Ecological Comparison of Disconnected and Connected Side Channels, Wapato Reach, Yakima River, Washington

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Research Objectives

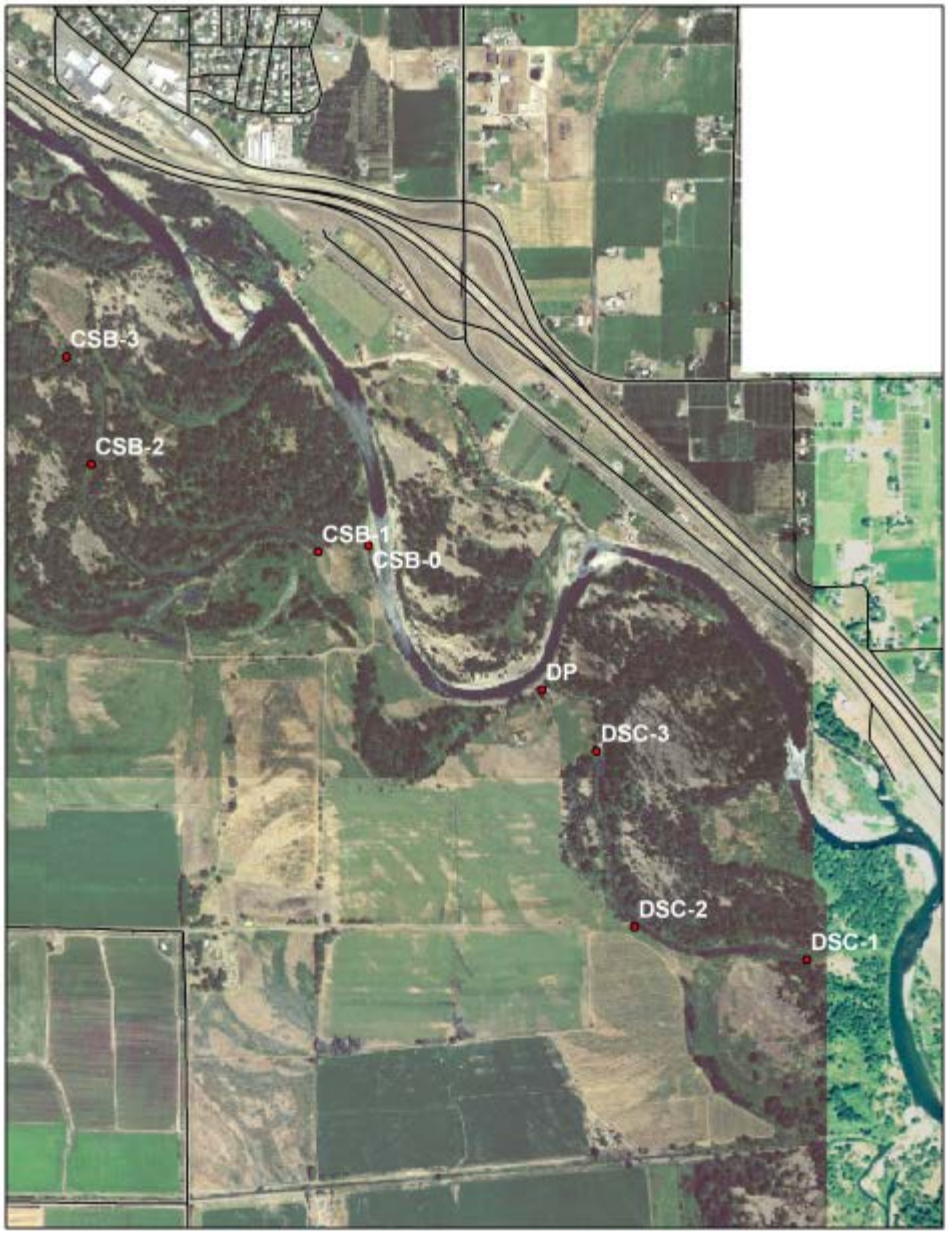
- Develop and execute a long-term monitoring protocol for the Wapato reach on the Yakima River floodplain
- Provide statistically significant measurement of changes in fluvial geomorphologic features and environmental and biological attributes within and between different areas of the Wapato reach before, during, and after a proposed restorative action

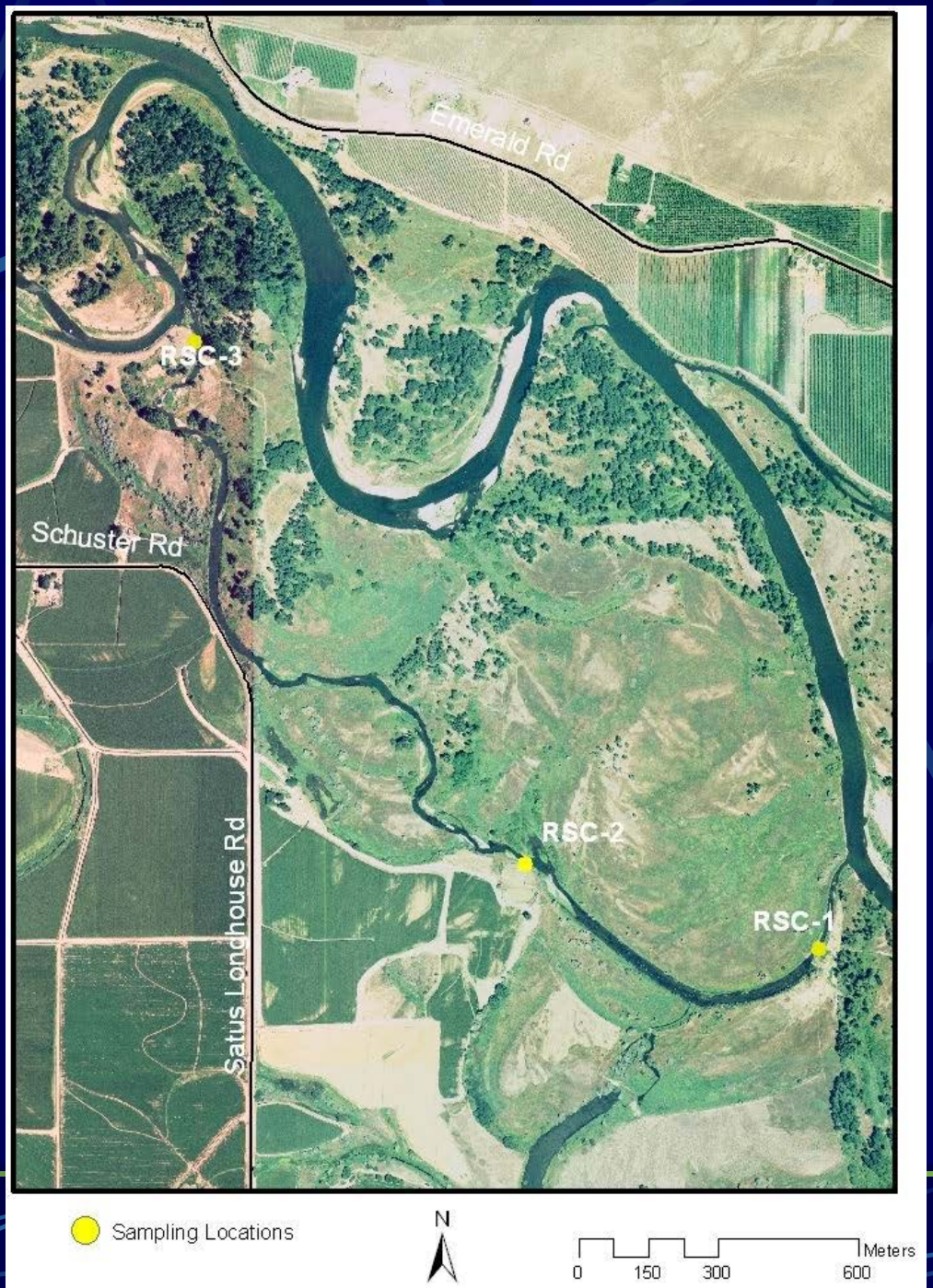
Research Objectives (cont.)

- Monitor conditions in a ‘reference’ side channel vs. a disconnected channel, using a before-after, control-impacted, design (Underwood 1994) - Summer 2003 to Fall 2005
- added third reconnected site in Fall 2004

Study Sites

- Meninick Wildlife Area: 1) disconnected side channel (DSC), (2) a connected spring brook upstream of a levee (CSB), (3) a disconnected pond (DP), and (4) the main stem (MC)
- Satus: reconnected channel (RSC)


CSB-3
CSB-2
CSB-1
CSB-0
DP
DSC-3
DSC-2
DSC-1


Emerald Rd
RSC-3
Schuster Rd
Satus Londhouse Rd
RSC-2
RSC-1
Sampling Locations
N
0
150
300
600
Meters

Data Collection

- water quality
- physical parameters
- biological parameters

Water Temperature

- thermographs recorded temperature at 30-minute intervals throughout the year
- temperature measurements were taken throughout the field season at the surface, mid-depth, and bottom at each site using a YSI dissolved oxygen meter
- DO, temperature - monthly measurements

Water Quality

- Monthly
- DO and conductivity- surface, mid-depth, and bottom using a YSI dissolved oxygen meter
- pH - samples collected 0.5 m below the surface, using IQ 120 waterproof pH meter
- Turbidity - samples collected 0.5 m below the surface, an Orbeco-Hellige portable turbidimeter

Physical Parameters

- stage-discharge relationships
- permanent photopoints
- channel cross-sections
- substrate composition

Biological Parameters

- major nutrients - seasonal
- macroinvertebrate samples - seasonal - Surber sample (connected springbrook and reconnected channel)
- Ekman dredge to sample the benthic macroinvertebrates in deeper water disconnected channel (late summer) - 25, 50 and 75% of channel width
- benthic chlorophyll concentration - seasonal
- large woody debris (250 m) and aquatic vegetation

Results

- 3 years of base-line, pre-restoration data have been collected at the initial set of study sites on the Yakima River floodplain
- 2 years of data have been collected at the reconnected side channel site

Descriptive Statistics

- Comparative graphs and tables of descriptive statistics have been completed for all the sites and parameters assessed, including annual and seasonal statistical summaries of water quality parameters for each sample location, as well as graphs comparing within-site and between-site differences

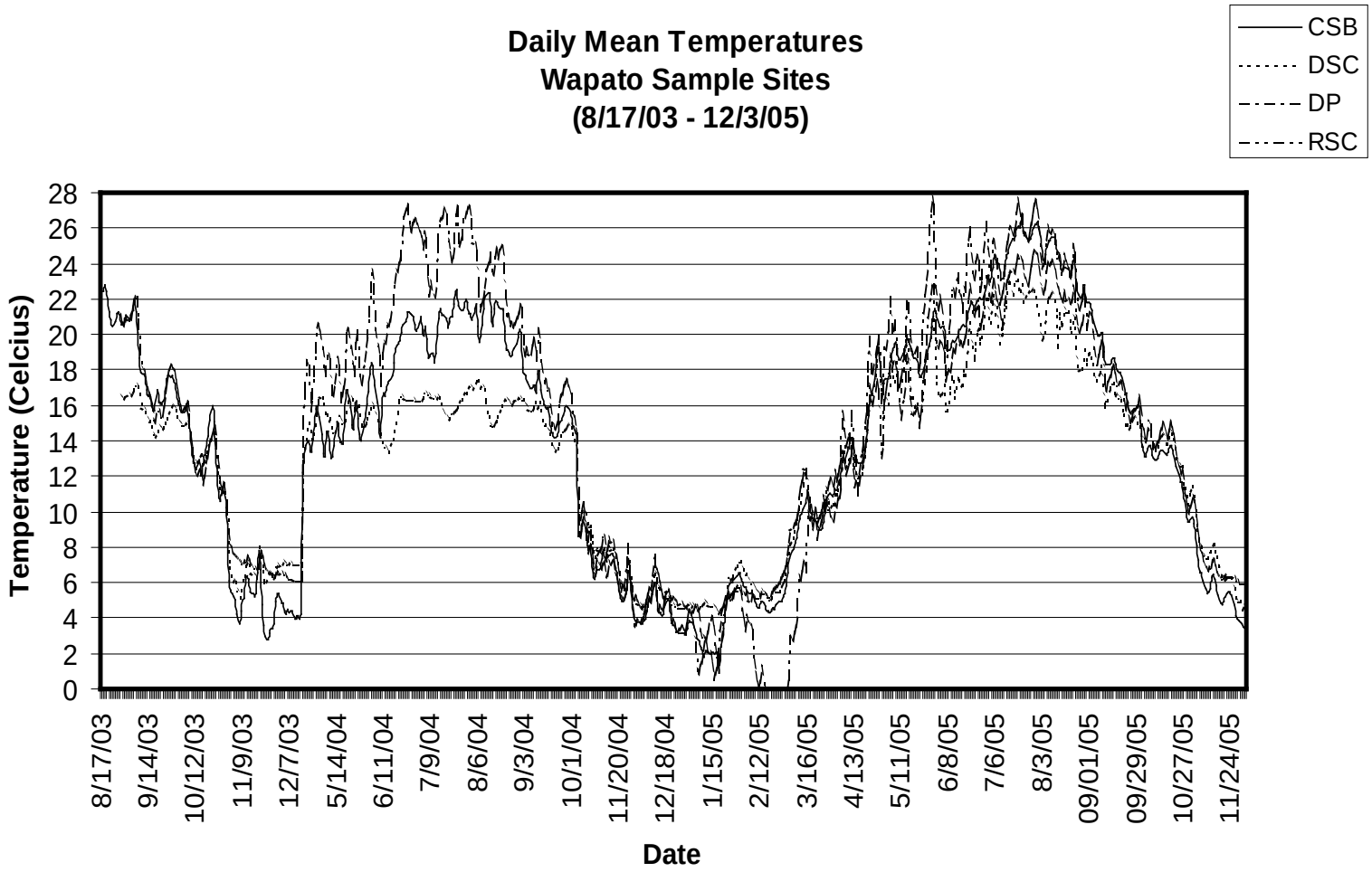
Statistical Analysis

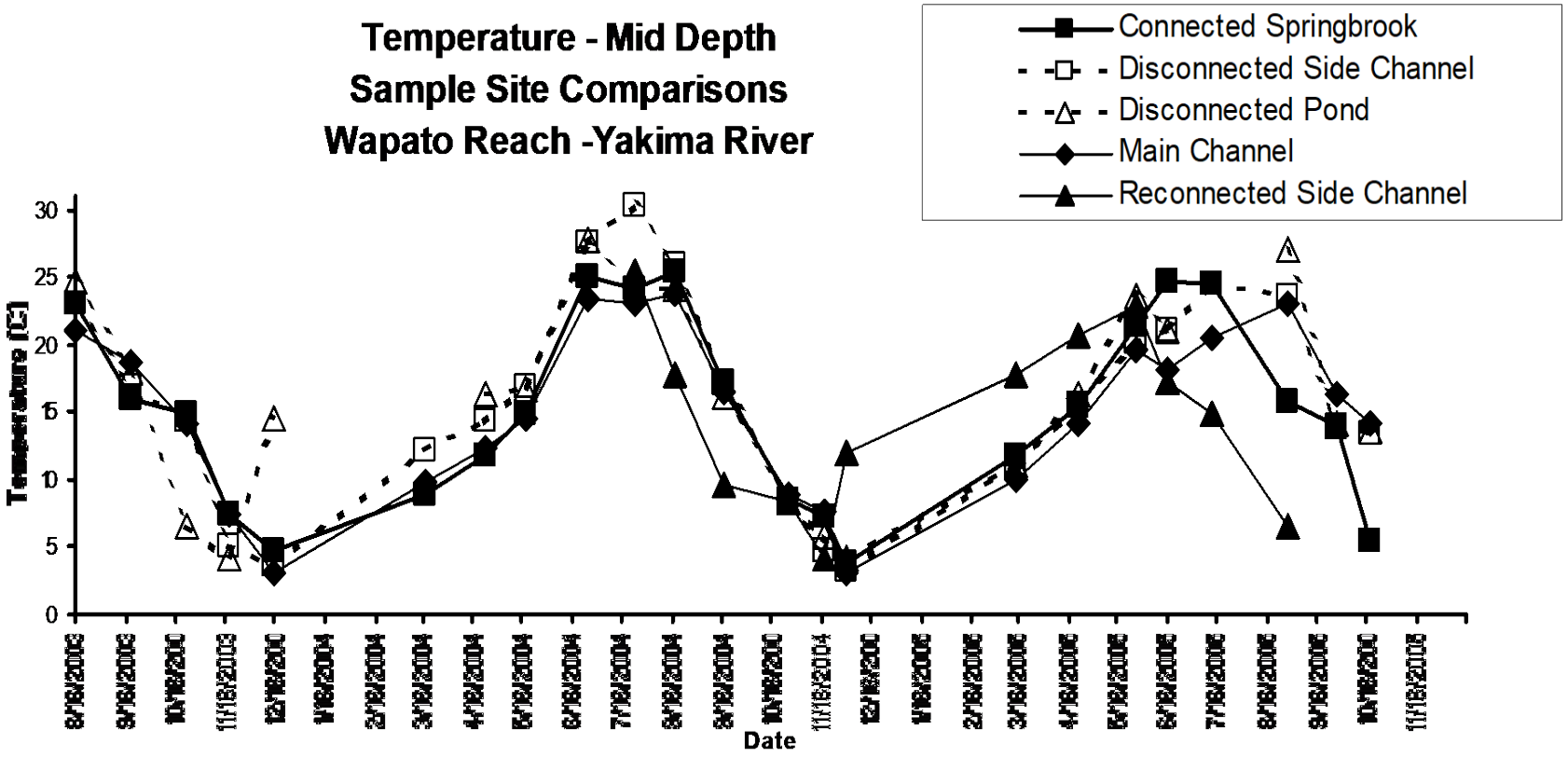
- Kruskal-Wallis and Mann-Whitney U tests were used to identify significant annual and seasonal differences in measured water quality parameters ($p<0.05$).
- tests were used to identify significant differences between: 1) comparable sample locations at each study site; 2) sample locations within a study site; and 3) the top and bottom sample location at each channel study site.

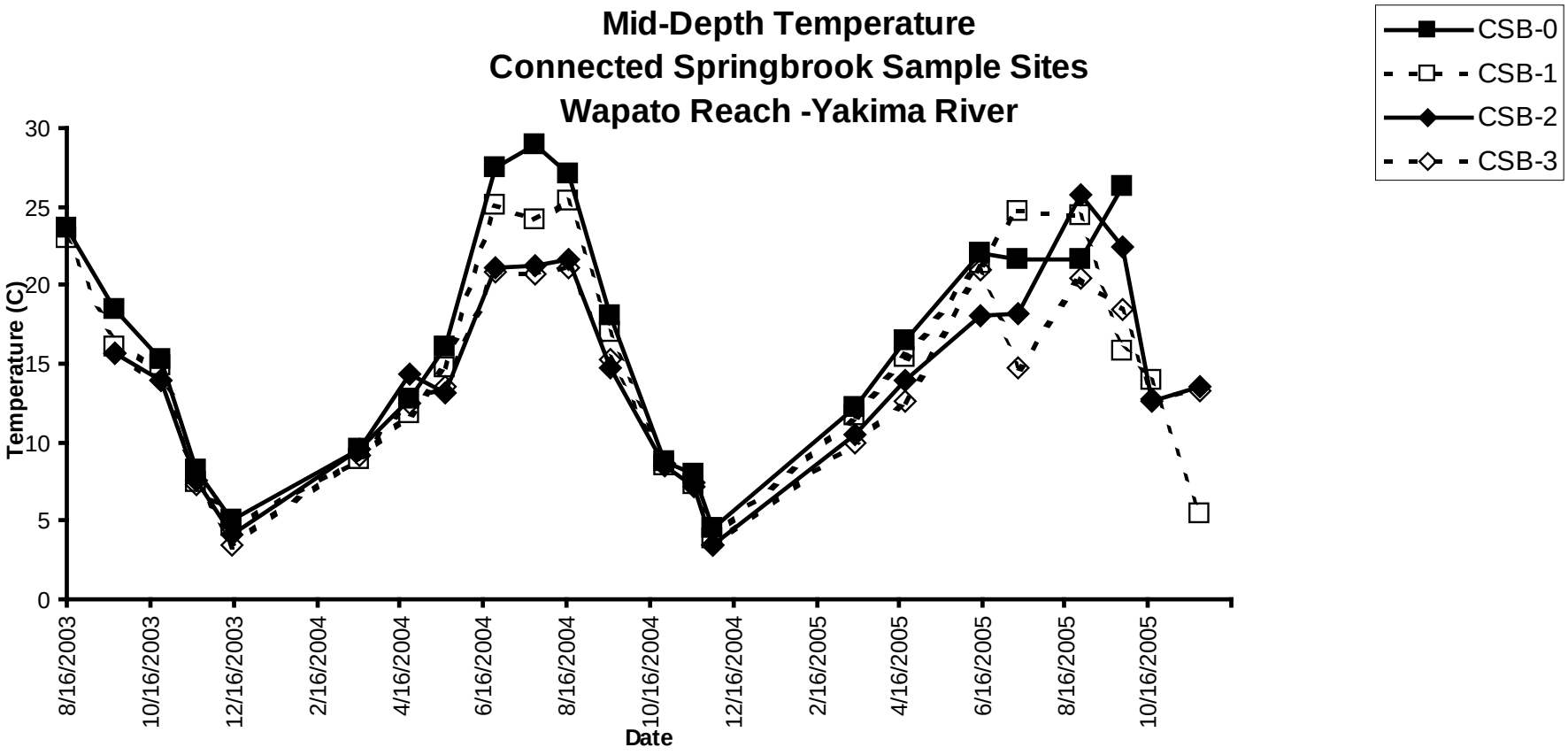
Results - Water Quality

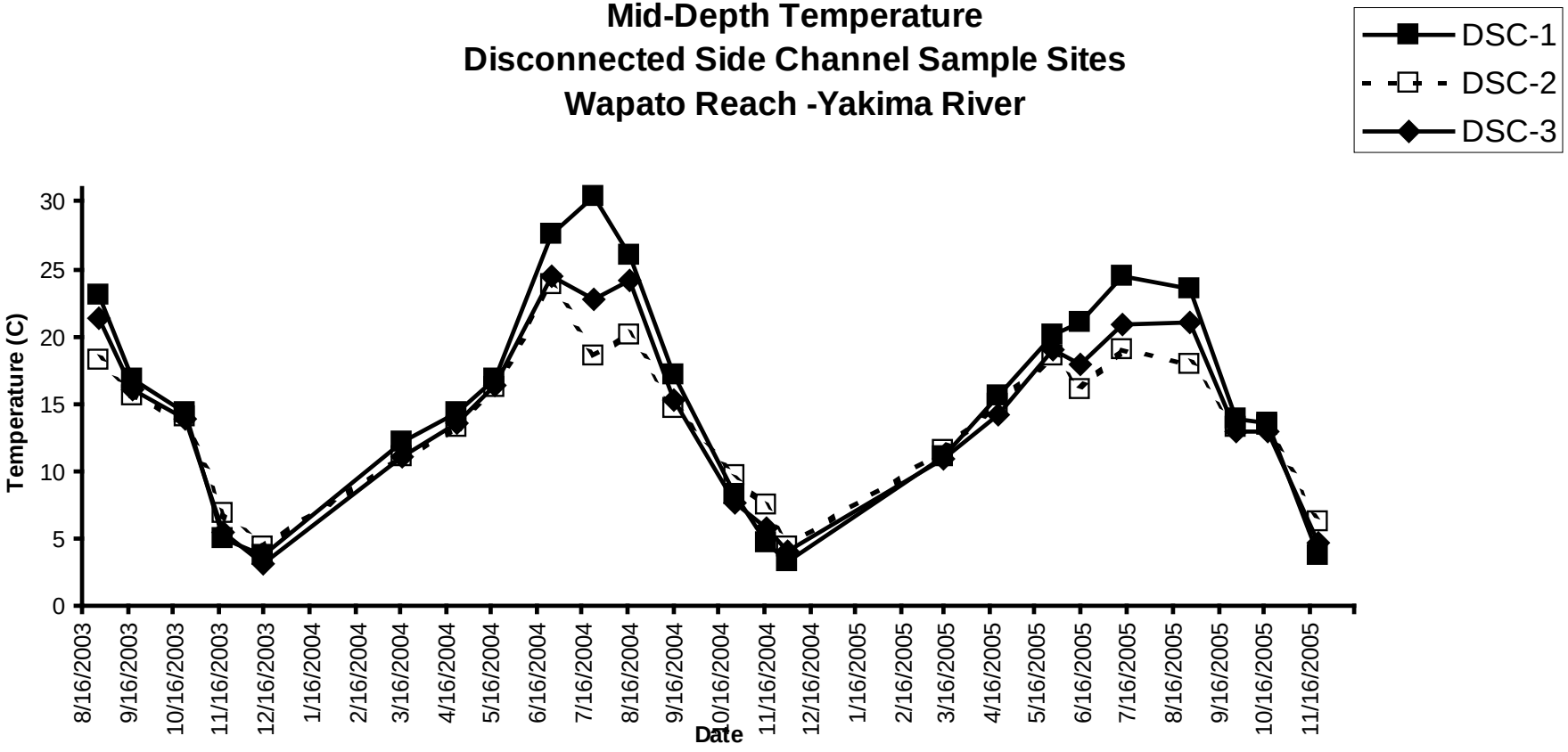
Temperature

- No significant difference between sites ($p<0.05$), either annually or seasonally
- Significant within-site differences occurred in the summer for the connected springbrook and disconnected channel sample locations


Daily Mean Temperatures
Wapato Sample Sites
(8/17/03 - 12/3/05)
CSB
DSC
DP
RSC
Temperature (Celcius)
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
8/17/03
9/14/03
10/12/03
11/9/03
12/7/03
5/14/04
6/11/04
7/9/04
8/6/04
9/3/04
10/1/04
11/20/04
12/18/04
1/15/05
2/12/05
3/16/05
4/13/05
5/11/05
6/8/05
7/6/05
8/3/05
09/01/05
09/29/05
10/27/05
11/24/05
Date


Temperature - Mid Depth
Sample Site Comparisons
Wapato Reach -Yakima River
Connected Springbrook
Disconnected Side Channel
Disconnected Pond
Main Channel
Reconnected Side Channel
Temperature [C]
30
25
20
15
10
5
0
Date

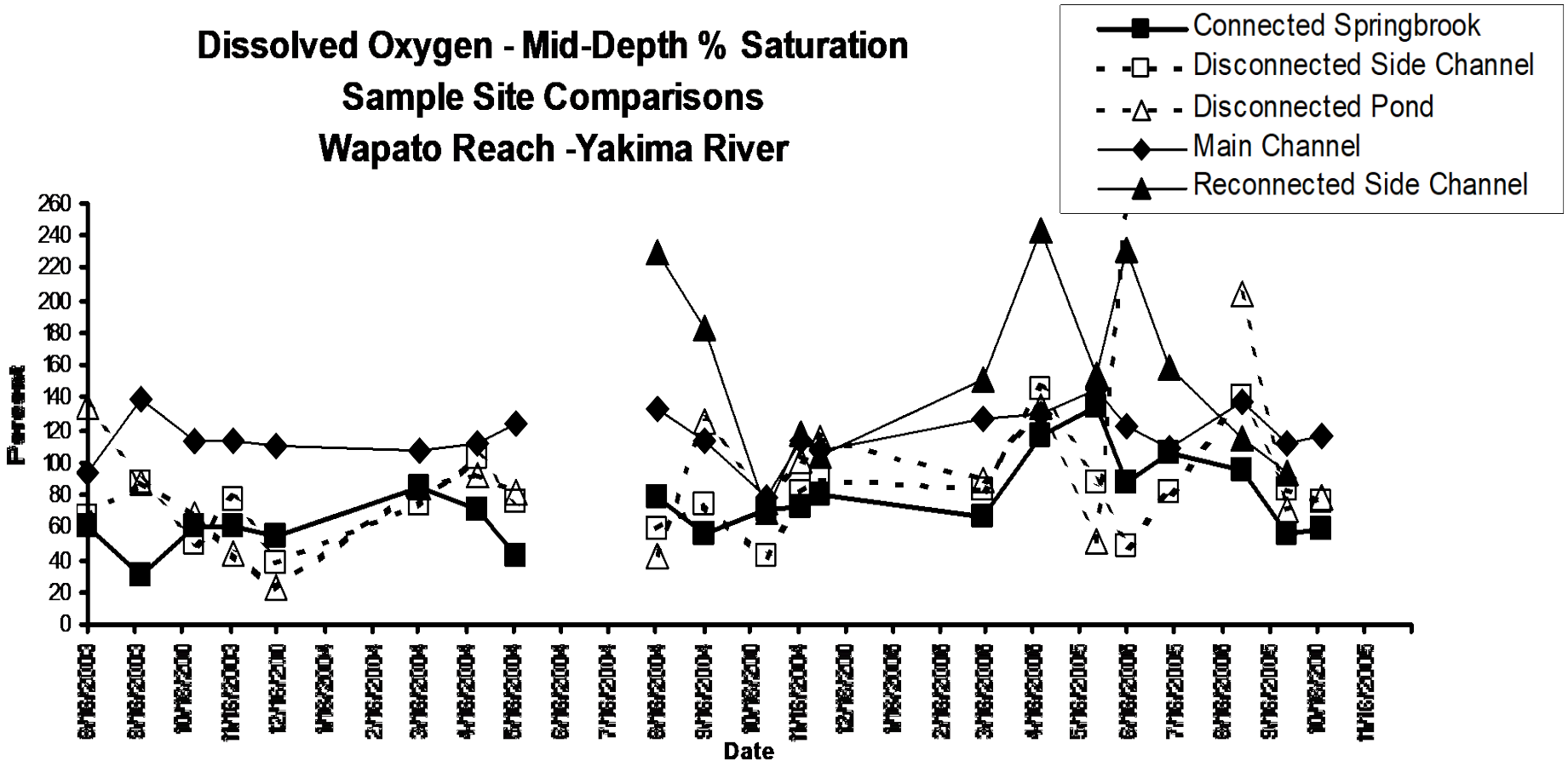

Mid-Depth Temperature
Connected Springbrook Sample Sites
Wapato Reach -Yakima River
CSB-0
CSB-1
CSB-2
CSB-3
Temperature (C)
30
25
20
15
10
5
0
8/16/2003
10/16/2003
12/16/2003
2/16/2004
4/16/2004
6/16/2004
8/16/2004
10/16/2004
12/16/2004
2/16/2005
4/16/2005
6/16/2005
8/16/2005
10/16/2005
Date


Mid-Depth Temperature
Disconnected Side Channel Sample Sites
Wapato Reach -Yakima River
DSC-1
DSC-2
DSC-3
Temperature (C)
0
5
10
15
20
25
30
8/16/2003
9/16/2003
10/16/2003
11/16/2003
12/16/2003
1/16/2004
2/16/2004
3/16/2004
4/16/2004
5/16/2004
6/16/2004
7/16/2004
8/16/2004
9/16/2004
10/16/2004
11/16/2004
12/16/2004
1/16/2005
2/16/2005
3/16/2005
4/16/2005
5/16/2005
6/16/2005
7/16/2005
8/16/2005
9/16/2005
10/16/2005
11/16/2005
Date

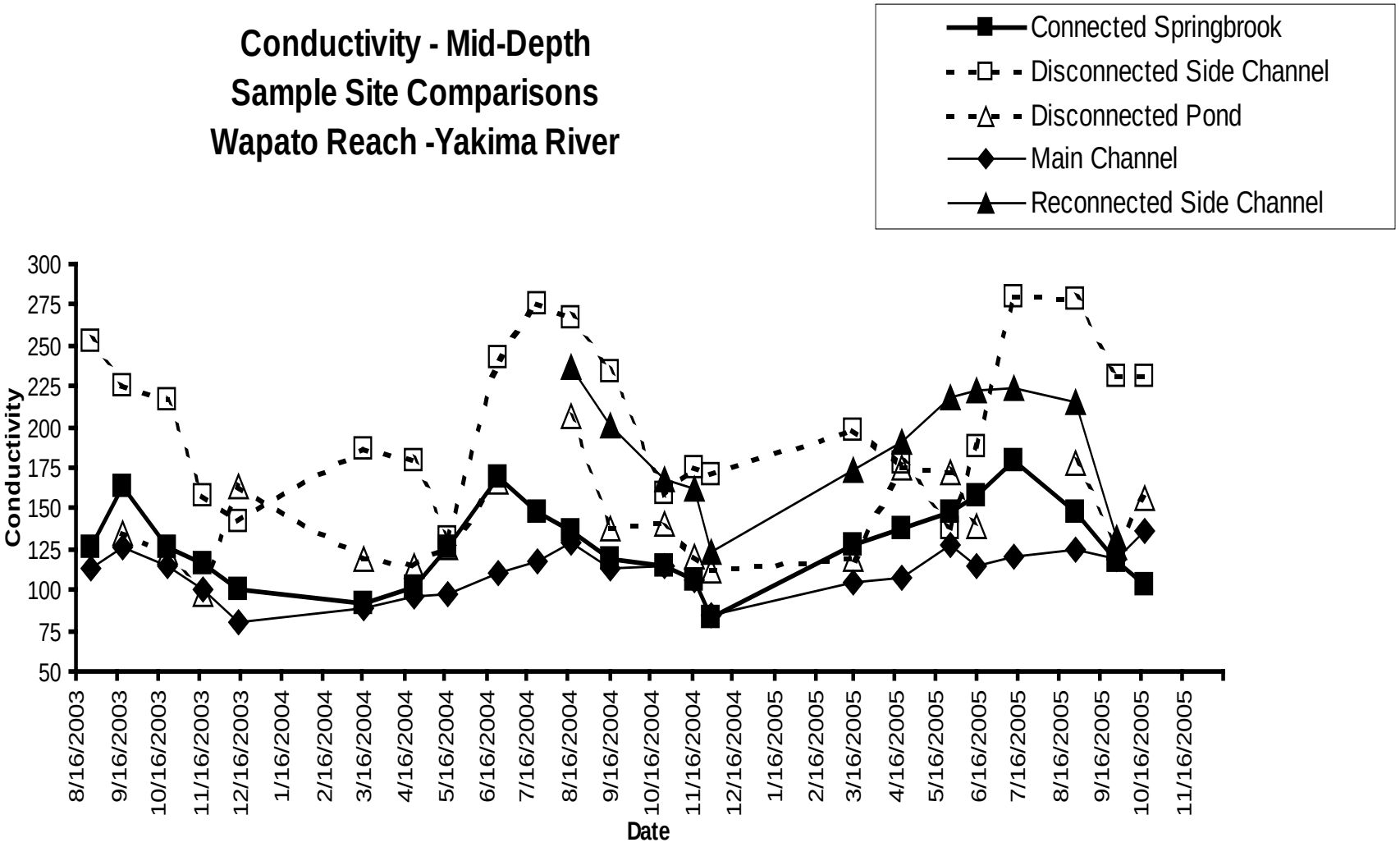
Other Water Quality Parameters

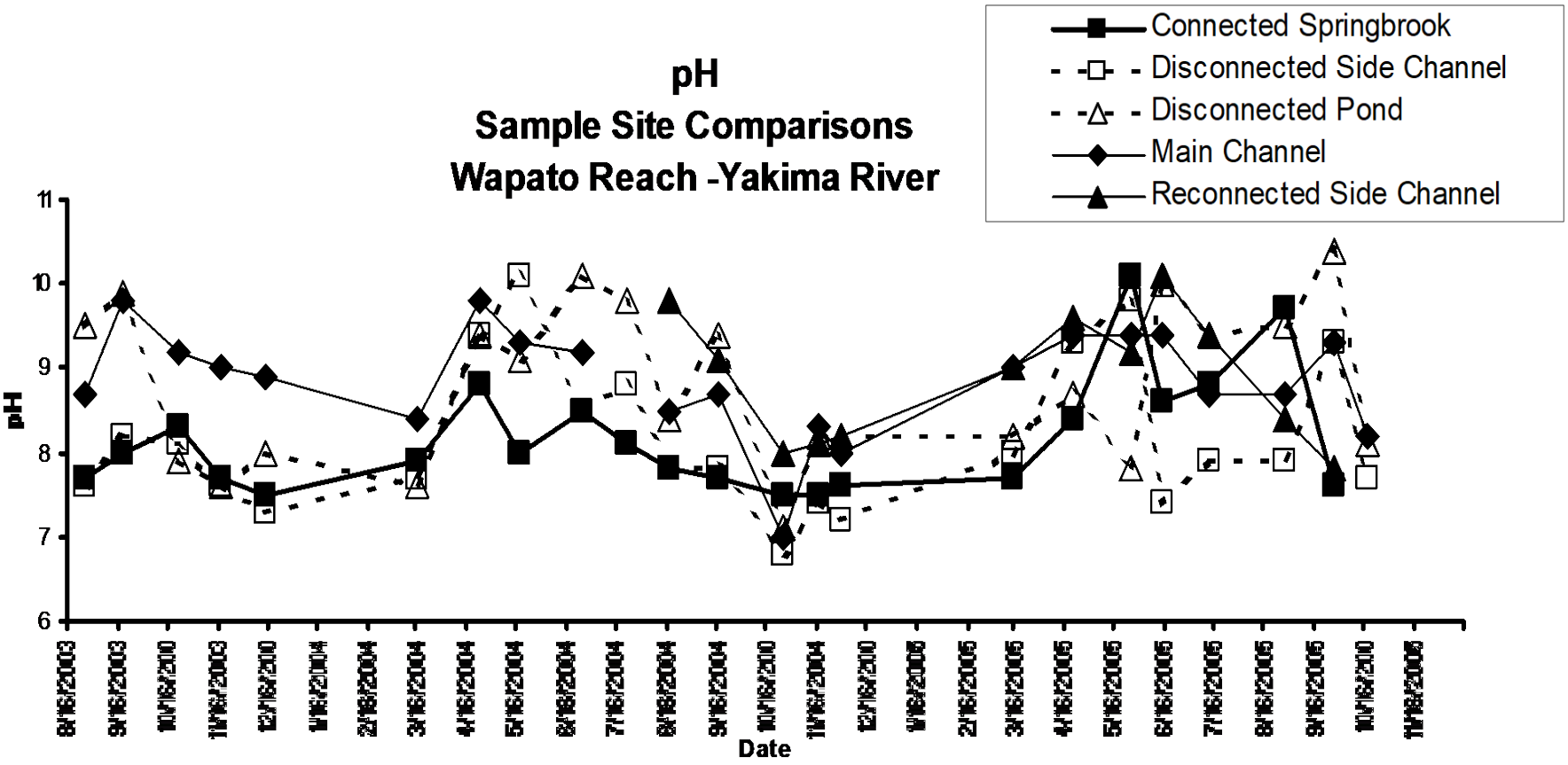
- significant differences between sites ($p<0.05$), both annually and for most seasons (no significant difference in turbidity in the spring)
- significant difference between disconnected channel sample locations for conductivity and DO, annually and seasonally
- significant difference in summer DO for connected springbrook locations

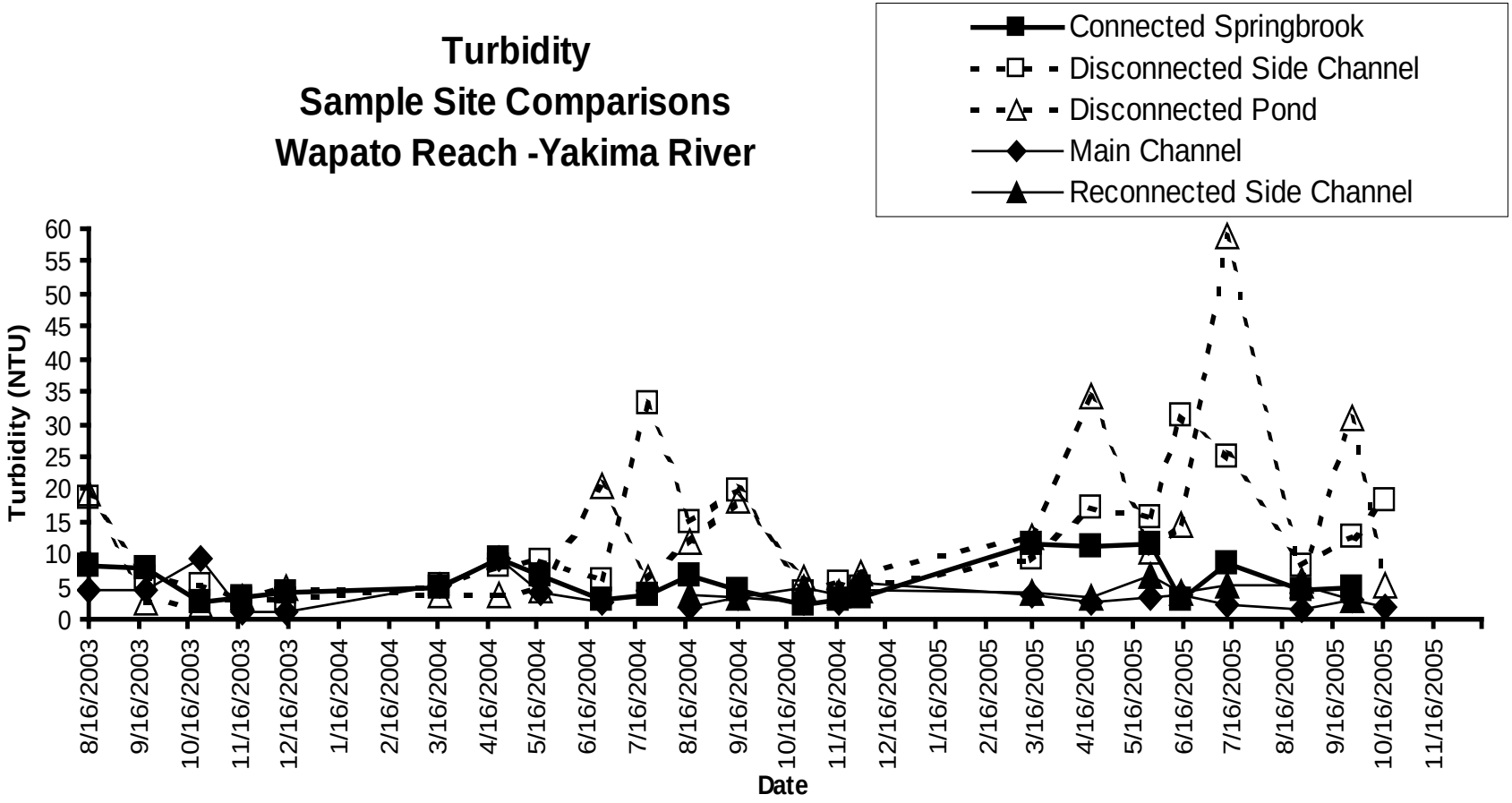
Between-Site Comparisons


Dissolved Oxygen - Mid-Depth % Saturation
Sample Site Comparisons
Wapato Reach -Yakima River
Connected Springbrook
Disconnected Side Channel
Disconnected Pond
Main Channel
Reconnected Side Channel
Percent
Date

Conductivity - Mid-Depth
Sample Site Comparisons
Wapato Reach -Yakima River



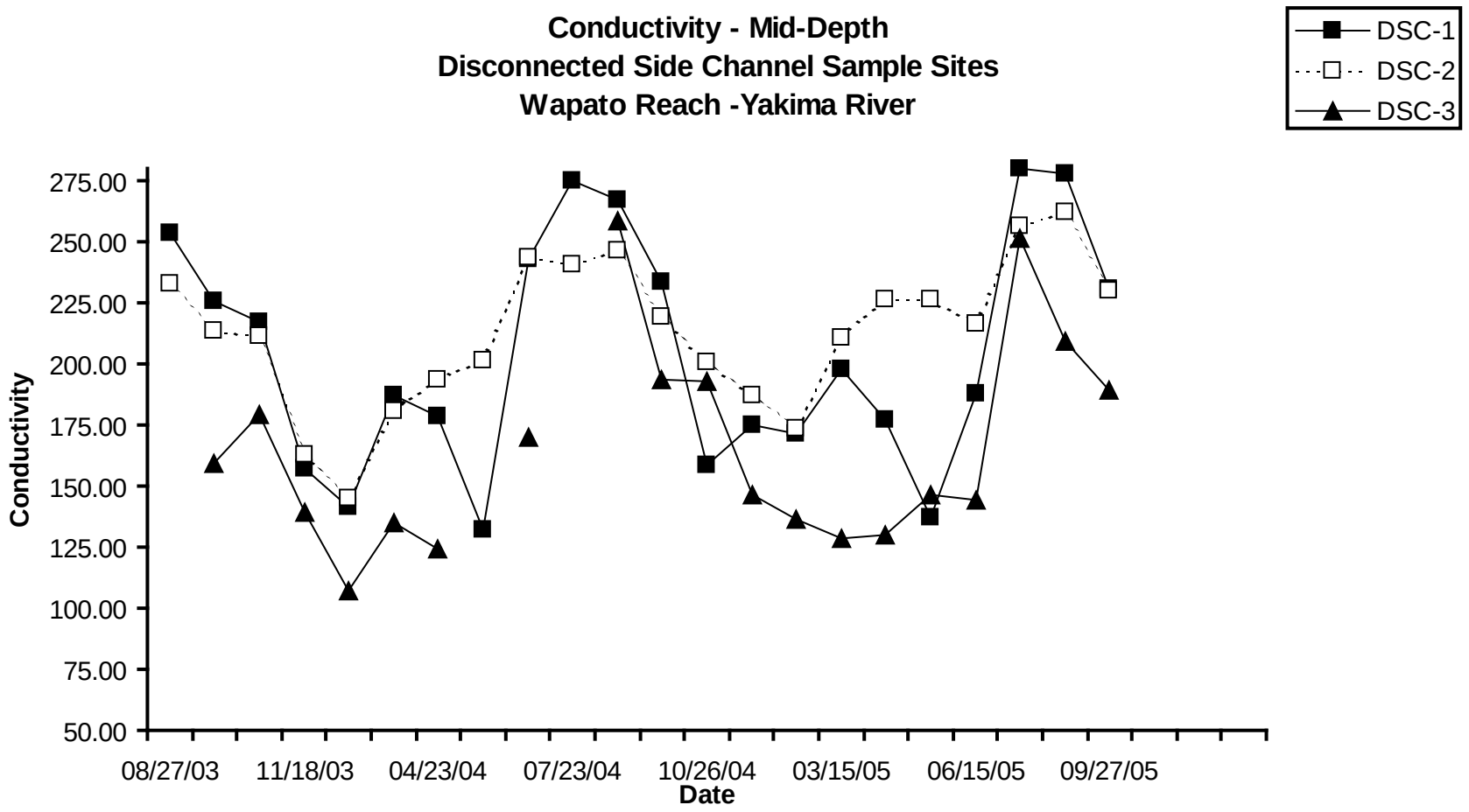

pH
Sample Site Comparisons
Wapato Reach -Yakima River
Connected Springbrook
Disconnected Side Channel
Disconnected Pond
Main Channel
Reconnected Side Channel
pH
11
10
9
8
7
6
Date

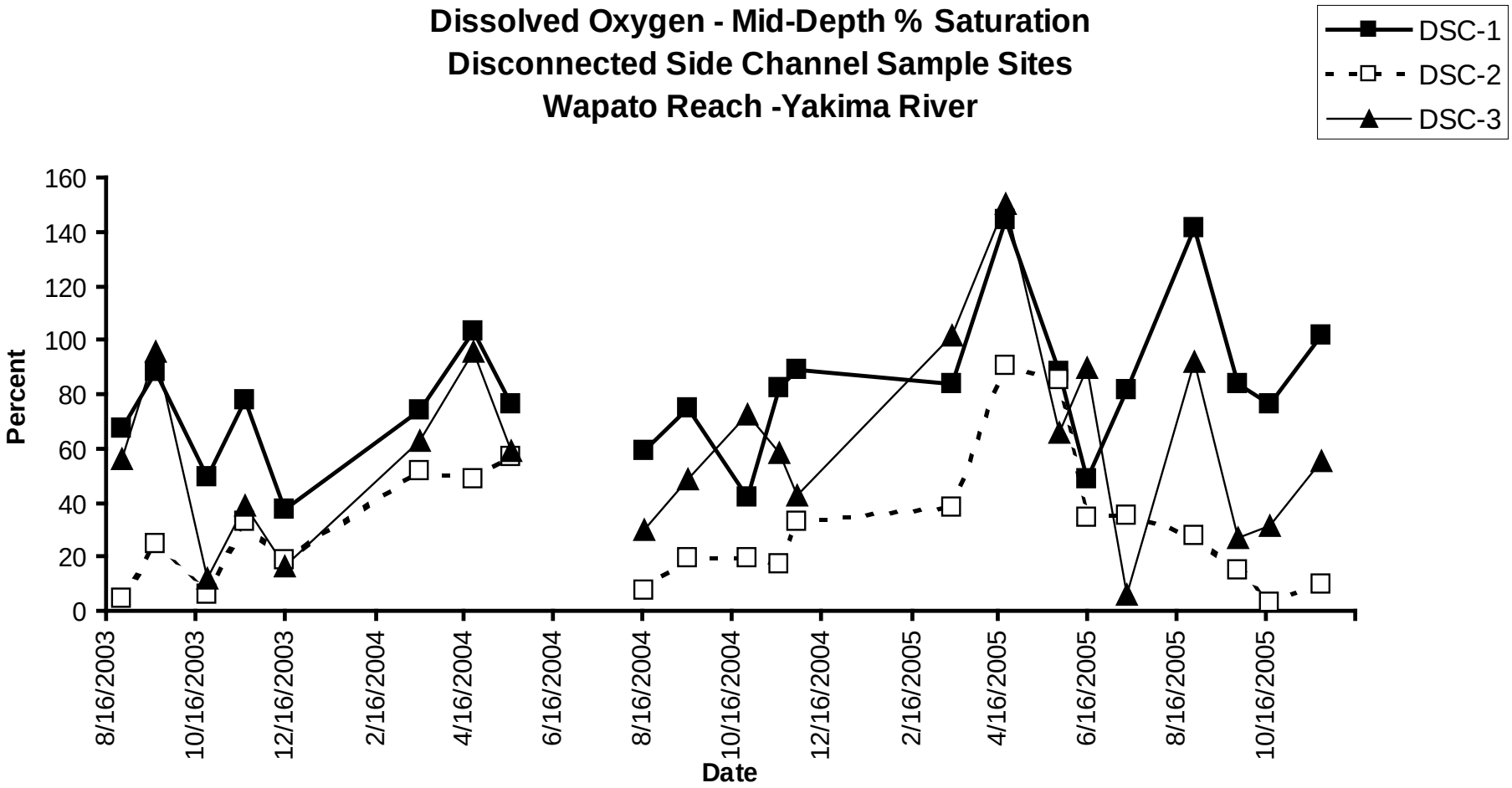

Turbidity
Sample Site Comparisons
Wapato Reach -Yakima River
Connected Springbrook
Disconnected Side Channel
Disconnected Pond
Main Channel
Reconnected Side Channel
Turbidity (NTU)
60
55
50
45
40
35
30
25
20
15
10
5
0
8/16/2003
9/16/2003
10/16/2003
11/16/2003
12/16/2003
1/16/2004
2/16/2004
3/16/2004
4/16/2004
5/16/2004
6/16/2004
7/16/2004
8/16/2004
9/16/2004
10/16/2004
11/16/2004
12/16/2004
1/16/2005
2/16/2005
3/16/2005
4/16/2005
5/16/2005
6/16/2005
7/16/2005
8/16/2005
9/16/2005
10/16/2005
11/16/2005
Date

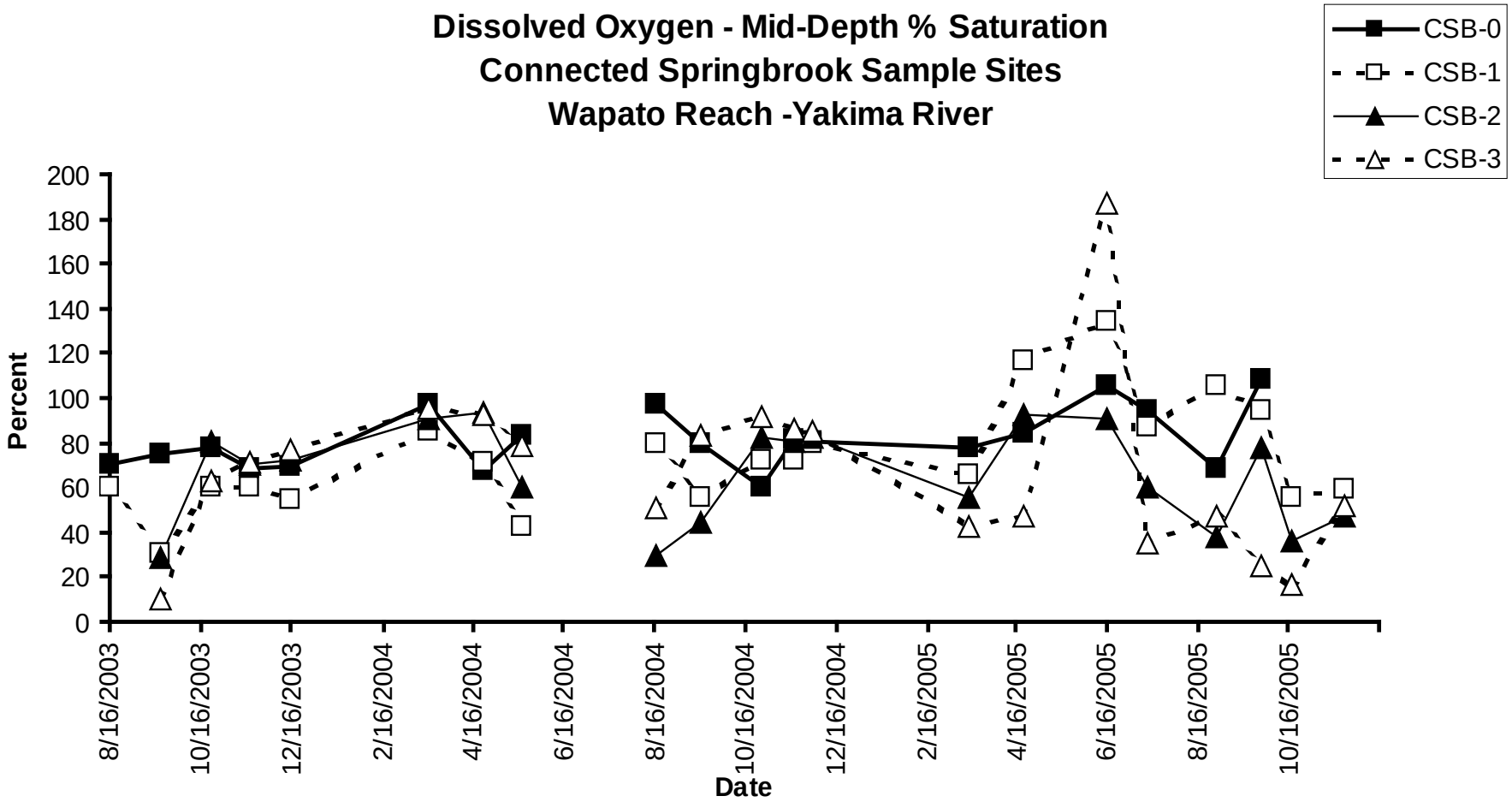
Main Stem - Study Sites

- No significant differences between main stem and other sites in temperature and turbidity ($p<0.05$), both annually and for all seasons
- No significant differences between main stem and other sites in pH in the spring and fall, as well as in DO in the spring ($p<0.05$)

Within-Site Comparisons

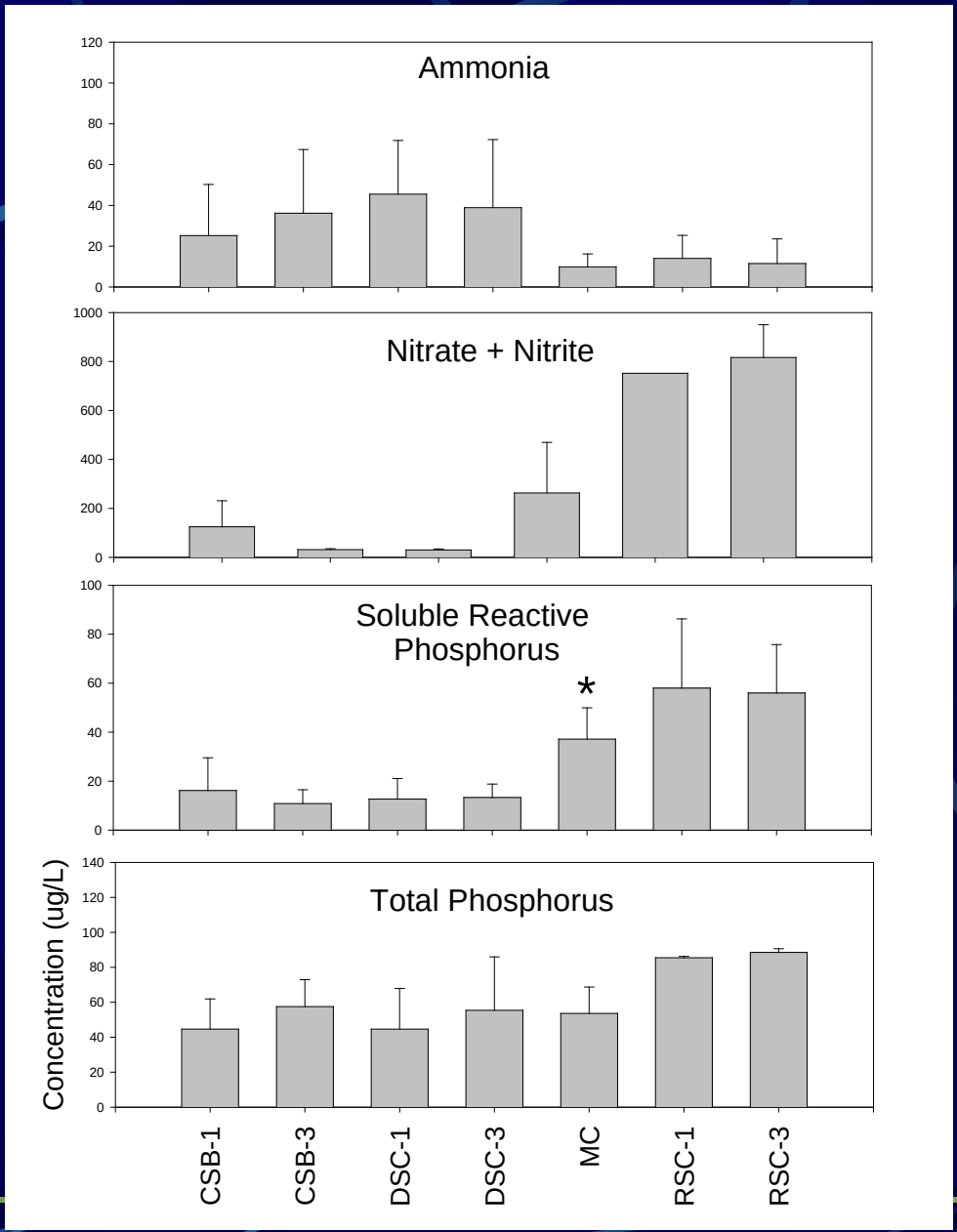

Conductivity - Mid-Depth
Disconnected Side Channel Sample Sites
Wapato Reach -Yakima River
DSC-1
DSC-2
DSC-3
Conductivity
275.00
250.00
225.00
200.00
175.00
150.00
125.00
100.00
75.00
50.00
08/27/03
11/18/03
04/23/04
07/23/04
10/26/04
03/15/05
06/15/05
09/27/05
Date


Dissolved Oxygen - Mid-Depth % Saturation
Disconnected Side Channel Sample Sites
Wapato Reach -Yakima River
DSC-1
DSC-2
DSC-3
Percent
160
140
120
100
80
60
40
20
0
8/16/2003
10/16/2003
12/16/2003
2/16/2004
4/16/2004
6/16/2004
8/16/2004
10/16/2004
12/16/2004
2/16/2005
4/16/2005
6/16/2005
8/16/2005
10/16/2005
Date


Dissolved Oxygen - Mid-Depth % Saturation
Connected Springbrook Sample Sites
Wapato Reach -Yakima River
CSB-0
CSB-1
CSB-2
CSB-3
Percent
200
180
160
140
120
100
80
60
40
20
0
8/16/2003
10/16/2003
12/16/2003
2/16/2004
4/16/2004
6/16/2004
8/16/2004
10/16/2004
12/16/2004
2/16/2005
4/16/2005
6/16/2005
8/16/2005
10/16/2005
Date

Nutrients

- Nutrient concentrations tended to be higher in the Satus vs. the Meninick area; a fact likely attributed to the general increase in available nutrients as one progresses from up to down-stream. In addition, soluble reactive phosphorus was higher in the mainstem vs. the Meninick off-channel habitats.


Ammonia
Nitrate + Nitrite
Soluble Reactive Phosphorus
*
Total Phosphorus
Concentration (ug/L)
CSB-1
CSB-3
DSC-1
DSC-3
MC
RSC-1
RSC-3

Further Work

- process of concluding higher-level assessments, mainly through quantification of the macroinvertebrate community.
- biological data will be combined with the physical/chemical data in a multivariate analysis (principal component analysis) that should identify a subset of these variables that best explain the patterns in insects
- anyone want to go fishing?

Acknowledgments

- Funding:Yakama Nation Wildlife
- Eric Snyder, Grand Valley State University (Co-Investigator)
- Tracy Hames, Yakama Nation Wildlife
- Amy Hamlin, Matt Collins, David Cordner, Justin Bader, Lennard Jordan, Adam Lindquist, CWU Geography and Resource Management Program

Table. Water quality summary statistics for Wapato sample sites, Summer 2003-Fall 2005.

Measures	CSB				CSC	DP	MC
	CSB-0	CSB-1	CSB-2	CSB-3			
Temperature (Celsius)							
Mean	16.7	15.0	13.7	13.1	12.4	15.5	14.5
Maximum	29.0	25.4	25.7	21.1	18.8	27.8	23.8
Minimum	4.5	3.8	3.5	3.4	4.2	4.1	3.1
Dissolved Oxygen (%)							
Mean	81.4	73.4	65.6	67.3	17.3	96.5	116.0
Maximum	108.6	134.2	93.5	186.7	47.2	261.7	145.5
Minimum	60.1	30.8	29.1	10.2	4.6	22.8	78.1
Conductivity							
Mean	134.0	127.9	119.6	114.3	167.9	140.1	110.1
Maximum	191.7	178.7	174.9	148.7	196.8	206.2	135.9
Minimum	85.0	83.6	85.2	83.1	128.3	97.5	79.6

Table. Water quality summary statistics for Wapato sample sites, Summer 2003-Fall 2005.

Measures	CSB				CSC	DP	MC
	CSB-0	CSB-1	CSB-2	CSB-3			
pH							
Mean	7.9	8.1	7.8	7.6	7.9	8.7	8.8
Maximum	8.9	10.1	9.1	9.7	8.2	10.4	9.8
Minimum	7.1	7.5	7.1	1.5	7.4	7.1	7.0
Turbidity (NTU)							
Mean	6.0	5.8	16.6	16.5	12.2	12.3	3.6
Maximum	19.7	11.4	162.9	167.0	25.8	58.7	9.4
Minimum	2.4	2.3	2.0	1.9	5.1	2.1	1.1

Table. Water quality summary statistics for Satus sample sites, Summer 2004-Fall 2004.

Measures	RSC-3	RSC-2	RSC-1
Temperature (Celsius)			
Mean	14.8	15.8	14.7
Maximum	24.3	24.4	25.3
Minimum	4.0	4.1	4.1
Dissolved Oxygen (%)			
Mean	127.6	146.4	154.4
Maximum	206.1	222.8	242.7
Minimum	75.7	73.2	70.2
Conductivity			
Mean	186.0	197.5	189.0
Maximum	223.5	247.7	236.5
Minimum	122.4	123.1	123.1
Specific Conductivity			
Mean	229.6	237.9	234.1
Maximum	256.9	260.4	266.0
Minimum	204.6	205.1	205.2

Water quality summary statistics for Satus sample sites, Summer 2004-Fall 2005.

Measures	**RSC-3**	**RSC-2**	**RSC-1**
pH			
Mean	8.5	8.6	8.8
Maximum	9.8	9.9	10.1
Minimum	7.5	7.5	7.8
Turbidity (NTU)			
Mean	4.2	4.3	4.2
Maximum	13.5	13.8	6.7
Minimum	2.3	2.1	2.8