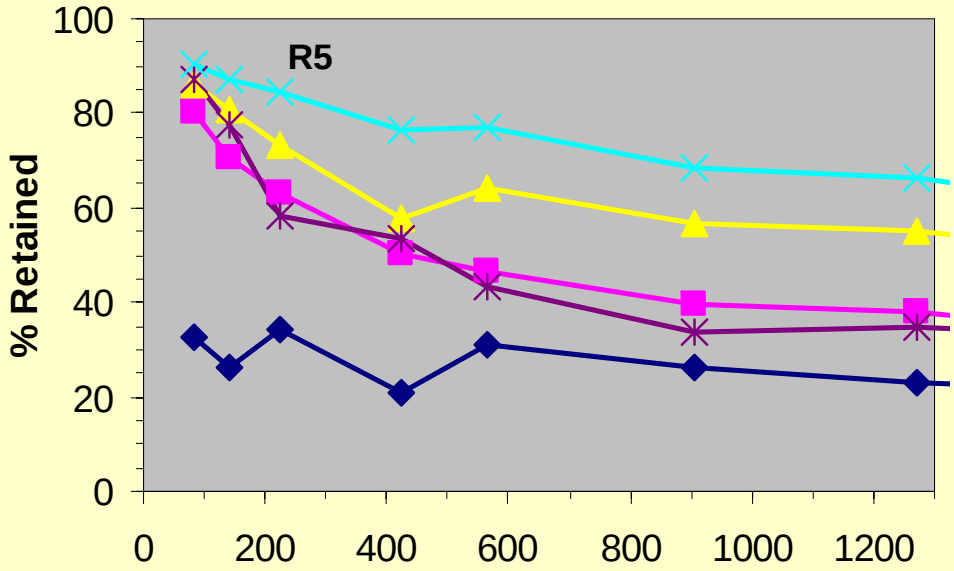


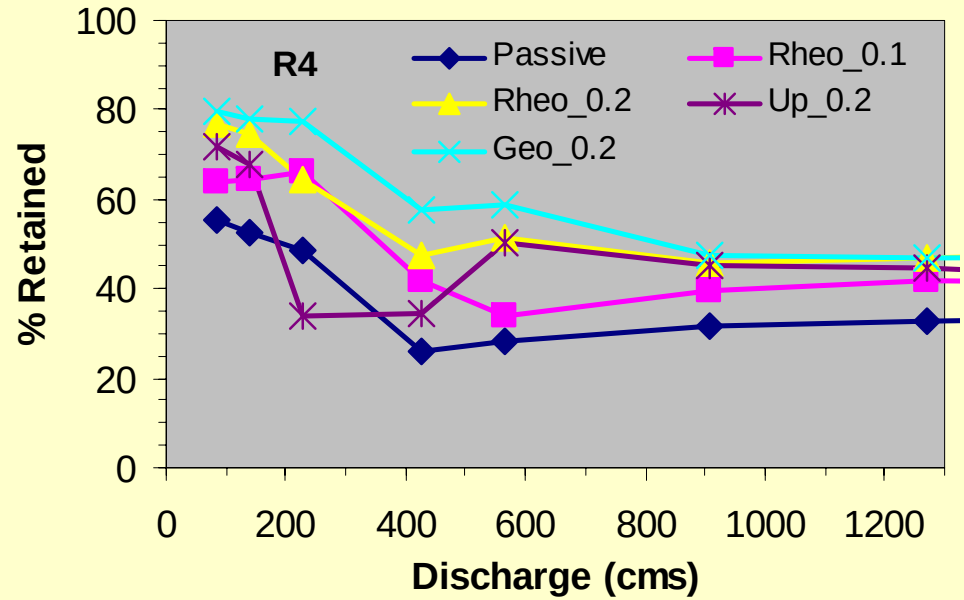
Particle Retention



Swimming Speed
And Behaviors

Passive
Geotactic
Rheotactic
0.1-0.2 m/s



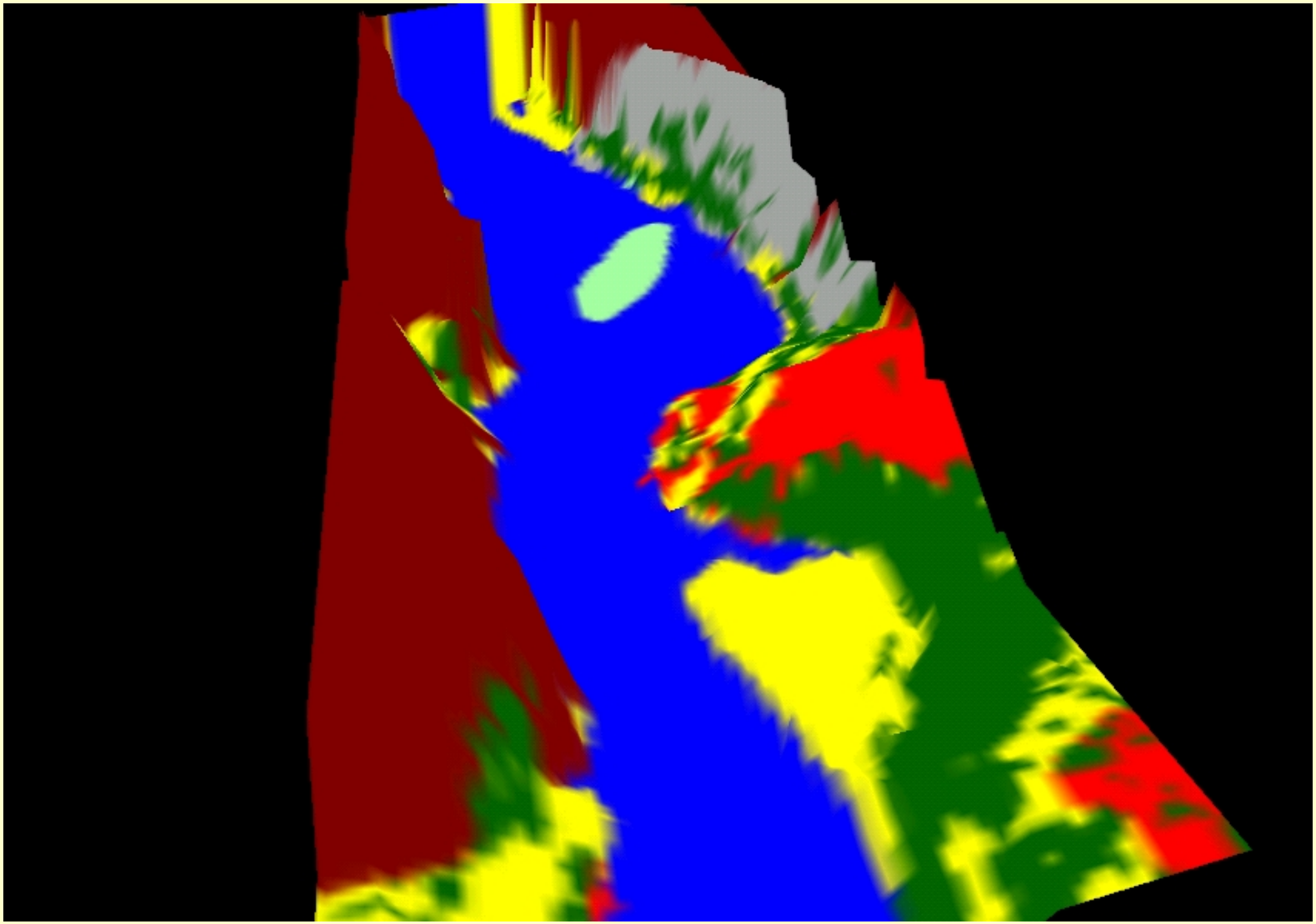


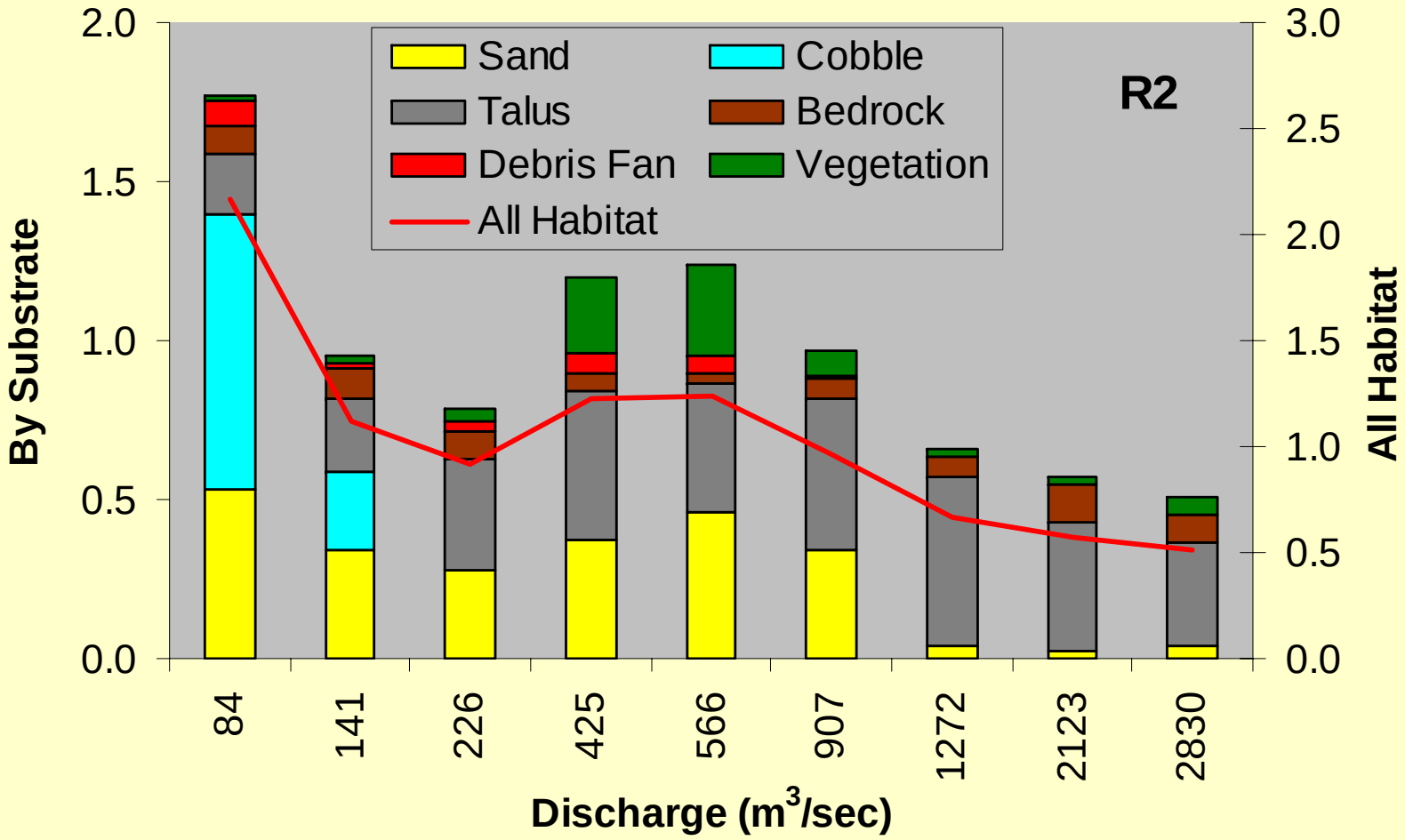
Effects of Discharge and Swimming Behavior on Ability to Remain in Suitable Habitat

Conclusions

- Effect of GCD on suitable habitat highly variable among seasons and reaches but overall effect is negative.
- On average MLFFA reduces suitable habitat relative to No Action by reducing frequency of low flow periods.
- MLFFA increases amount of persistent (stable) suitable habitat relative to No Action. The extent of improvement depends on average discharge and hydraulic sensitivity of reach.
- Dispersal mostly determined by swimming behavior and discharge at lower end of operational range. Discharge likely only effects dispersal of larval fish.
- Model useful for defining possible biologically-relevant hydraulic breakpoints for defining experimental flows.

Substrate Classification (ALC)




R2
Sand
Cobble
Talus
Bedrock
Debris Fan
Vegetation
All Habitat
By Substrate
All Habitat
2.0
1.5
1.0
0.5
0.0
3.0
2.5
2.0
1.5
1.0
0.5
0.0
84
141
226
425
566
907
1272
2123
2830
Discharge (m3/sec)