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Managing Water in the West

San Joaquin River Spawning Habitat Suitability Study

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Bureau of Reclamation

San Joaquin River Restoration Program (SJRRP)

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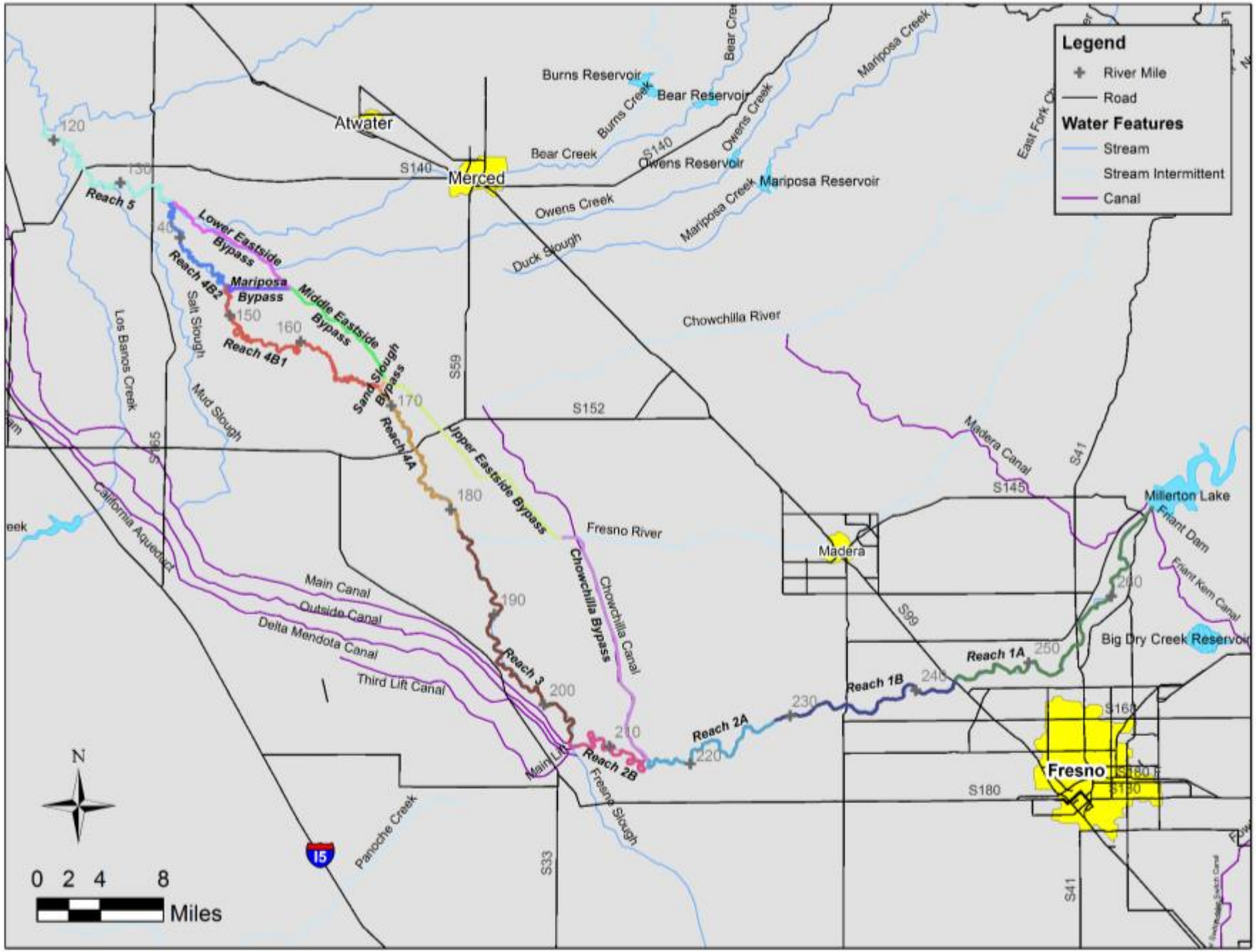
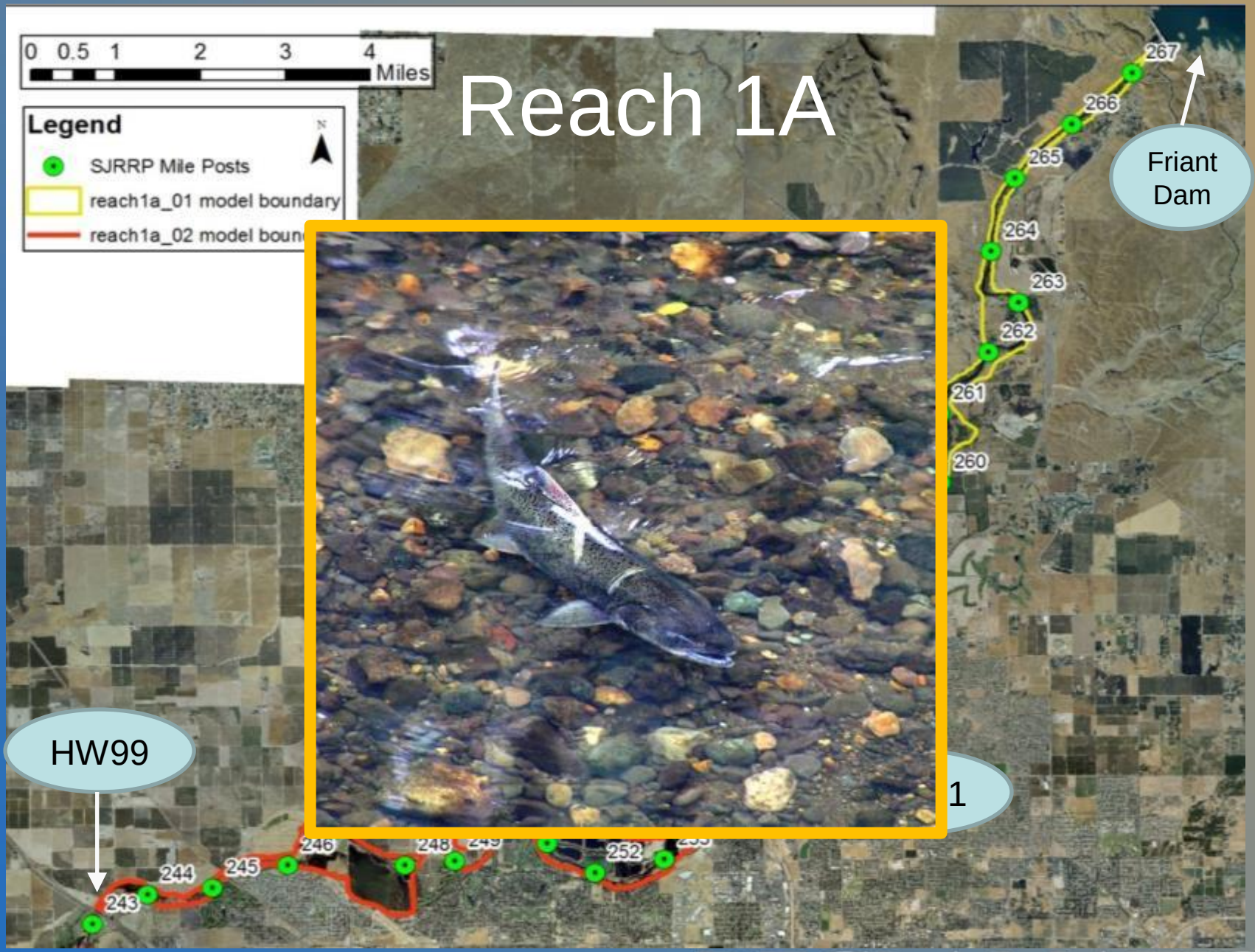

Legend
River Mile
Road
Water Features
Stream
Stream Intermittent
Canal
Atwater
Merced
Burns Reservoir
Bear Reservoir
Owens Reservoir
Mariposa Reservoir
Bear Creek
Burns Creek
Owens Creek
Mariposa Creek
East Fork
Duck Slough
Chowchilla River
Fresno River
Los Banos Creek
Salt Slough
Mud Slough
California Aqueduct
Main Canal
Outside Canal
Delta Mendota Canal
Third Lift Canal
Chowchilla Canal
Madera Canal
Friant Kern Canal
Millerton Lake
Friant Dam
Big Dry Creek Reservoir
Madera
Fresno
Panoche Creek
Fresno Slough
Reach 5
Lower Eastside Bypass
Reach 4B2
Mariposa Bypass
Middle Eastside Bypass
Reach 4B1
Sand Slough Bypass
Reach 4A
Upper Eastside Bypass
Chowchilla Bypass
Reach 3
Reach 2B
Reach 2A
Reach 1B
Reach 1A
120
130
140
150
160
170
180
190
200
210
220
230
240
250
260
S140
S59
S152
S99
S145
S41
S160
S180
S190
S33
I5
N
0 2 4 8
Miles

Reach 1A



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Anthropogenic impacts to Reach 1A

- Reduced flow and sediment supply
- Increased grain size and reduced mobility below Dam
- Gravel pits- online and offline
- Channelization
- Main channel and side channel narrowing
- Grade control
- Reduced topographic diversity, complexity and cover
- Invasive Species (vegetation and aquatic)
- Potential groundwater contamination

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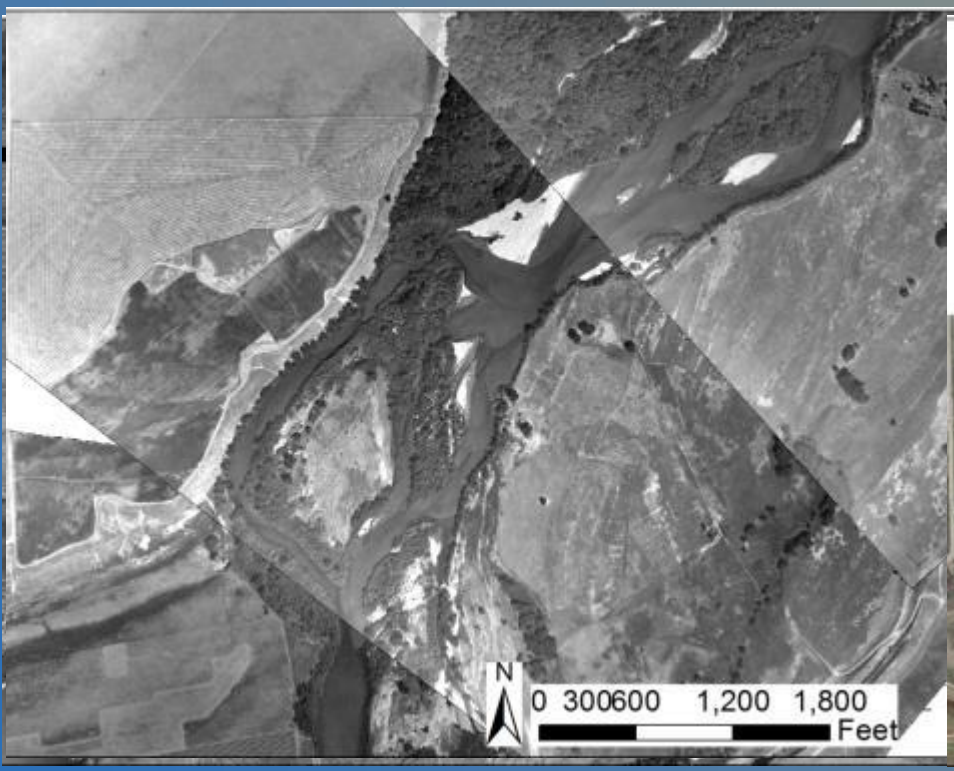

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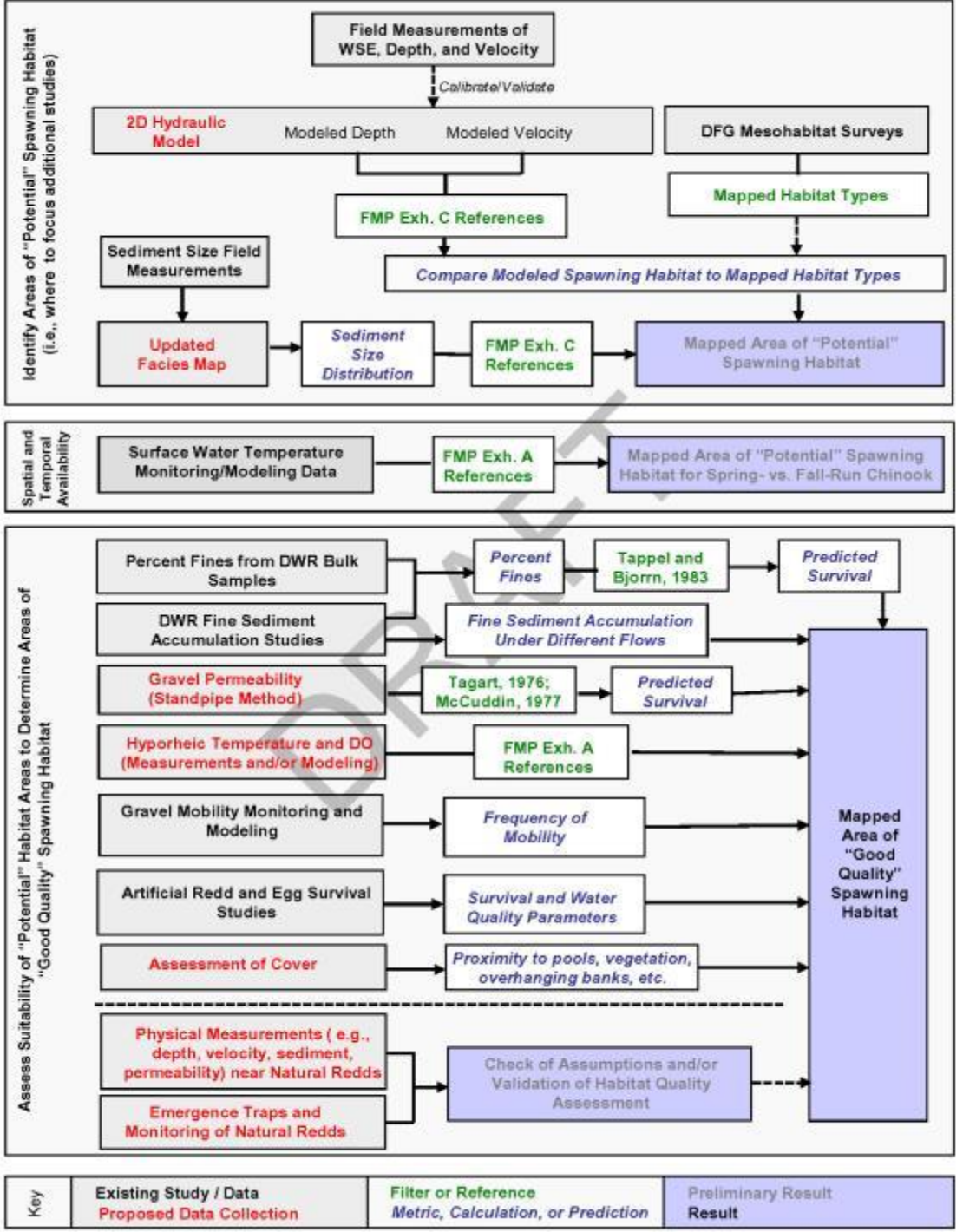
Potential Quantity

- Compr sed o
  sciencti fro

Spring vs Fall-Run

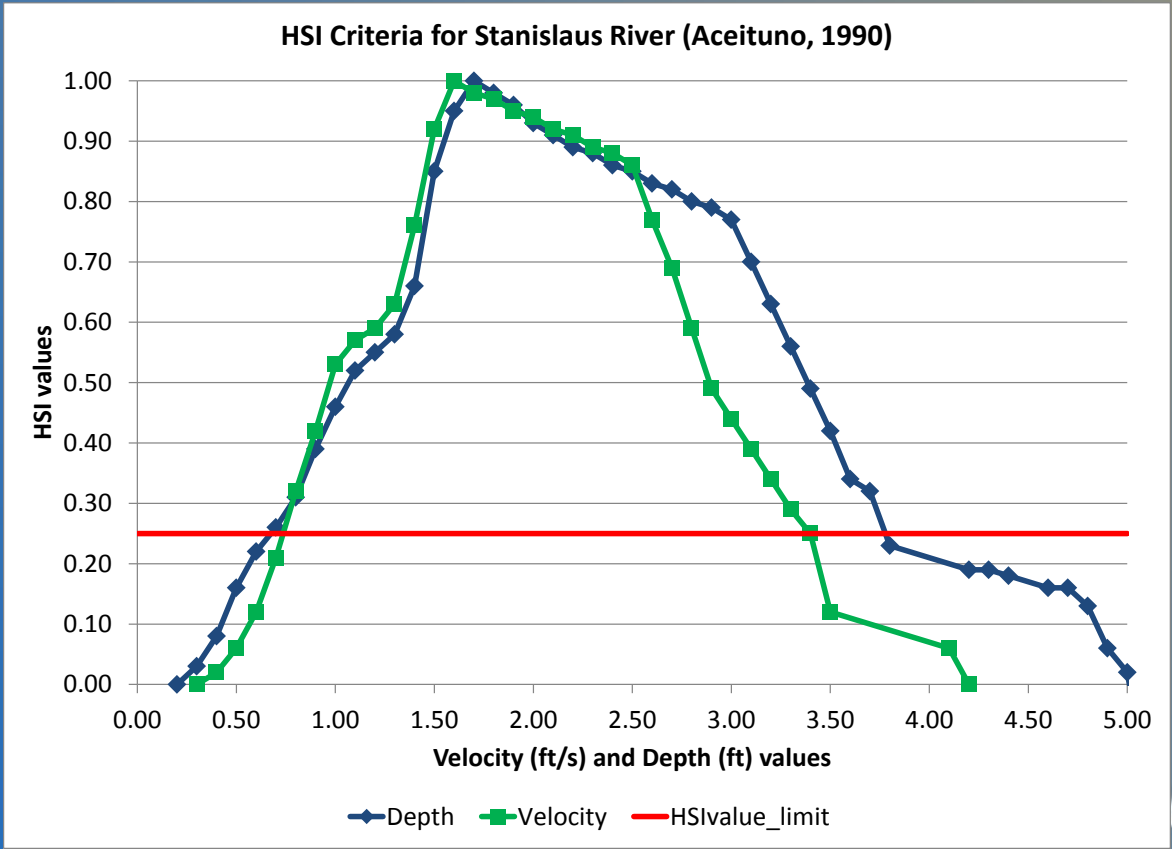
Quality Habitat



Requirements for spawning habitat

- **Hydraulic**
  - ➢ **Depths between 0.7 and 3.7 ft**
  - ➢ **Velocities between 0.8 and 3.4 ft/s**

(Aceituno, 1990, Stanislaus River)



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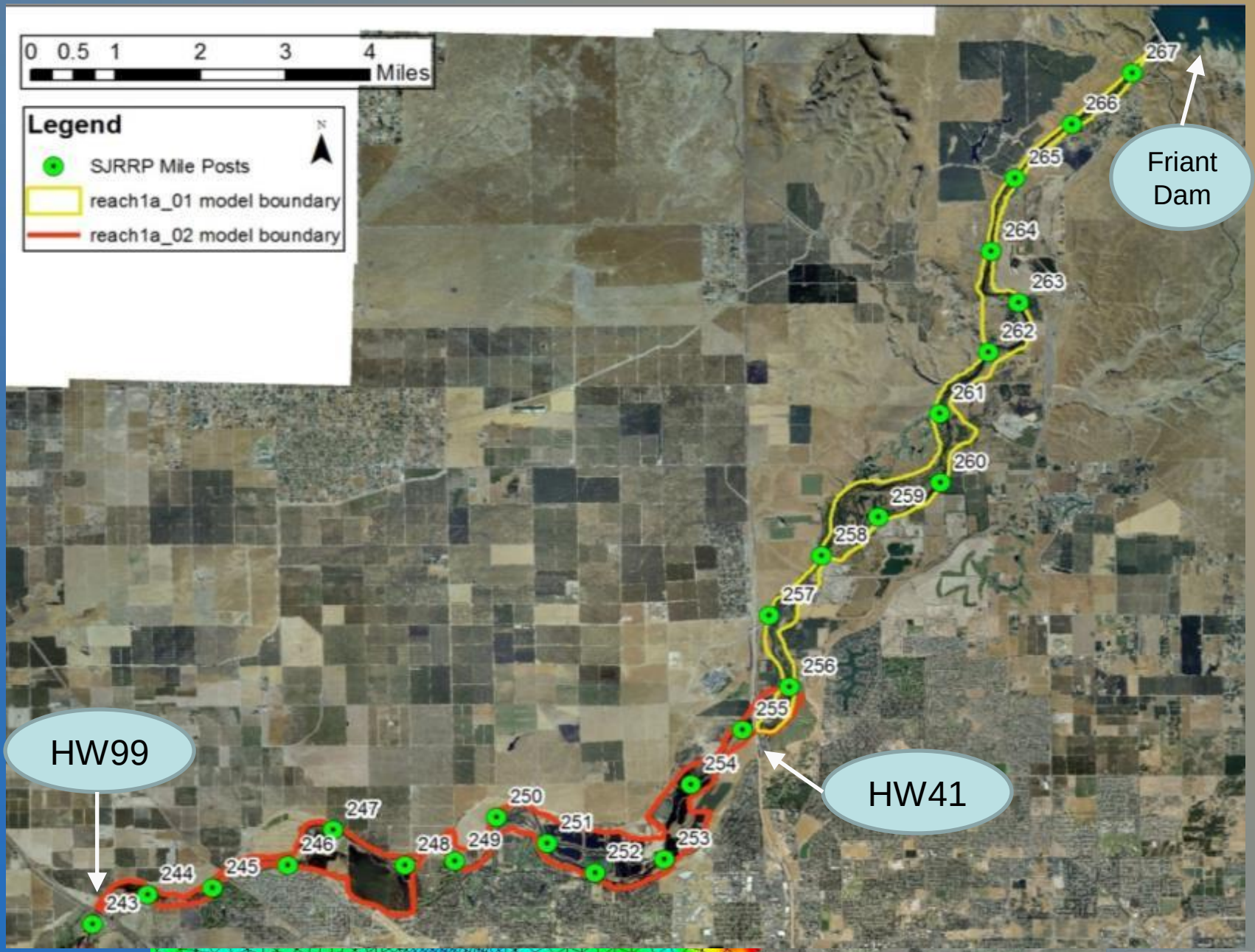
Requirements for spawning habitat

- **Sediment**
  - **Preferred range- 25 to 100 mm, some reports up to 300 mm (SJRRP, 2010, Fisheries Management Plan)**

- **Water Temperature**

	Spawning
Optimal	≤ 57 °F (13.9 °C)
Critical	60-62.6 °F (15.6-17°C)
Lethal	≥62.6 °F (17 °C)

(SJRRP, 2010, Fisheries Management Plan)


0 0.5 1 2 3 4
Miles
Legend
SJRRP Mile Posts
reach1a_01 model boundary
reach1a_02 model boundary
N
Friant Dam
HW99
HW41
243
244
245
246
247
248
249
250
251
252
253
254
255
256
257
258
259
260
261
262
263
264
265
266
267


(6781946.0, 1800699.9)

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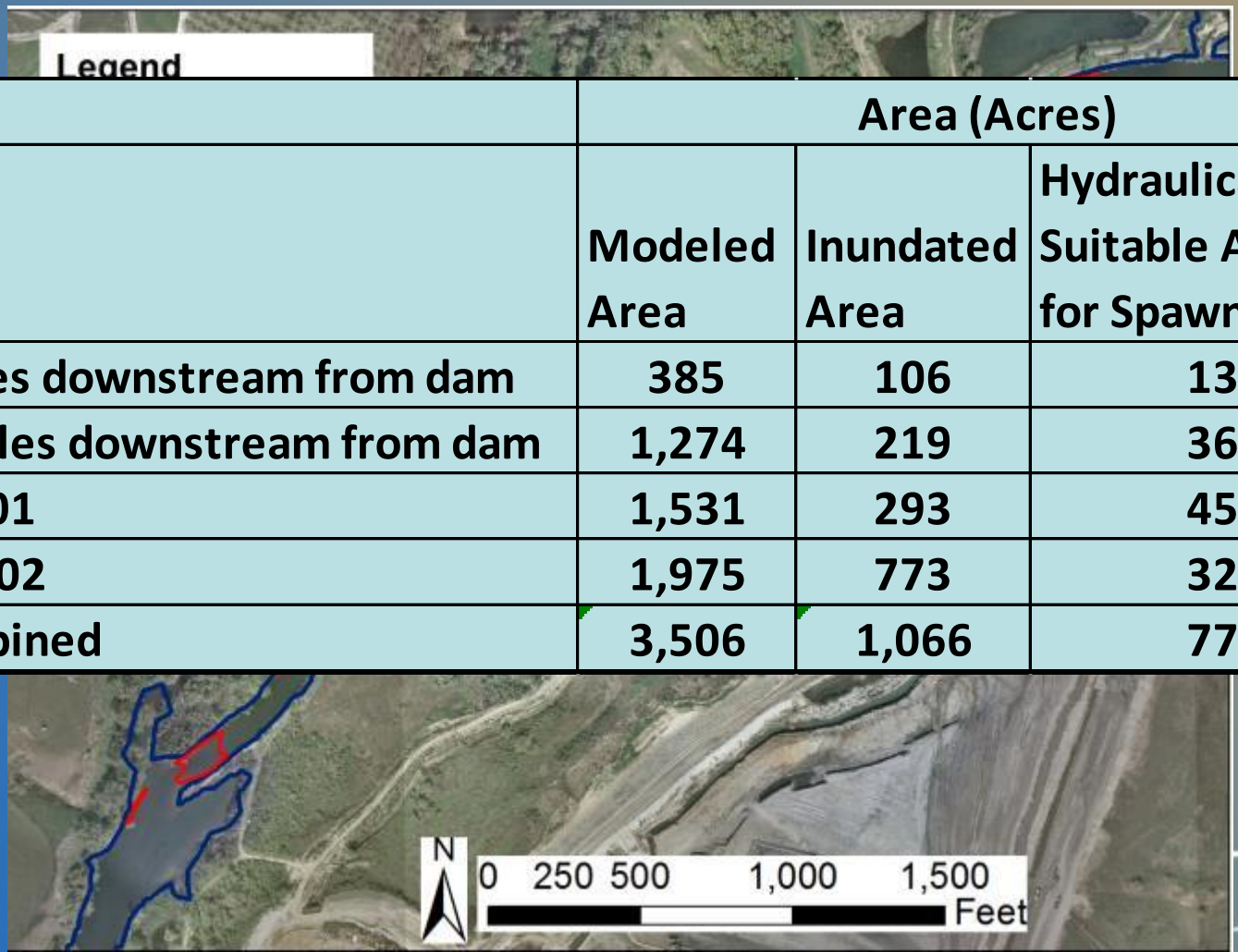
2D Hydraulic Model Results

- Binary mapping of suitability at 350 cfs

	Area (Acres)		
	Modeled Area	Inundated Area	Hydraulically Suitable Area for Spawning
First 5 miles downstream from dam	385	106	13
First 10 miles downstream from dam	1,274	219	36
Reach1A_01	1,531	293	45
Reach 1A_02	1,975	773	32
Total Combined	3,506	1,066	77



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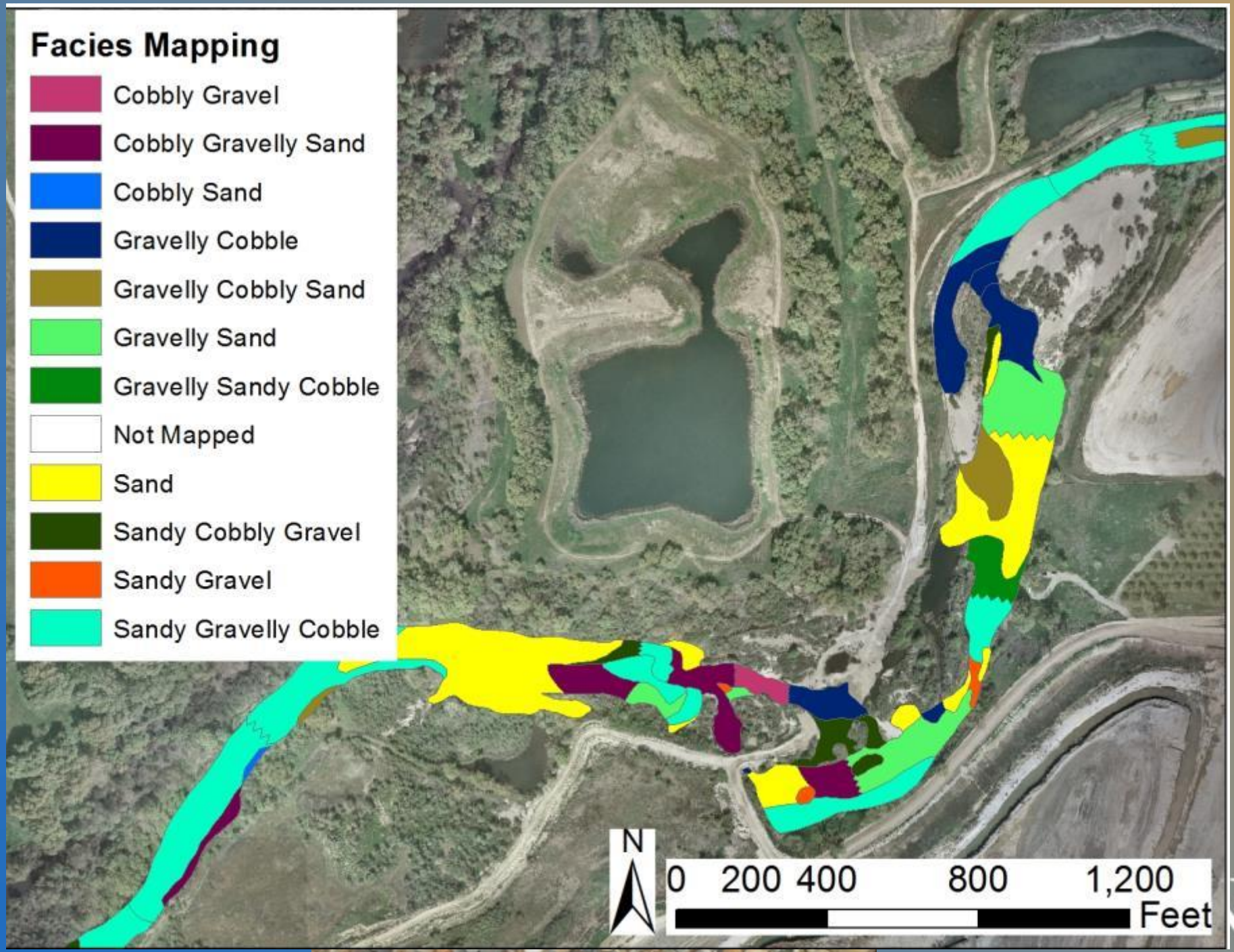
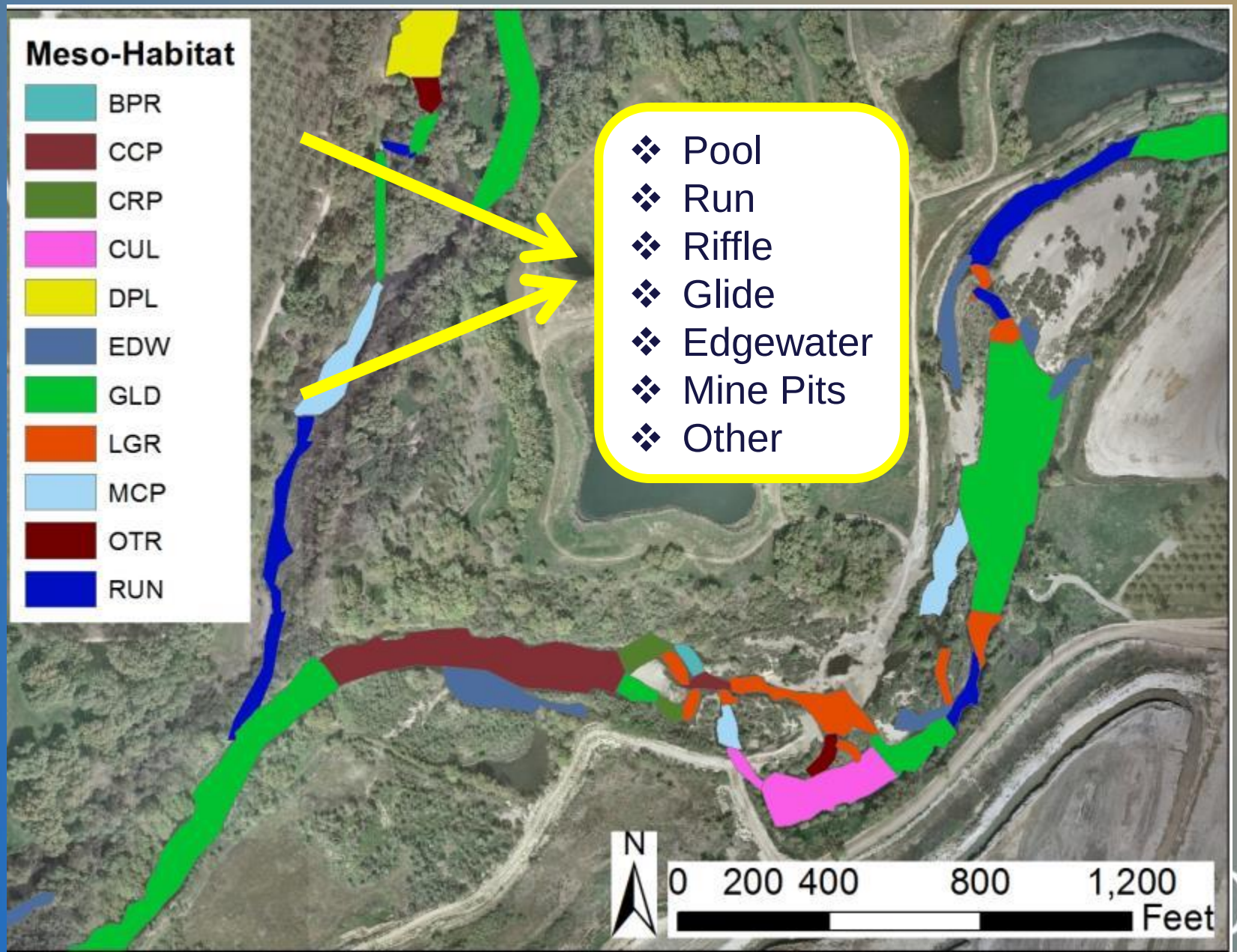
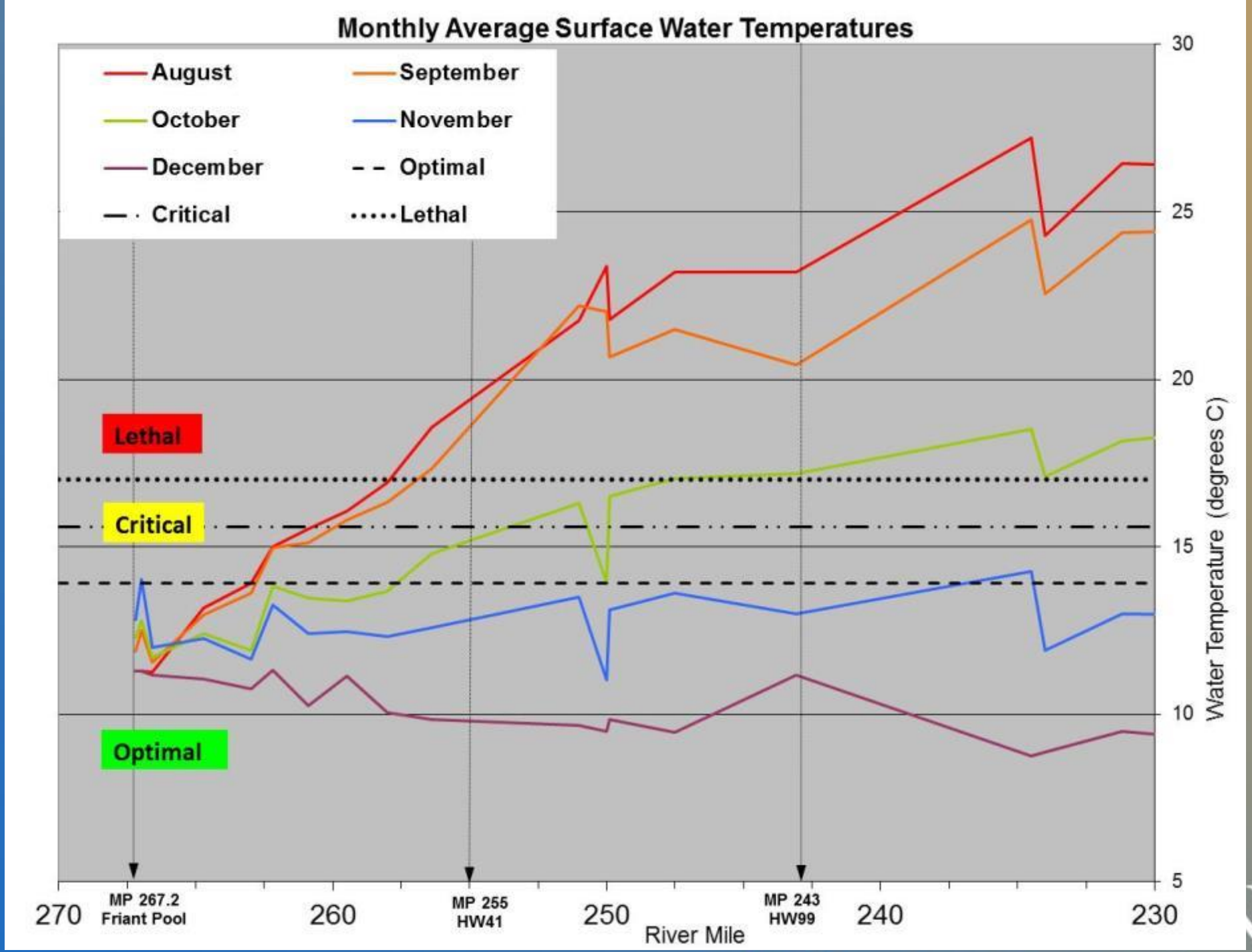
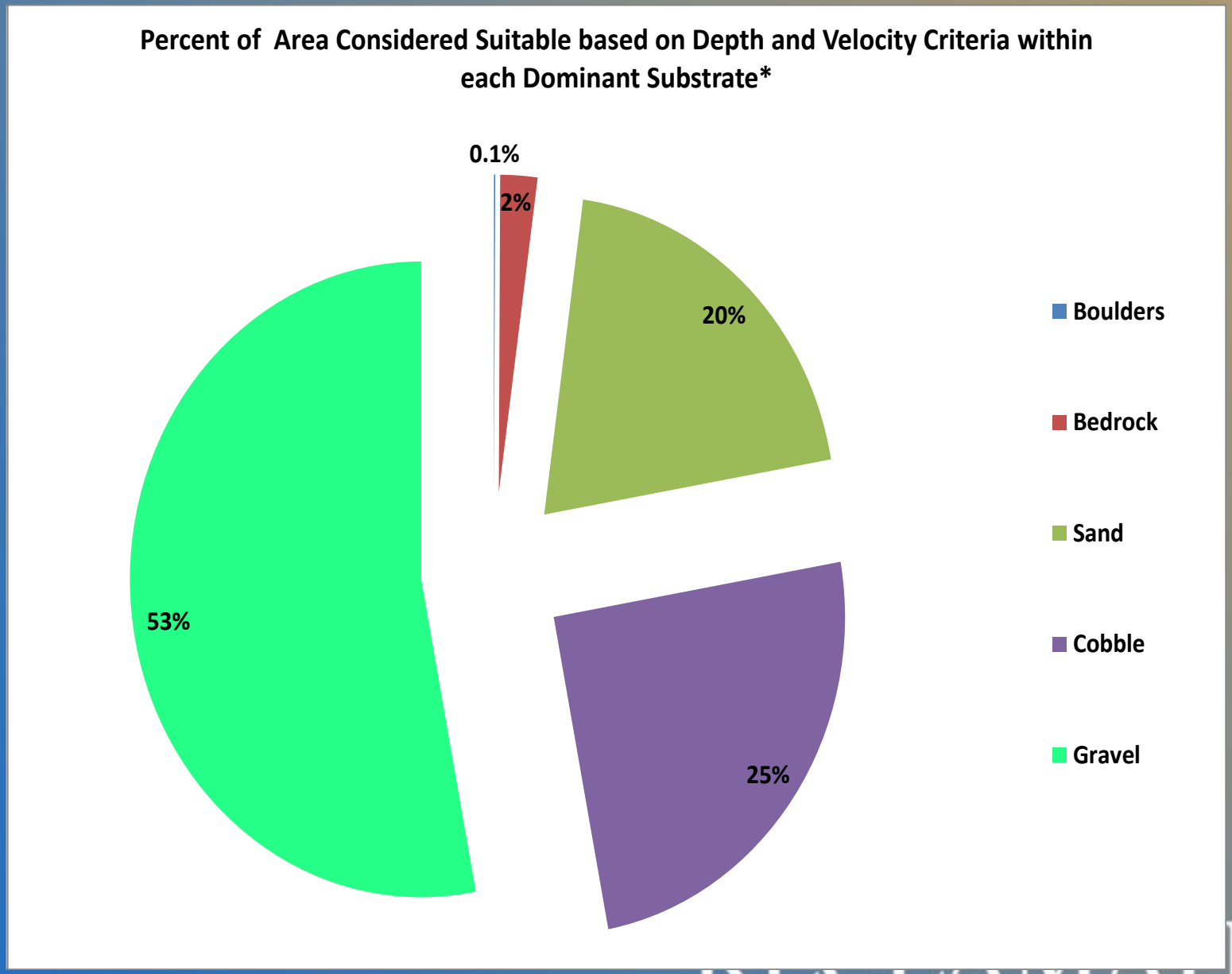

Facies Mapping
Cobbly Gravel
Cobbly Gravelly Sand
Cobbly Sand
Gravelly Cobble
Gravelly Cobbly Sand
Gravelly Sand
Gravelly Sandy Cobble
Not Mapped
Sand
Sandy Cobbly Gravel
Sandy Gravel
Sandy Gravelly Cobble
N
0 200 400 800 1,200
Feet

Meso-Habitat Mapping (CDFW, 2009)

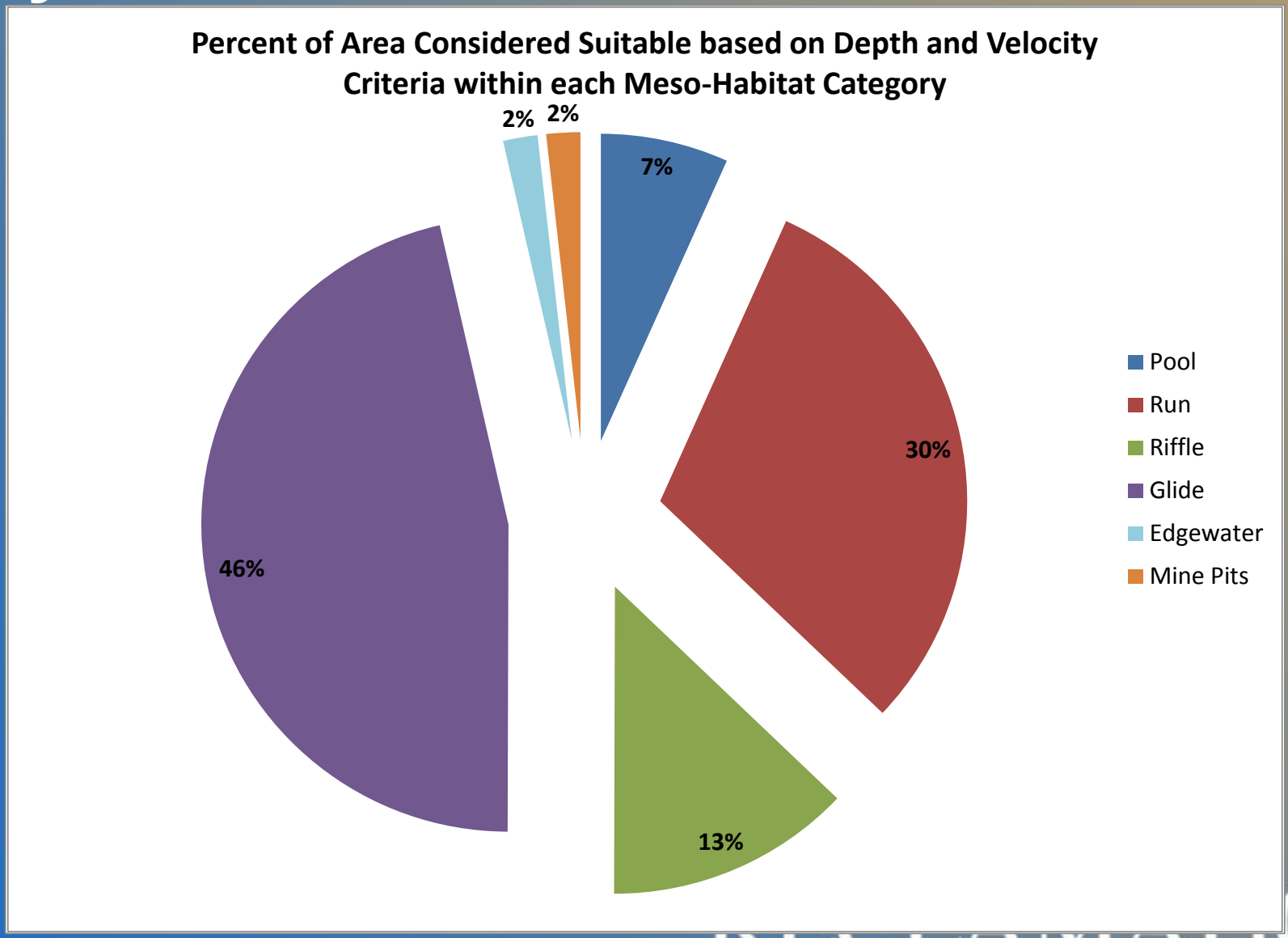


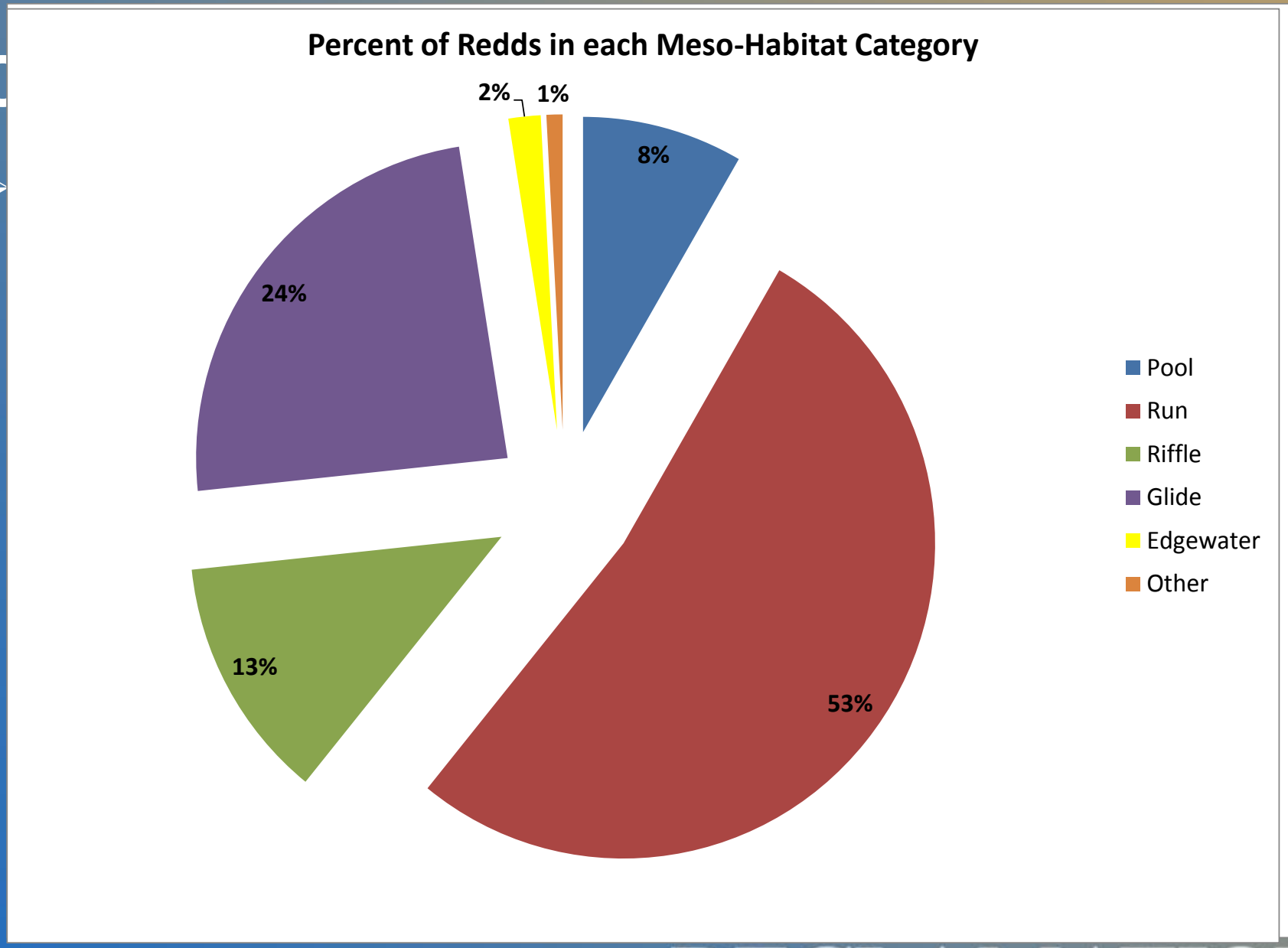

Monthly Average Surface Water Temperatures
August
September
October
November
December
Optimal
Critical
Lethal
Lethal
Critical
Optimal
30
25
20
15
10
5
Water Temperature (degrees C)
270
MP 267.2
Friant Pool
260
MP 255
HW41
250
River Mile
MP 243
HW99
240
230

Bed Material and Hydraulics



Meso-Habitat Mapping and Hydraulics




Percent of Redds in each Meso-Habitat Category
2%
1%
8%
24%
13%
53%
Pool
Run
Riffle
Glide
Edgewater
Other

Statistical Analysis of Spawning Preference

- **Used Jacob's electivity analysis (**Hamann et al., 2014)

$$D = (r - p)/(r + p - 2rp)$$

D = degree of preference (-1 to 1)
r = proportion of habitat used
p = proportion of habitat available

Statistical Analysis of Spawning Preference

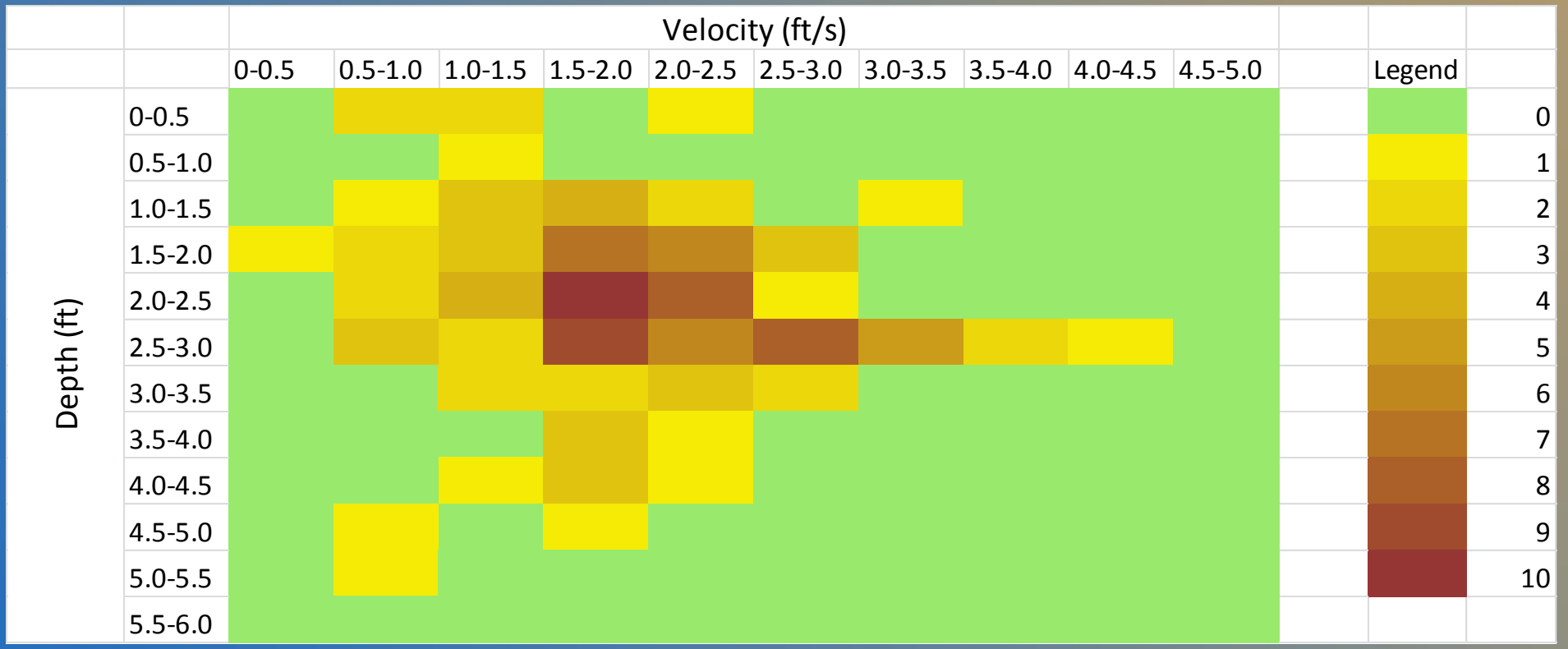
Designation	Range
Strong Preference	0.9 to 1.0
Preference	0.6 to 0.8
Mild Preference	0.3 to 0.5
Indifference	-0.2 to 0.2
Mild Avoidance	-0.3 to -0.5
Avoidance	-0.6 to -0.8
Strong Avoidance	-0.9 to -1

Dominant Substrate	Interpretation
Boulders	Strong Avoidance
Bedrock	Avoidance
Sand	Strong Avoidance
Cobble	Mild Preference
Gravel	Preferrence
Silt	Strong Avoidance
Cobble and Gravel	Strong Preference

Hydraulics	Interpretation
Hydraulically Suitable Area	Strong Preference
Non-hydraulically Suitable Area	Strong Avoidance

Mesohabitat category	Interpretation
Pool	Indifference
Run	Strong Preference
Riffle	Strong Preference
Glide	Avoidance
Edgewater	Indifference
Captured Mine Pits	Strong Avoidance

Spawning Preferences for Hydraulic Conditions



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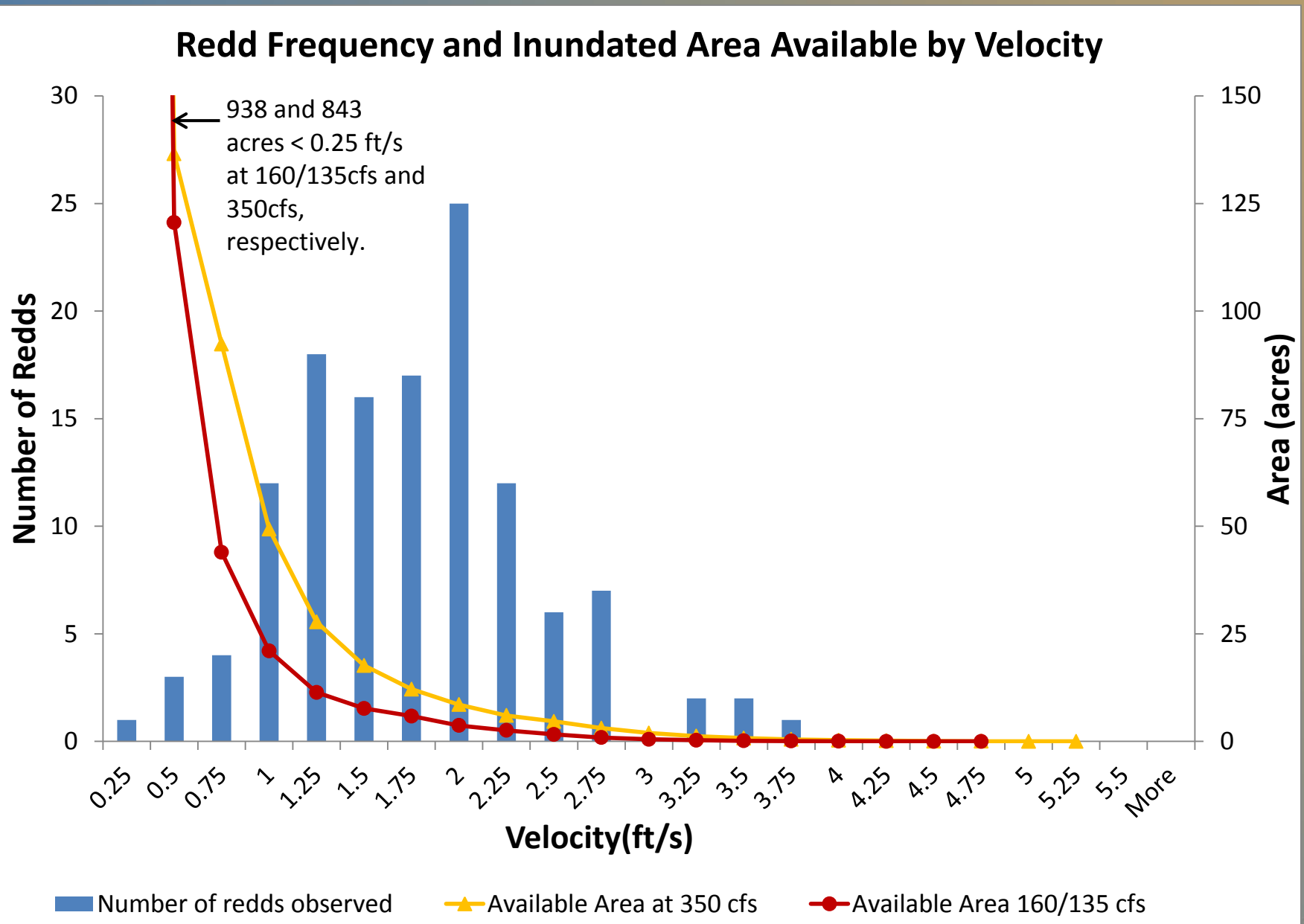
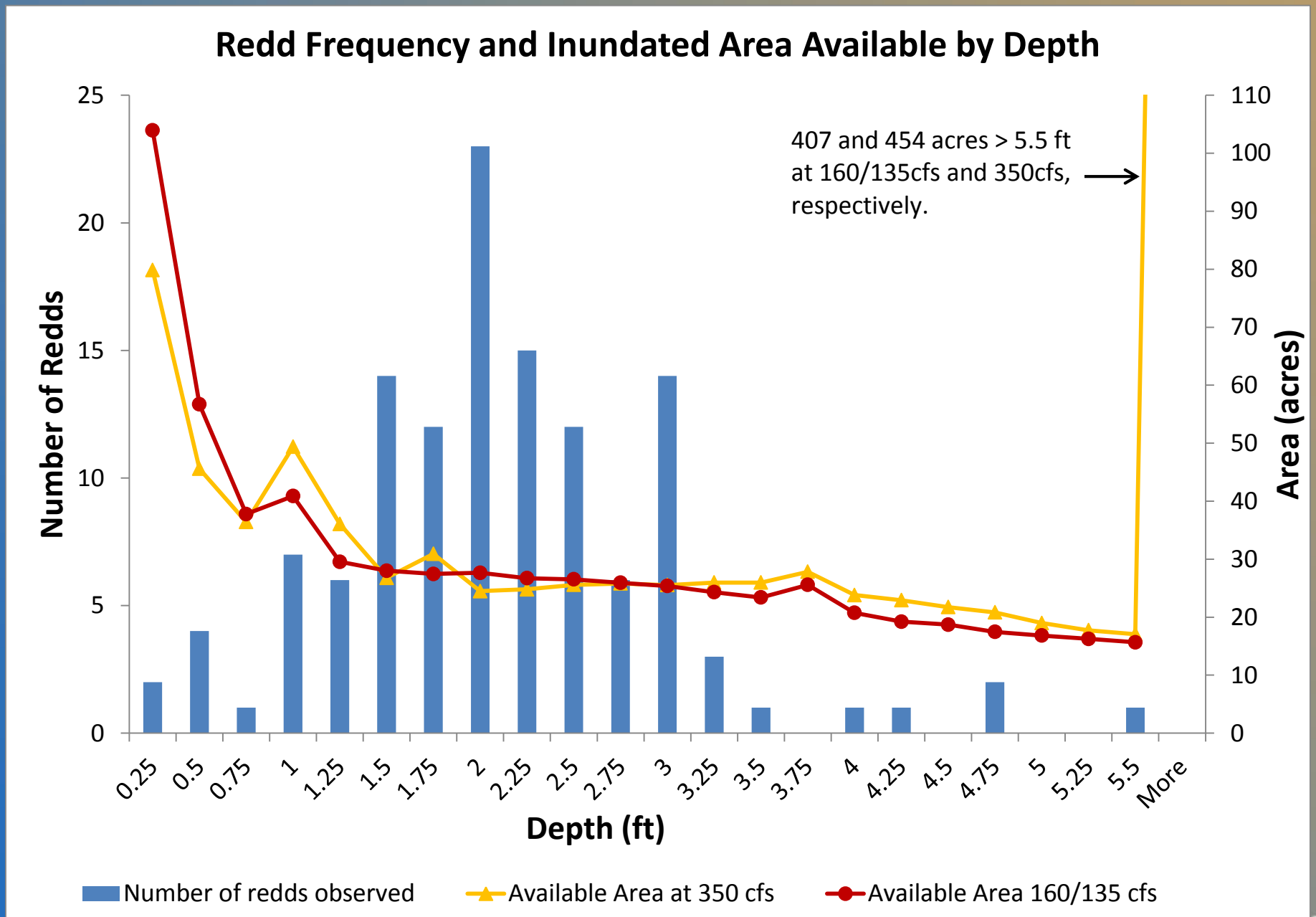

Redd Frequency and Inundated Area Available by Velocity
938 and 843 acres < 0.25 ft/s at 160/135cfs and 350cfs, respectively.
Number of Redds
Area (acres)
Velocity(ft/s)
0.25
0.5
0.75
1
1.25
1.5
1.75
2
2.25
2.5
2.75
3
3.25
3.5
3.75
4
4.25
4.5
4.75
5
5.25
5.5
More
Number of redds observed
Available Area at 350 cfs
Available Area 160/135 cfs


Redd Frequency and Inundated Area Available by Depth
407 and 454 acres > 5.5 ft at 160/135cfs and 350cfs, respectively.
Number of Redds
Area (acres)
Depth (ft)
0.25
0.5
0.75
1
1.25
1.5
1.75
2
2.25
2.5
2.75
3
3.25
3.5
3.75
4
4.25
4.5
4.75
5
5.25
5.5
More
Number of redds observed
Available Area at 350 cfs
Available Area 160/135 cfs

Pilot Sites

- 3 riffles selected with substantial redd activity in 2013 or 2014
- Field measured at each site:
  - High density topography
  - Grid of D84 and % fines
  - Velocity and WSE measurements
- Goal of study to evaluate sensitivity of predicted areas of suitability to scale of model inputs.

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Refined 2D Models at 3 Pilot Sites

- Example of Woodward Park at Highway 41 at 350 cfs
  - Improved topographic representation
  - Reduced mesh cell size to 3-5 ft width within channel
  - Continuous HSI criteria

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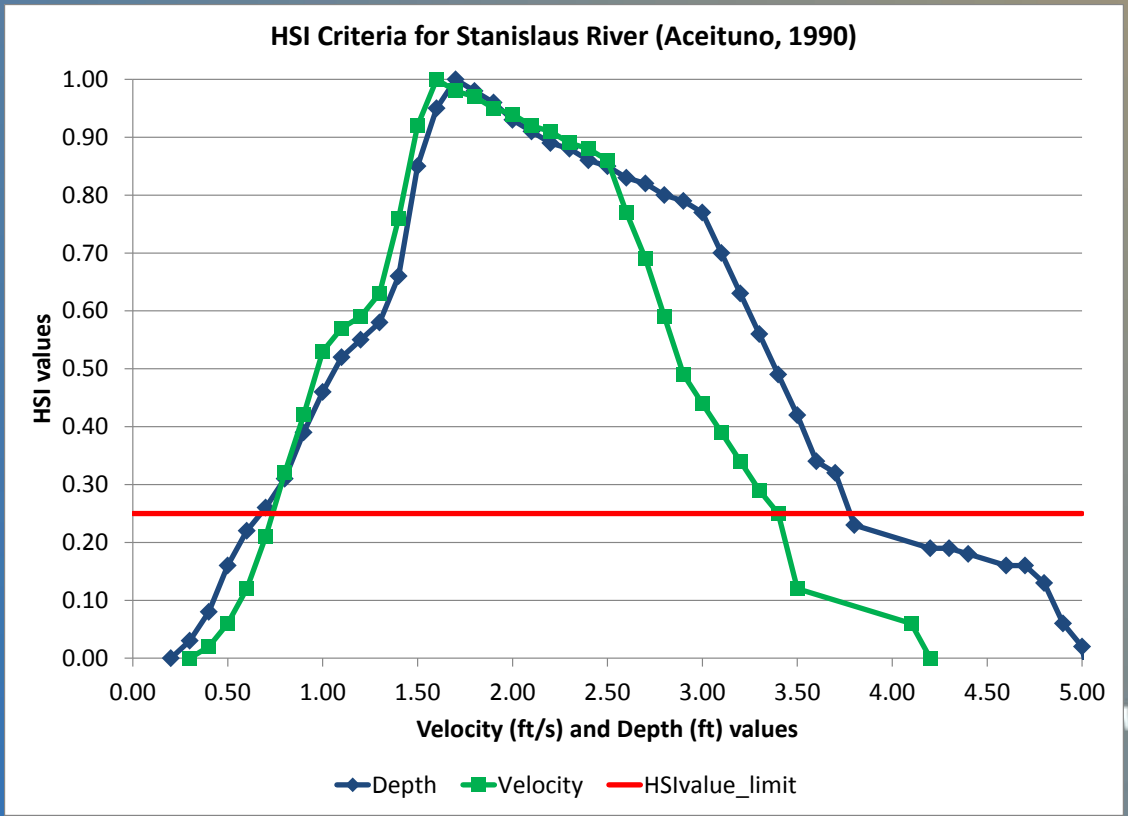
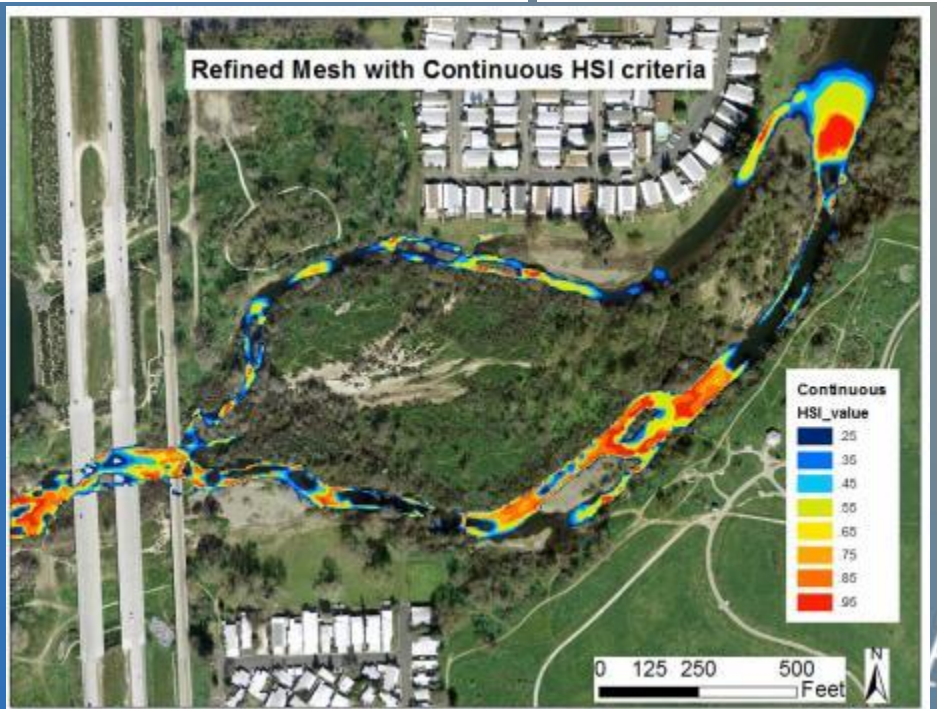
Binary Vs. Continuous HSI

- *Binary:* 1- meet both depth and velocity criteria above 0.3 HSI values or 0- does not meet both depth and velocity criteria
- *Continuous:* minimum HSI value for depth or velocity above 0.3





350 cfs

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Sensitivity of Suitable Area Prediction to Method Used

Summary of Suitable Area at Woodward Park

Prediction Method	Area (acres)
Coarse Mesh Binary Mapping	7.77
Refined Mesh Binary Mapping	7.12
Refined Mesh Continuous Mapping >0.25	7.39
Refined Mesh Continuous Mapping Weighted by HSI value	4.24

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Take Home Points

- Strong correlation between hydraulically suitable area and spawning site selection.
- Salmon prefer cobble and gravel dominated substrate, but sometimes selected sand.
- Both hydraulics and substrate are important to redd site selection!
- Water temps may limit Spring-run to first 5-10 miles downstream from dam.
  - 13-36 acres of hydraulically suitable area

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Study Direction

- Comparison of continuous HSI for coarse mesh and 3 pilot sites
- Comparison of refined bed material representation (point measurements of D84 and %fines) with facies mapping
- Incorporate substrate HSI
- Incorporate other indicators of quality
- Ultimately determine need for and potential locations of additional spawning habitat in Reach 1A

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Acknowledgements

- Spawning and Incubation Subgroup
  - Erica Meyers (CA DFW)
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- San Joaquin Restoration Program

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