Ecological Characterization of Salmon Habitat Restoration Efforts for Abandoned Gravel Pits, Yakima River, WA

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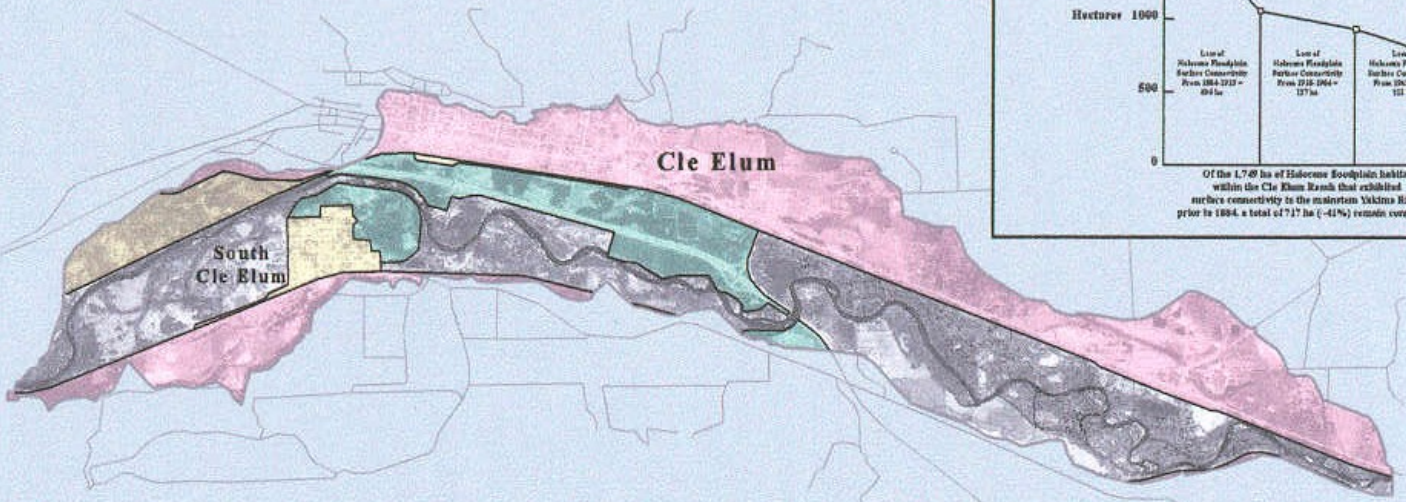
Research Objectives - to examine:

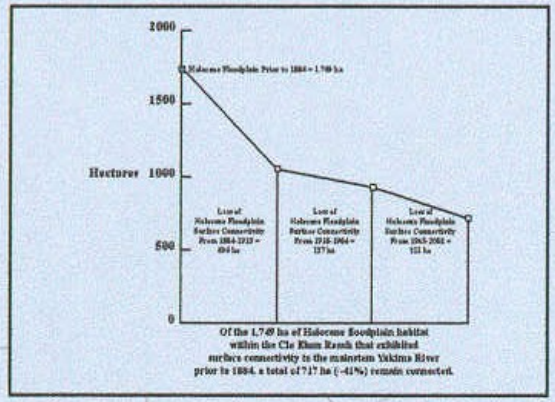
- ecological differences between comparable reconnected and disconnected gravel pit sites
- differences in the degree of hydrologic connectivity between gravel pit systems
- potential water quality gradients in the reconnected system
- whether restoration has provided adequate habitat for salmon in the Hansen Ponds system.

Study Location

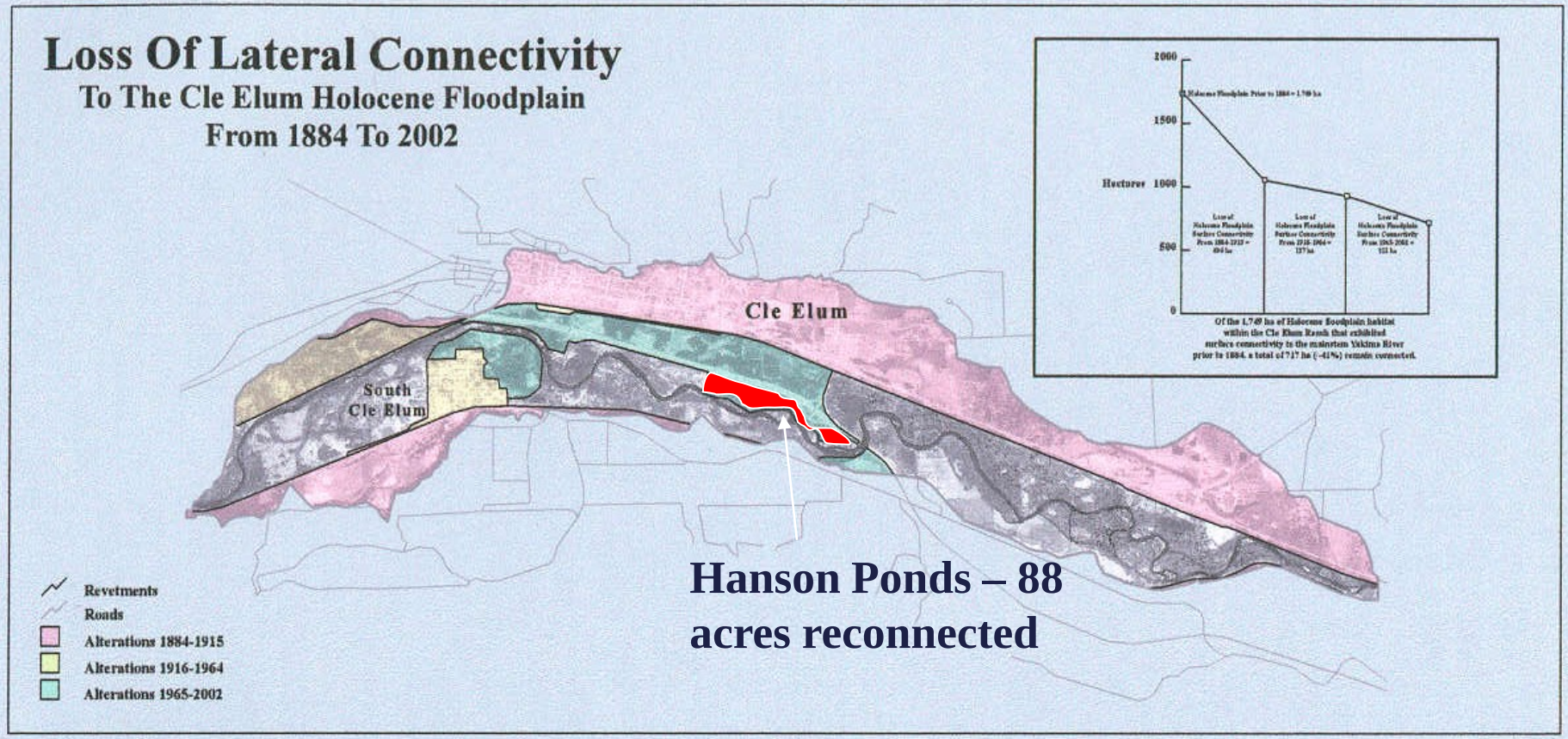
Loss Of Lateral Connectivity

To The Cle Elum Holocene Floodplain From 1884 To 2002



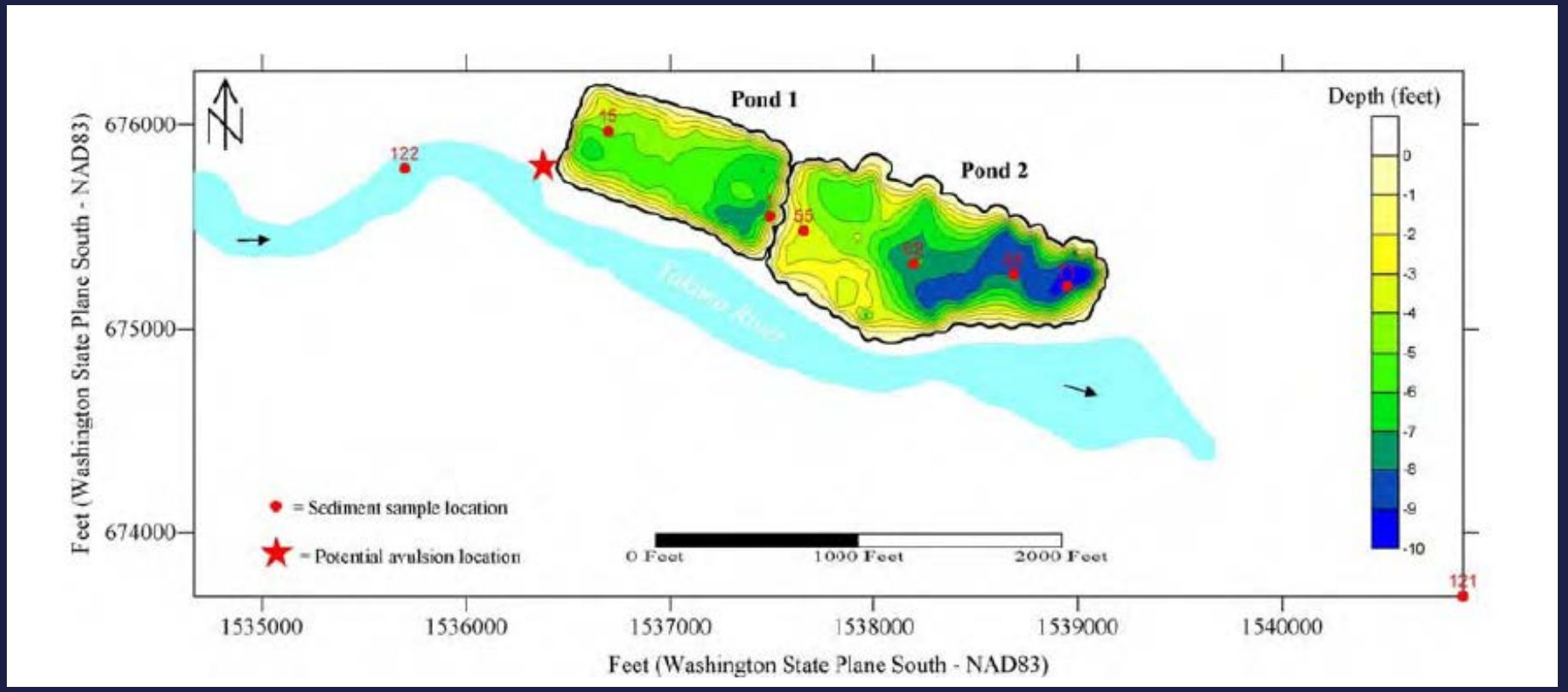


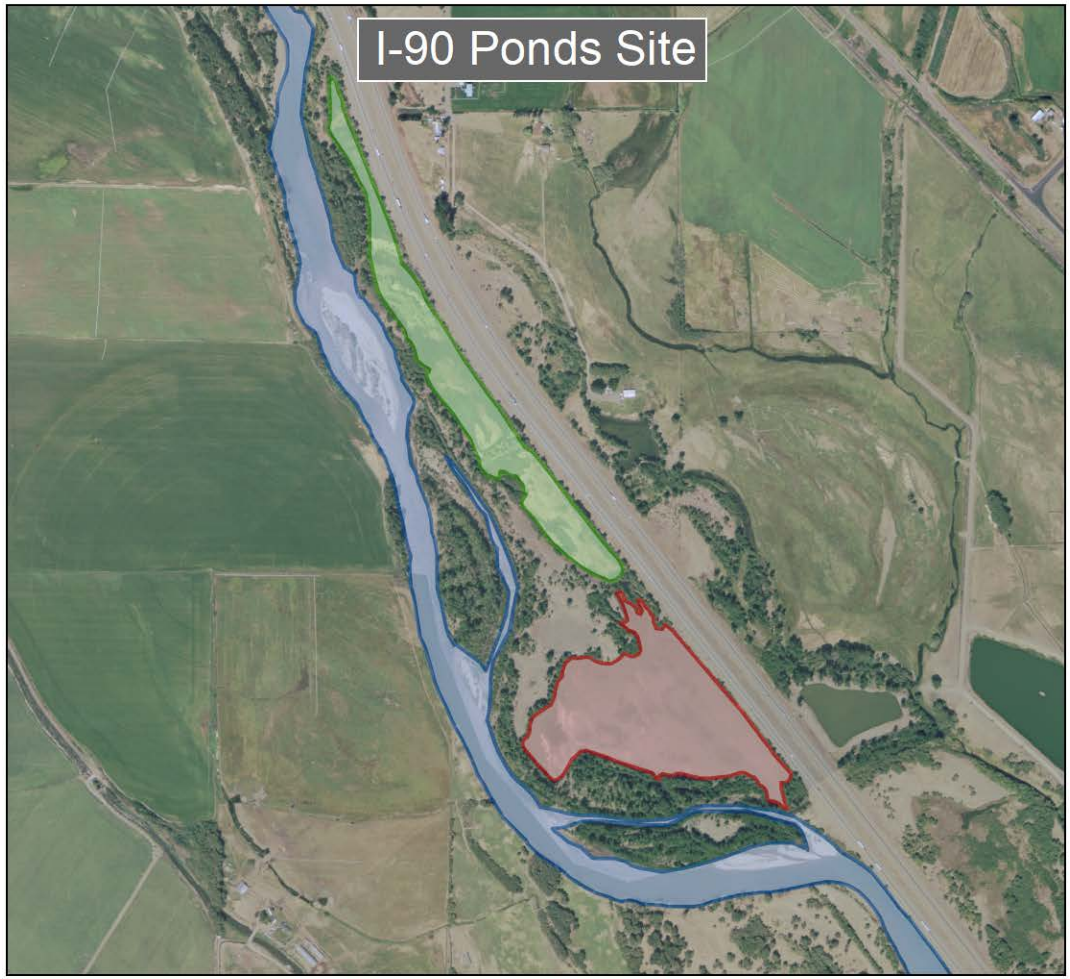
- Revetments
- Roads
- Alterations 1884-1915
- Alterations 1916-1964
- Alterations 1965-2002


Loss Of Lateral Connectivity
To The Cle Elum Holocene Floodplain
From 1884 To 2002
Cle Elum
South
Cle Elum
Revetments
Roads
Alterations 1884-1915
Alterations 1916-1964
Alterations 1965-2002
2000
1500
1000
500
0
Hectares
Of the 1,749 ha of Holocene floodplain habitat
within the Cle Elum Ranch that exhibited
surface connectivity to the mainstem Yakima River
prior to 1884, a total of 717 ha (~41%) remain connected.
Hanson Ponds – 88
acres reconnected

Wetland Peninsulas

Levee Breaches


Pond 1
Pond 2
Depth (feet)
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
15
122
55
121
= Sediment sample location
= Potential avulsion location
0 Feet
1000 Feet
2000 Feet
676000
675000
674000
Feet (Washington State Plane South - NAD83)
1535000
1536000
1537000
1538000
1539000
1540000
Feet (Washington State Plane South - NAD83)

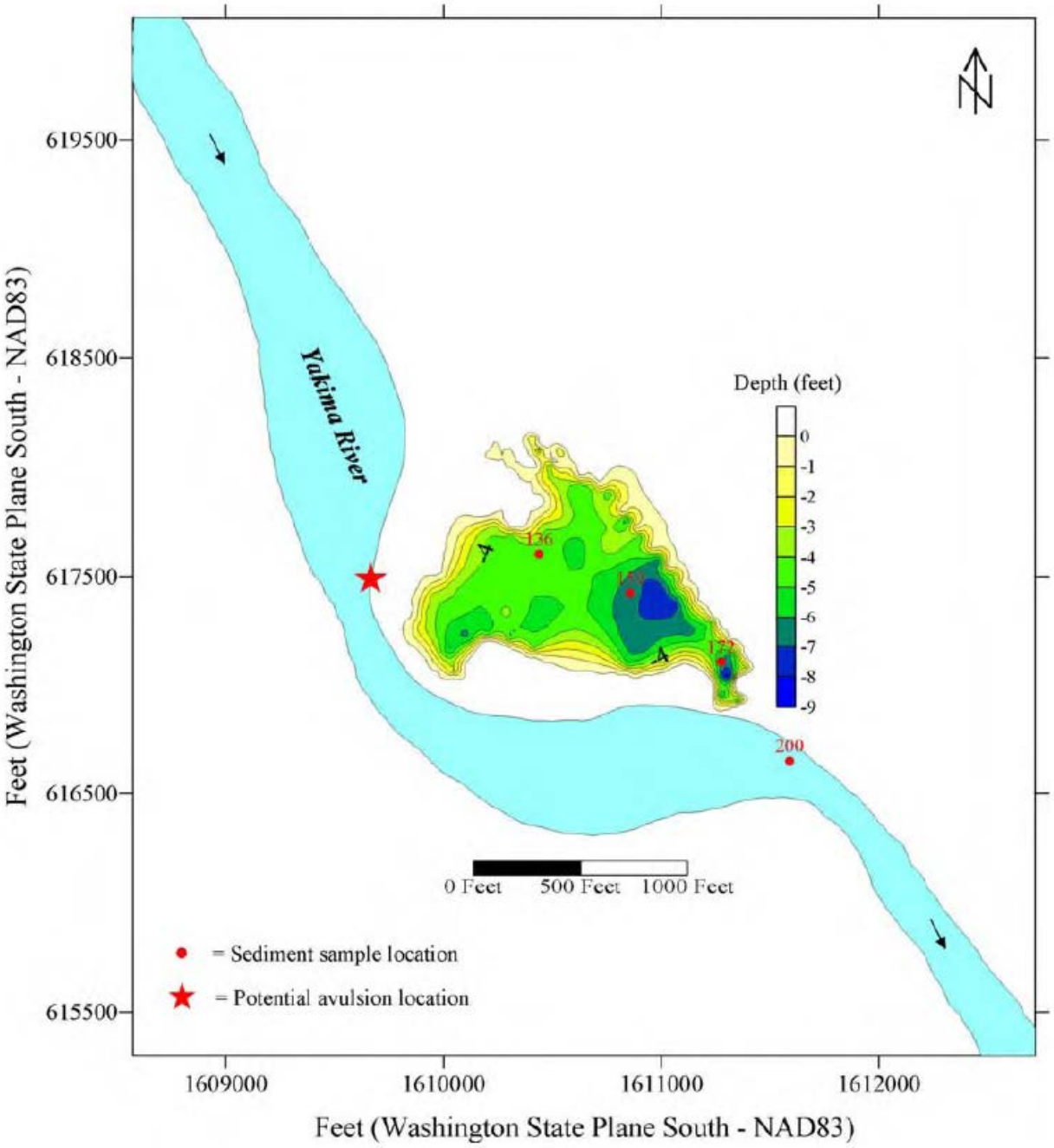


Legend

- I-90 Ponds 1, 2, & 3
- 1-90 Pond 4
- Yakima River

0 0.4 0.8 km

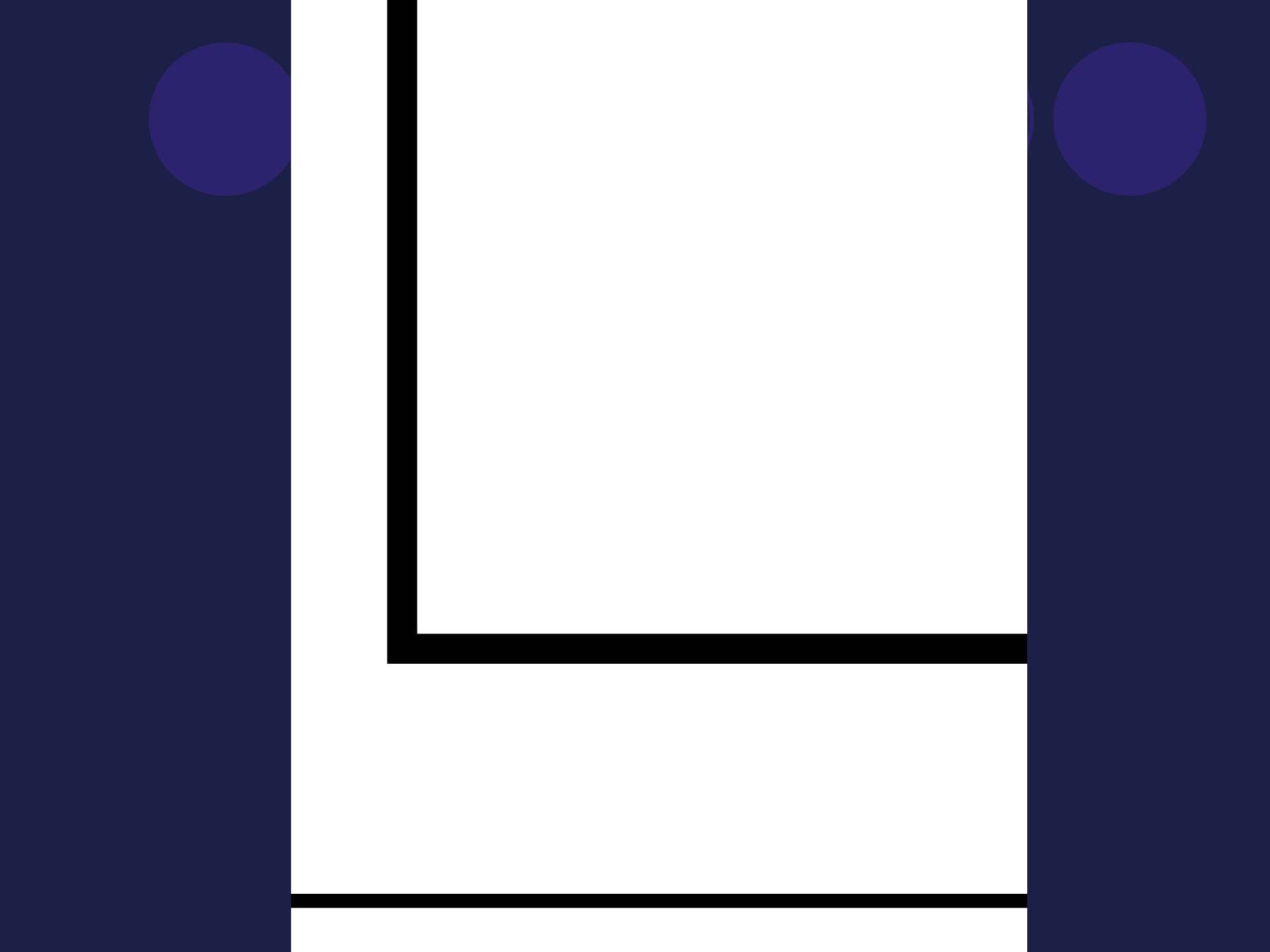
N

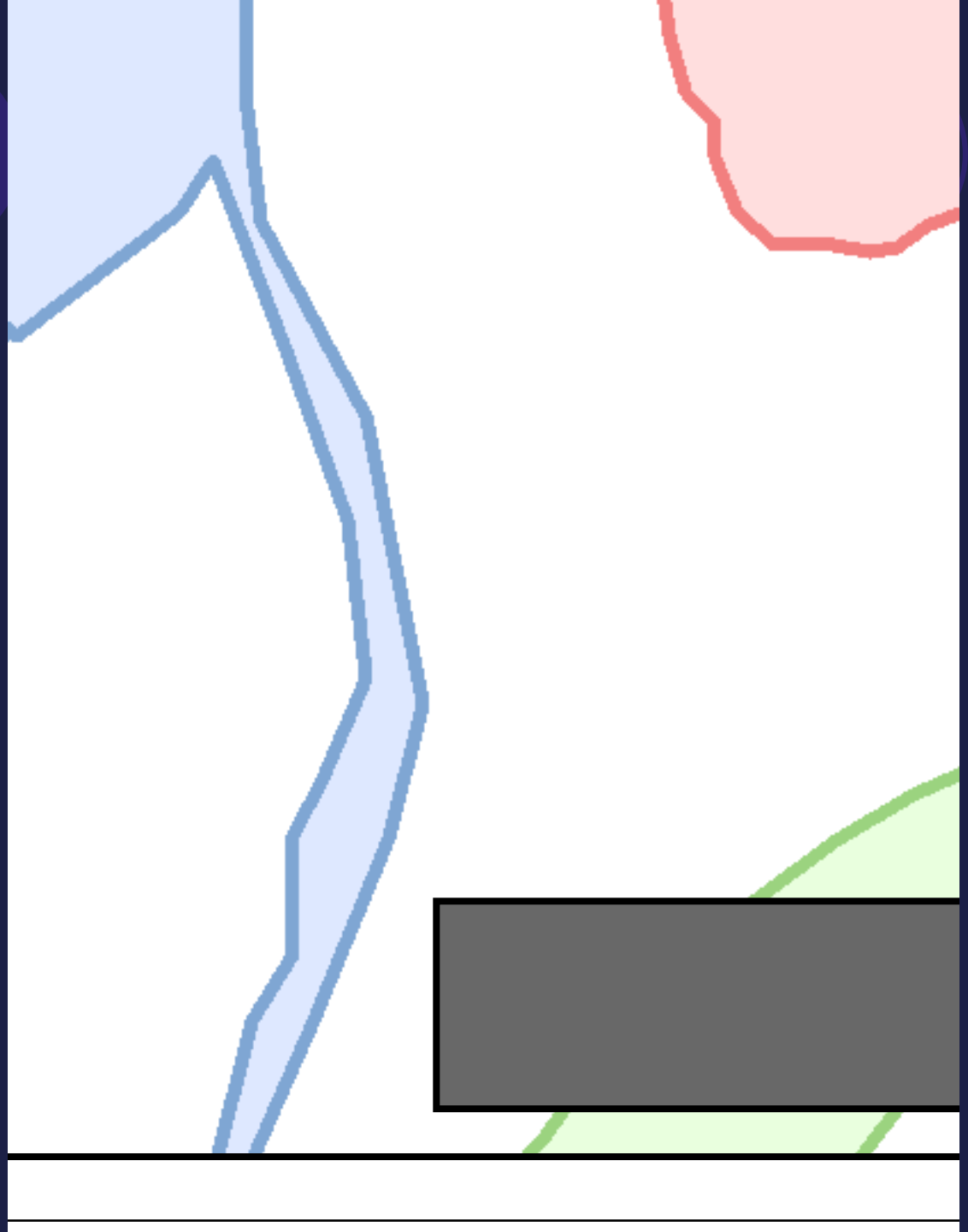

Yakima River
Depth (feet)
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
136
150
177
200
A
A
0 Feet
500 Feet
1000 Feet
= Sediment sample location
= Potential avulsion location
619500
618500
617500
616500
615500
1609000
1610000
1611000
1612000
Feet (Washington State Plane South - NAD83)
Feet (Washington State Plane South - NAD83)

Methods

Water Quality Sampling Protocol

- Sampling frequency:
  - Every two weeks for one year
- Shore and main channel Samples
  - Surface, mid-depth, bottom
    - DO, temp, conductivity, specific conductivity
  - Surface Sample
    - turbidity, pH
- Mid Pond Samples
  - 1 m increments
    - DO, temp, conductivity, specific conductivity
  - Surface Sample
    - Turbidity, pH





Substrate

Gabriel “High Tech” Sediment Trap

- Sedimentation
  - Sediment Traps
  - 4 months
- Substrate
  - Size
  - Organic Composition

Aquatic Vegetation

- Sampling
  - Along transects (70m) perpendicular to shore
  - Every 10 m
- Materials
  - Garden Bow Rake
  - Drag Rake (Double-Side Garden Bow Rake)
- Sampling Frequency: one sample in June 2003

Stage, Inlet and Outlet Discharge

- Streamflow of the inlet and outlet
  - Hansen Ponds
  - Every two weeks
- Stage
  - Hansen and I-90 Ponds
  - Every two weeks
  - Measured relative to a shoreline benchmark
- Yakima River discharge from USBR gages near Cle Elum and Ellensburg

Salmon Presence

- Focus: Hansen Ponds
- Transect established parallel to shoreline
  - Represent 4 distinct habitat types
  - 30 m long
- Tally within section:
  - Salmon species & non-salmon
- Sampling Frequency:
  - Seasonal: Spring, Summer, Fall, Winter

Habitat Types

Habitat Type	Aquatic Vegetation	Large Woody Debris	Flow	Shade
A		X	X	
B	X			X
C		X		X
D				

Large Woody Debris

- Utilize fish survey transect
- 1 cm, that intersect transect
- Length and diameter to closest cm
- Quantify volume for each section

Analysis

- Hydrologic connectivity
  - Stage, Yakima River discharge, Inlet and Outlet discharge
- Inlet-outlet comparisons
  - Water quality
- Site comparisons
  - Water quality, aquatic vegetation, substrate, sedimentation
- Fish habitat comparisons
  - Salmon presence, large woody debris, water quality

Results

- Hydrologic connectivity
- Inlet-outlet comparisons
- Site comparisons
- Fish habitat comparisons

Results

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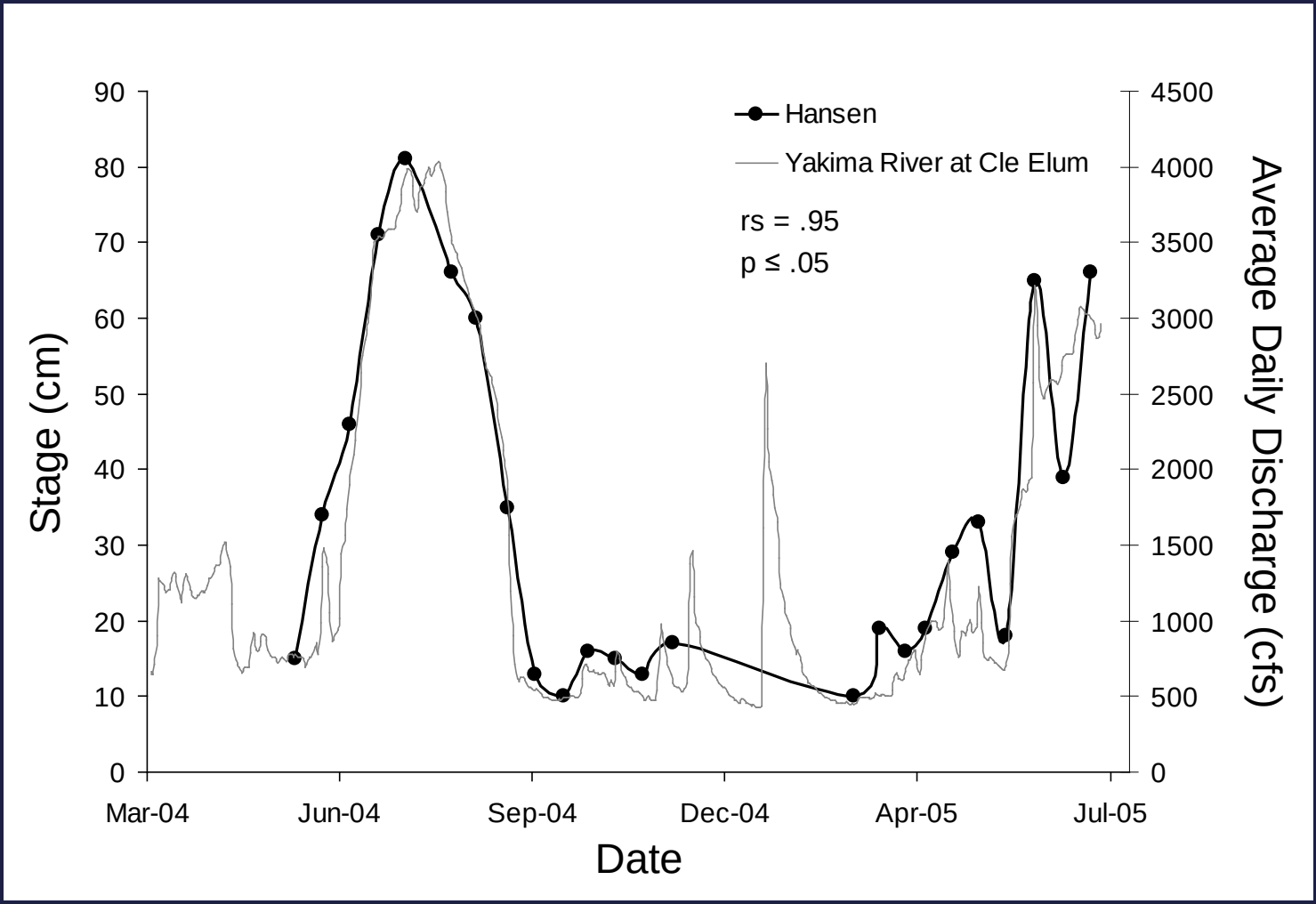
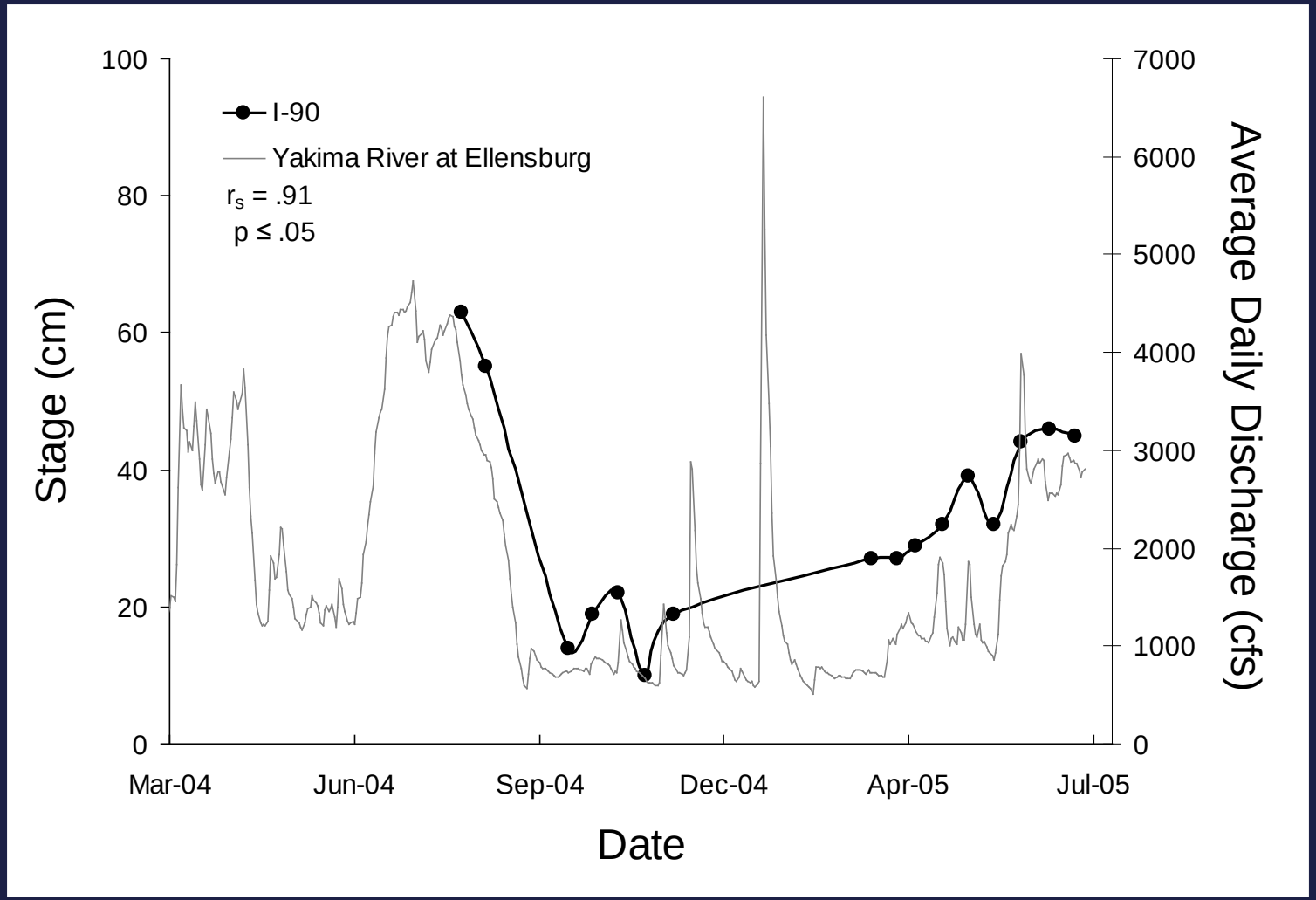
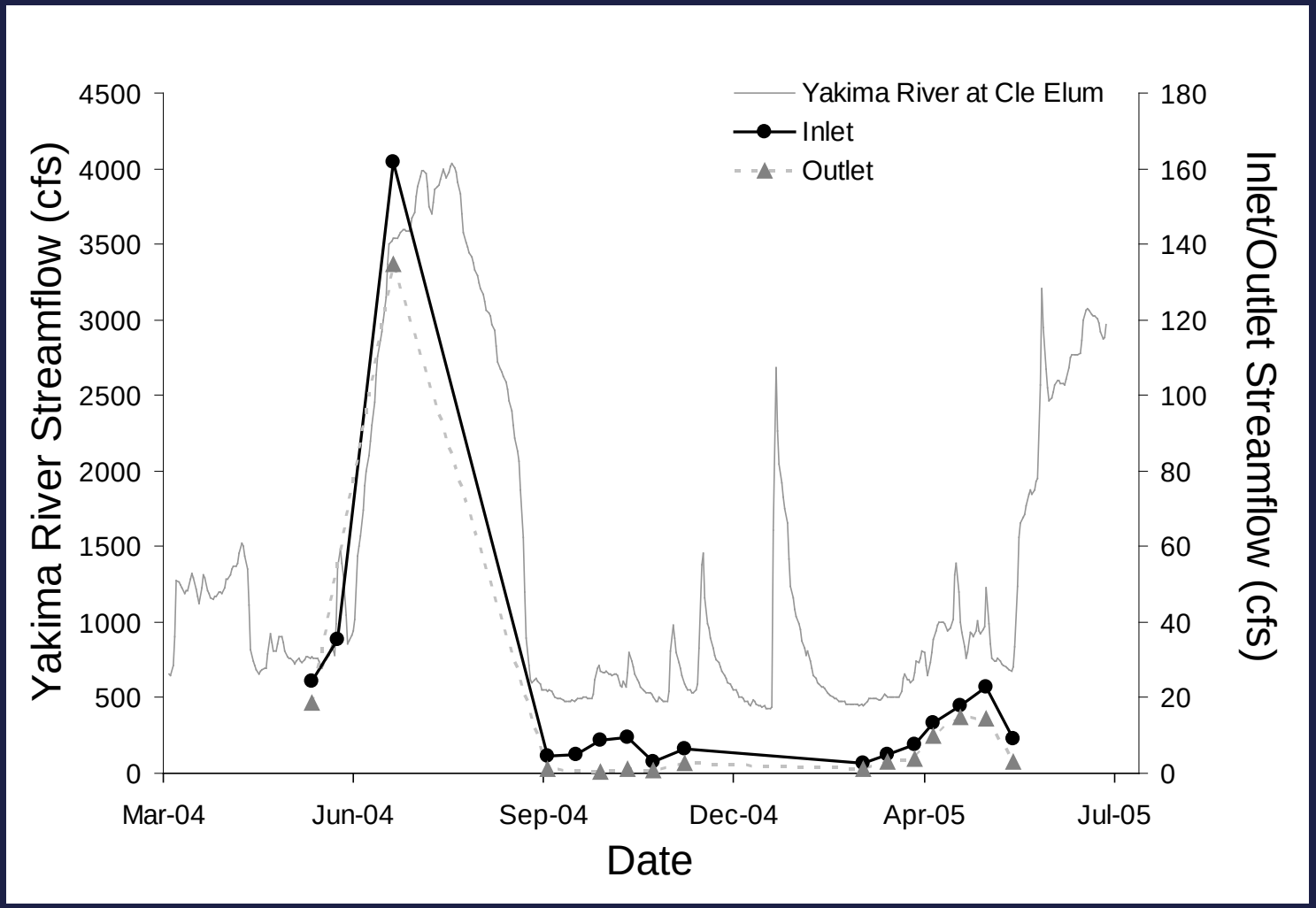
Hansen Ponds



I-90 Ponds


I-90
Yakima River at Ellensburg
r_s = .91
p ≤ .05
Stage (cm)
Average Daily Discharge (cfs)
Date
100
80
60
40
20
0
7000
6000
5000
4000
3000
2000
1000
0
Mar-04
Jun-04
Sep-04
Dec-04
Apr-05
Jul-05

Hansen Inlet/Outlet & Yakima River Discharges



Hydrologic Connectivity: Discussion

- Each site has a high degree of hydrologic connectivity
- Surface water connection appears to increase hydrological connectivity

Results

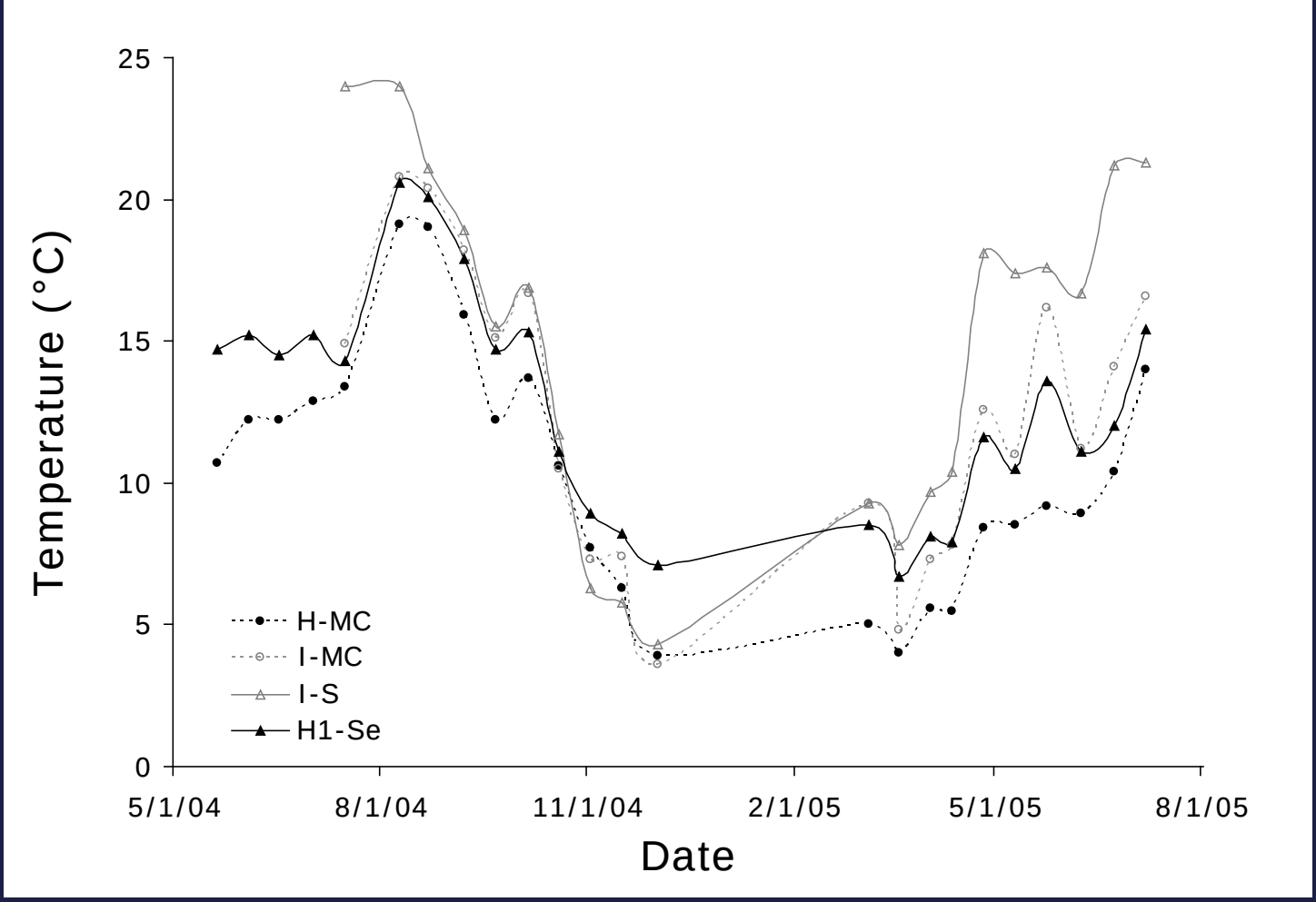
- Hydrologic connectivity
- Inlet-outlet comparisons
- Site comparisons
- Fish habitat comparisons

Seasonal significant differences between I-90 and Hansen Ponds

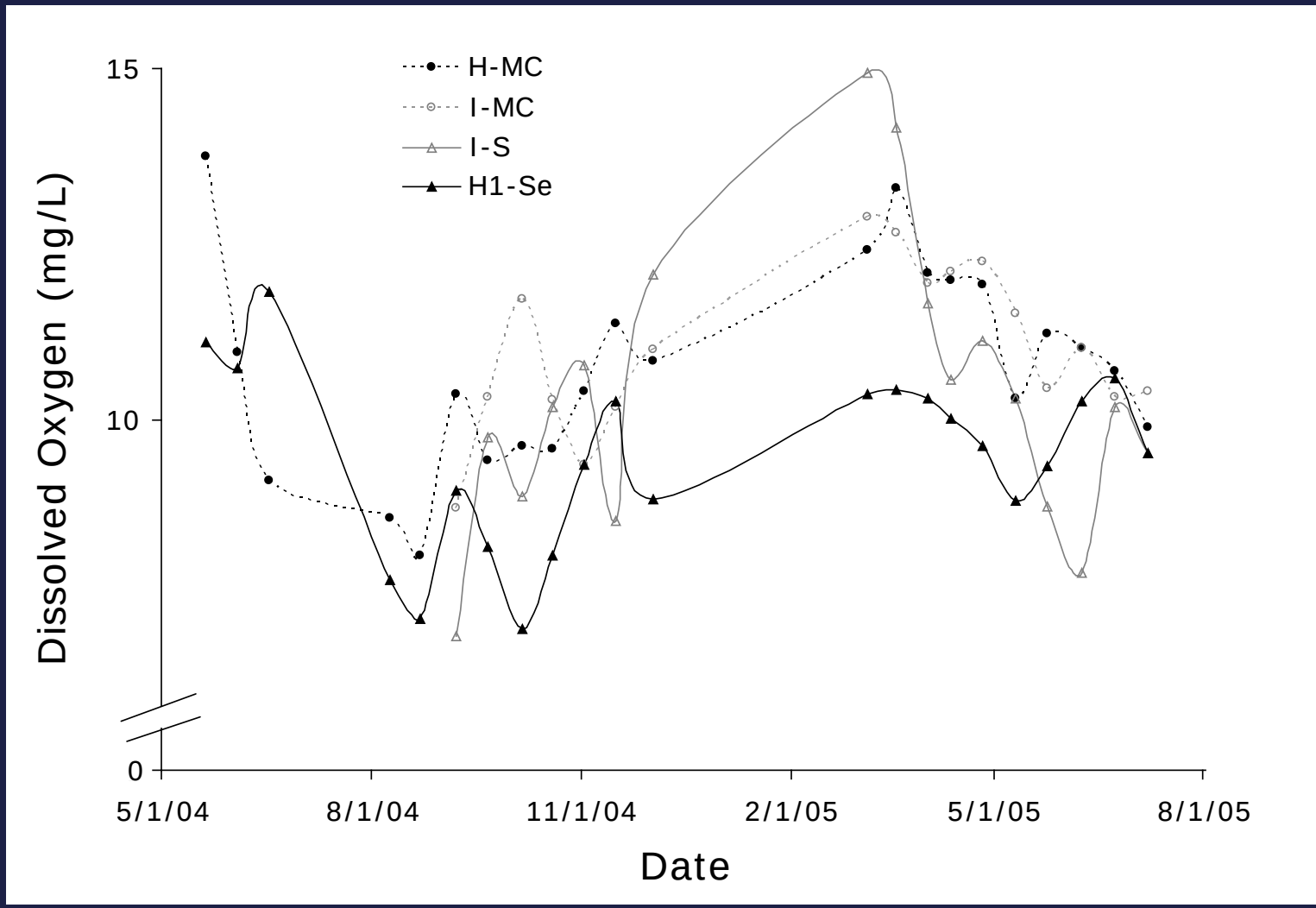
Site	Temp.		DO_{ps}		DO_c		SPC		Ph		Turb.	
Comparison	Zw	n	Zw	n	Zw	n	Zw	n	Zw	n	Zw	n
Annual												
H-MC v. I-MC	**3.68***	20	**3.10***	19	0.74	19	**3.90***	20	0.79	19	0.27	20
H1-Se v. H-MC	**4.27***	24	**3.12***	22	**3.41***	22	**4.27***	24	1.79	21	1.33	24
I-S v. I-MC	**3.20***	19	0.42	19	1.83	19	**3.90***	20	**3.66***	20	**3.90***	20
H1-Se v. I-S	**2.71***	19	**3.52***	19	1.83	19	**3.90***	20	**3.80***	20	**3.90***	20

Nonparametric Wilcoxon signed-ranks test; * p <.05

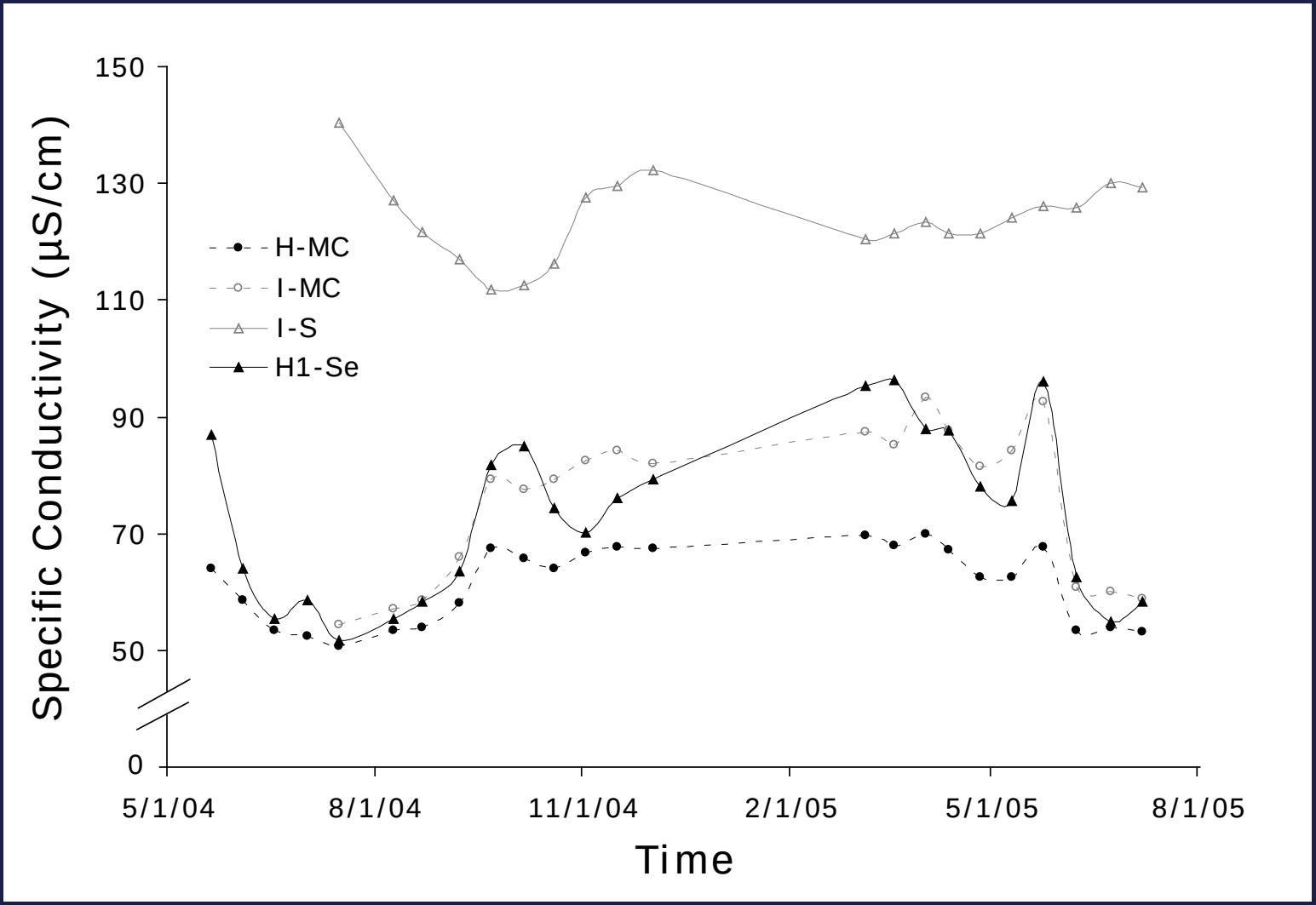
Temperature



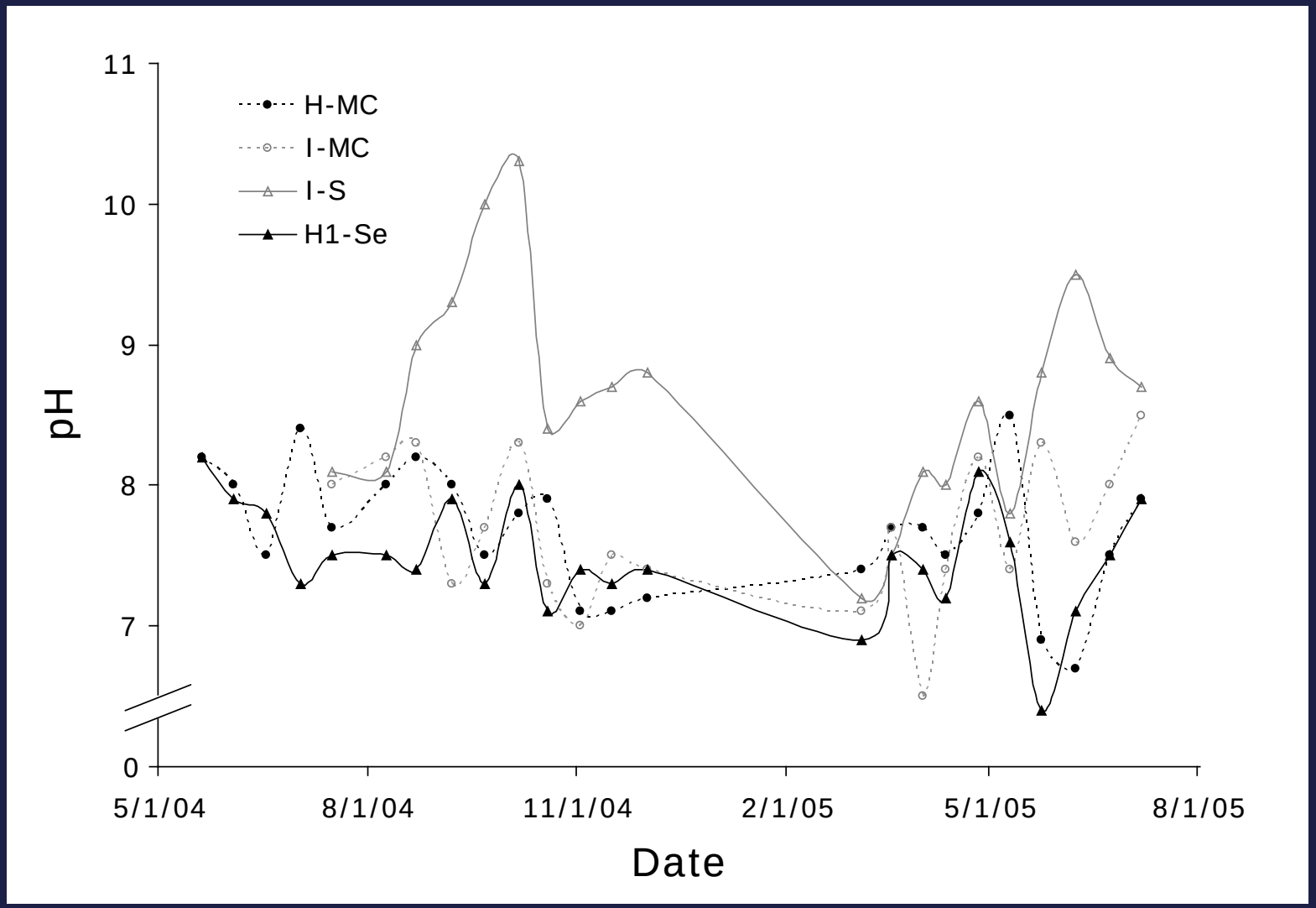
Dissolved Oxygen Concentration



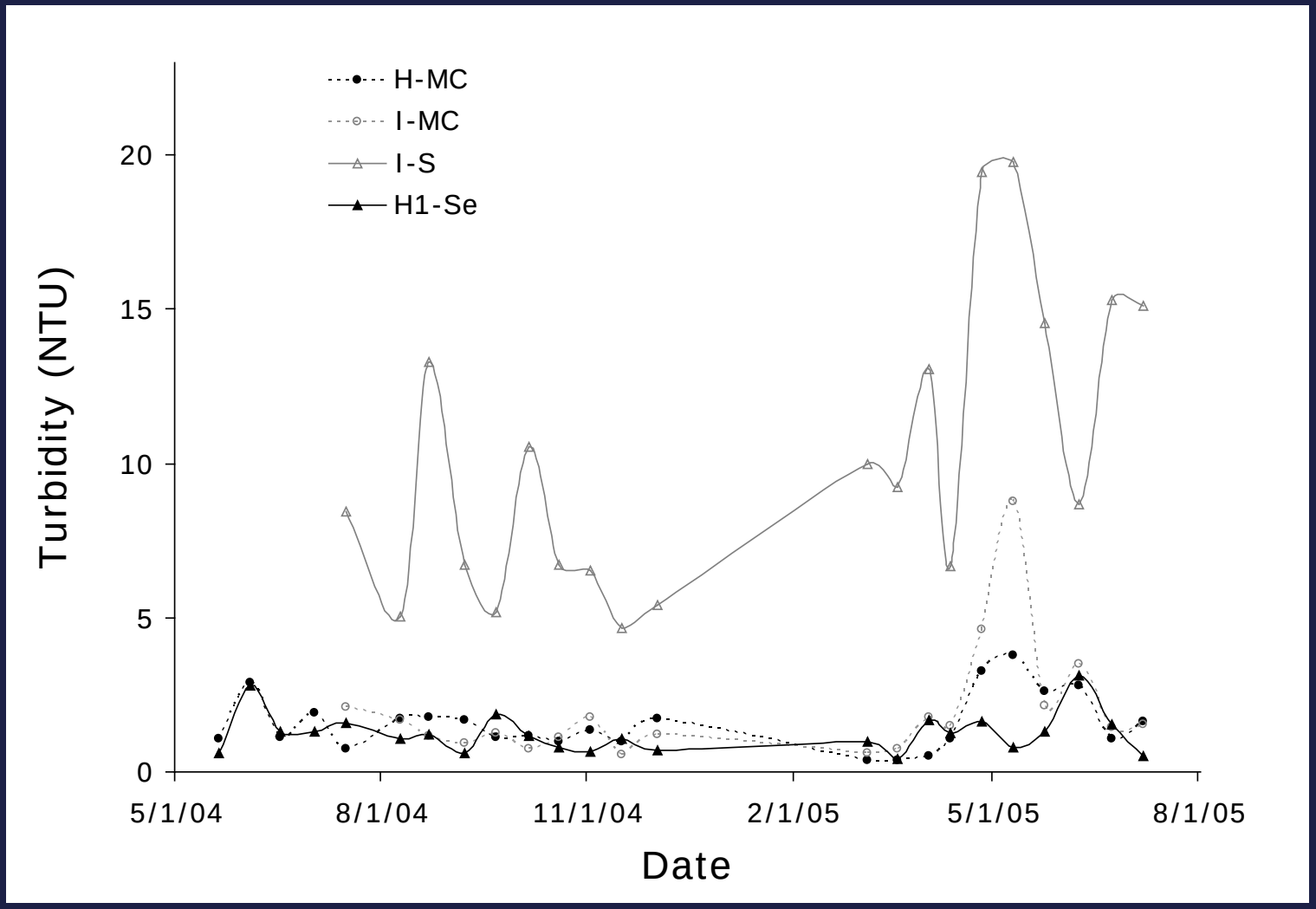
Specific Conductivity



pH


11
10
9
8
7
0
pH
H-MC
I-MC
I-S
H1-Se
5/1/04
8/1/04
11/1/04
2/1/05
5/1/05
8/1/05
Date

Turbidity


H-MC
I-MC
I-S
H1-Se
Turbidity (NTU)
0
5
10
15
20
5/1/04
8/1/04
11/1/04
2/1/05
5/1/05
8/1/05
Date

Aquatic Vegetation

Hansen Ponds		I-90	
Common name	Scientific name	Common name	Scientific name
Long leaf pondweed	*Potamogeton nodosus*	Eurasian watermilfoil	*Myriophyllum spicatum*
		Brazilian elodea	*Egeria densa*
		Sago pondweed	*Potamogeton pectinatus*
		Elodea	*Elodea canadensis*
		Crowsfoot	*Ranunculus Peltatus*

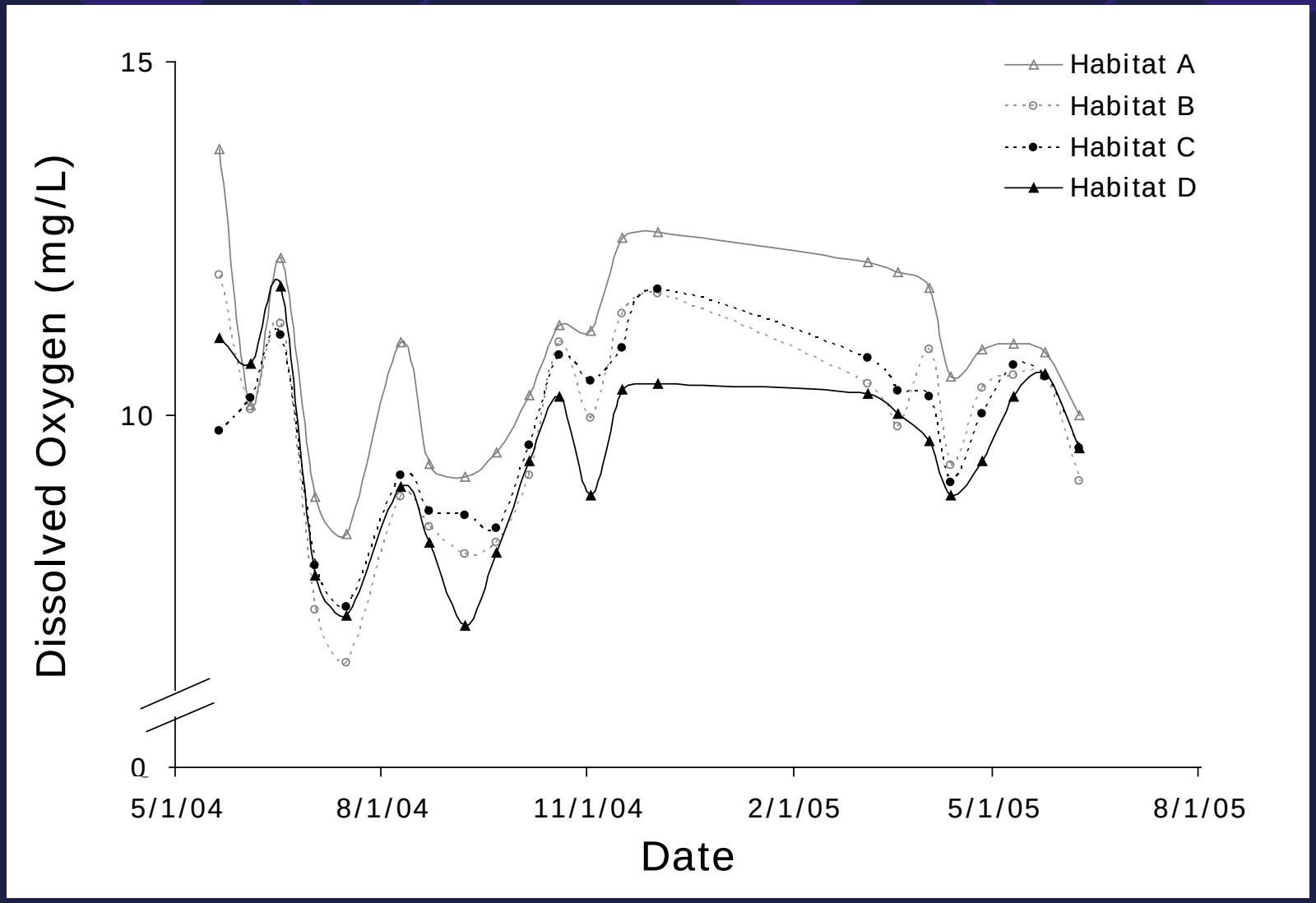
Site Comparison: Discussion

- Significantly higher at I-90 ($p<0.05$): Temperature, dissolved oxygen percent saturation, specific conductivity, pH, and turbidity
- I-90 = more diverse population of aquatic plants.
- A greater proportion of fine sediments in substrate at Hansen
- Differences primarily due to biological productivity
- Other factors: agricultural runoff and irrigation

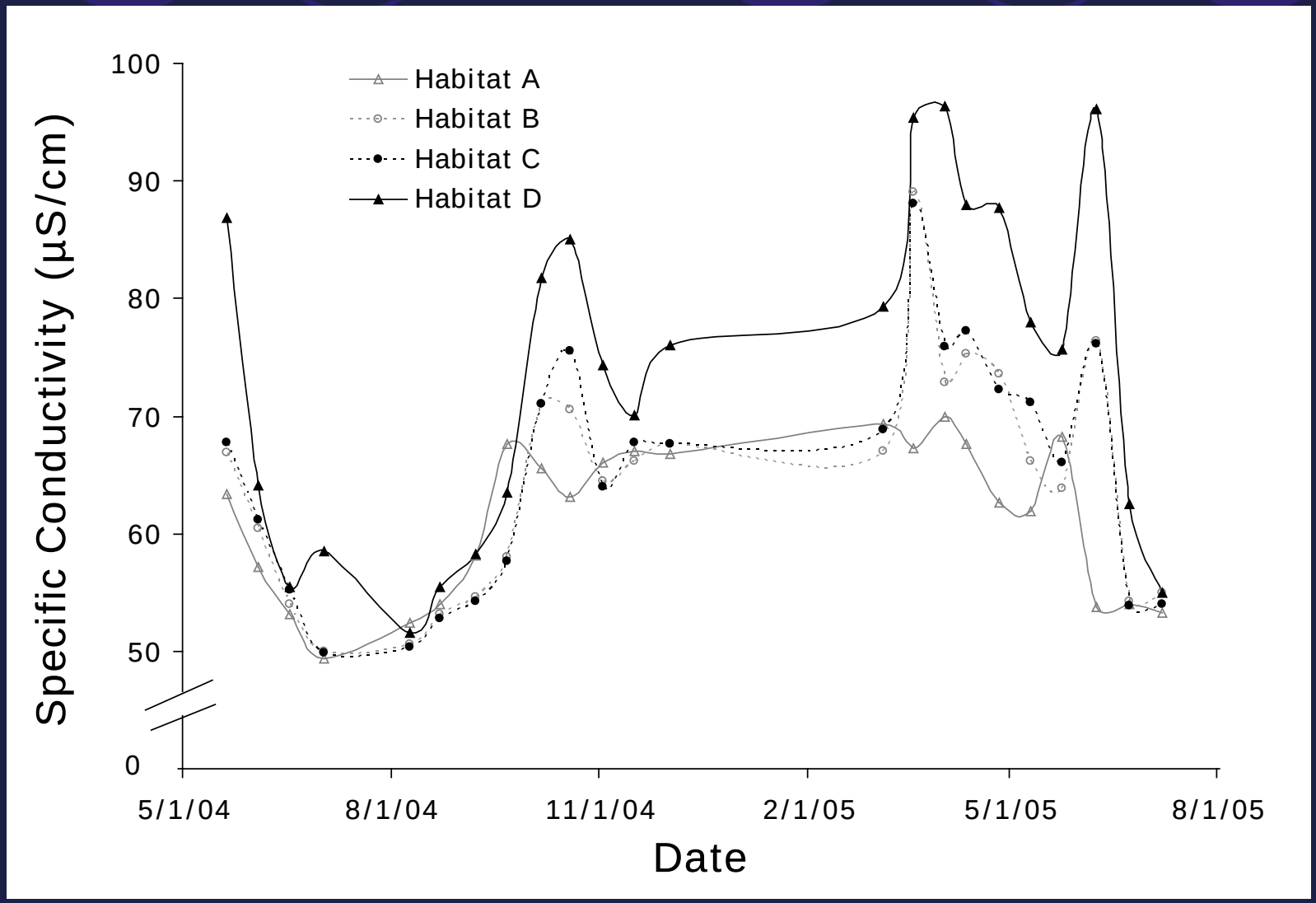
Results

- Hydrologic connectivity
- Inlet-outlet comparisons
- Site comparisons
- Fish habitat comparisons

Dissolved Oxygen Concentration



Specific Conductivity



Sedimentation rates and organic content

Habitat Type	Sediment Volume Collected (cm3)	Percent Organic (%)
A	2315	43.6
B	2384	61.1
C	386	33.3
D	1419	78.2

Fish Species	Day				Night			
	A	B	C	D	A	B	C	D
				Fall				
Salmon Total	11	0	0	0	2	-	0	0
Chinook	0	0	0	0	0	-	0	0
Rainbow	11	0	0	0	2	-	0	0
Unidentified	0	0	0	0	0	-	0	0
Non-Salmonid	1	6	0	3	5	-	6	8
				Spring				
Salmon Total	18	30	85	100	2	15	19	60
Chinook	18	30	85	100	0	0	10	60
Rainbow	0	0	0	0	0	0	0	0
Unidentified	0	0	0	0	2	15	9	0
Non-Salmonid	0	0	30	1	3	2	7	7
				Summer				
Salmon Total	0	0	1	0	30	6	6	6
Chinook	0	0	0	0	0	0	0	0
Rainbow	0	0	0	0	0	0	0	0
Unidentified	0	0	1	0	30	6	6	6
Non-Salmonid	6	0	33	150	30	5	0	4

Habitat Comparison: Discussion

- Significant differences: dissolved oxygen and specific conductivity
- Differences in dissolved oxygen may be partially responsible for the fish distributions
- Juvenile salmon were observed
  - In all habitat types
  - In all seasons
  - At both day and night

Summary

- Hansen and I-90 sites both experience a high degree of hydrologic connectivity
- A water quality gradient exists between the inlet and outlets of Hansen Ponds
- Hansen Ponds = more oligotrophic
- I-90 Ponds = more eutrophic
- Reconnection efforts have been successful

Conclusion and Management Recommendations

- I-90 has good potential for similar restoration
- Future restoration should be coupled with pre- and post- monitoring
- Reference sites combined with pre- and post data

Acknowledgements

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