Willits Highway 101 Bypass Project: Multi-year Aquatic Bioassessment of Eight Non-Perennial North Coast Streams; Challenges and Opportunities

California Aquatic Bioassessment Workgroup
19th Annual Meeting

November 8, 2012

Introduction / Outline

- Background/Objectives
- Watershed Characteristics
- Methods
  - Challenges and Opportunities
- Results/Discussion
- Summary

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Project Background

- Construction of Willits Bypass project, a new section of U.S. Highway 101 to improve traffic circulation
- Numerous mitigation components (onsite vs offsite)

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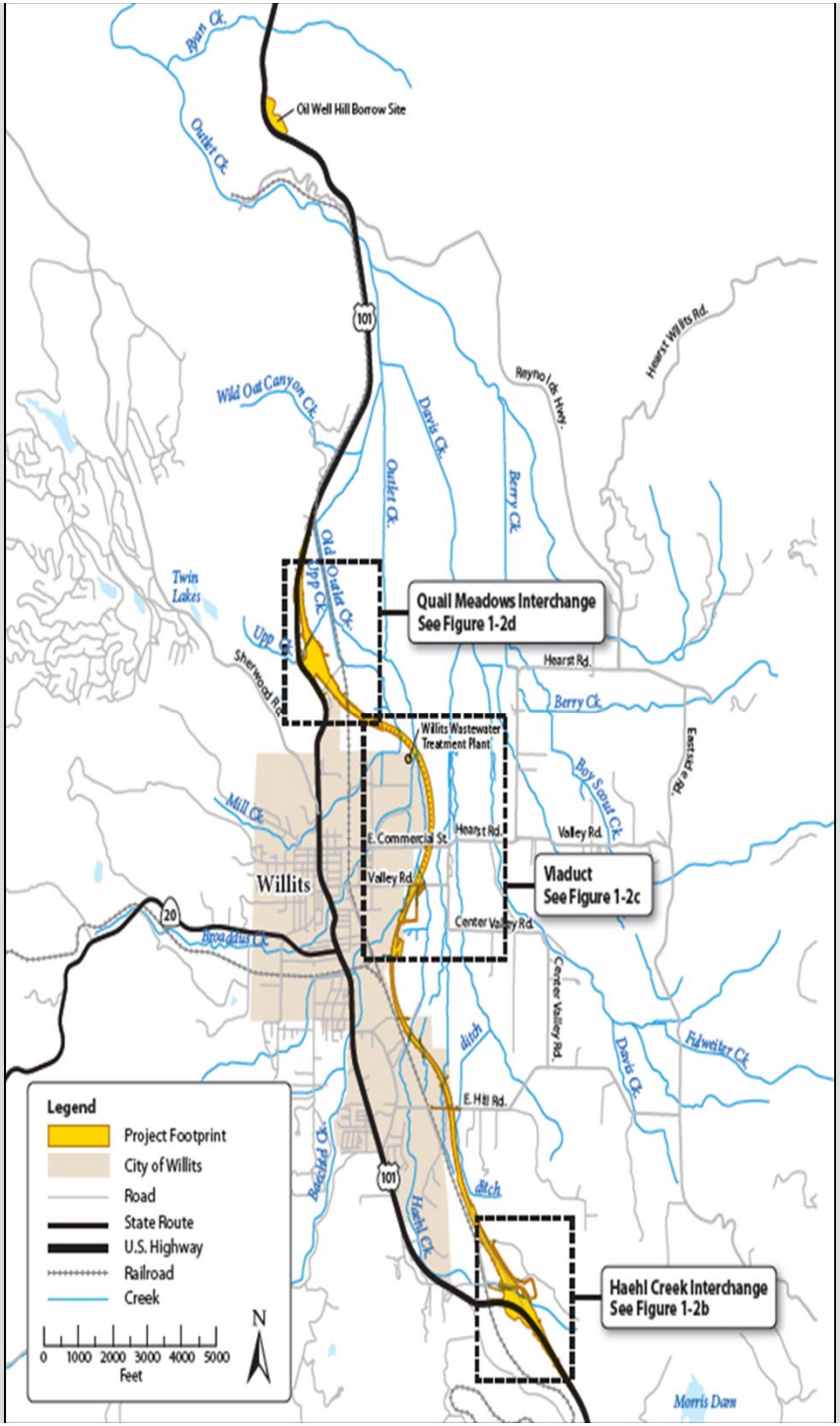
Highway Relocation



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Project Objectives

- *Provide RWQCB with baseline conditions*
- Assess changes in stream ecosystems as result of project construction and mitigation activities
- Assess changes to biological integrity of streams under the project's mitigation and monitoring program

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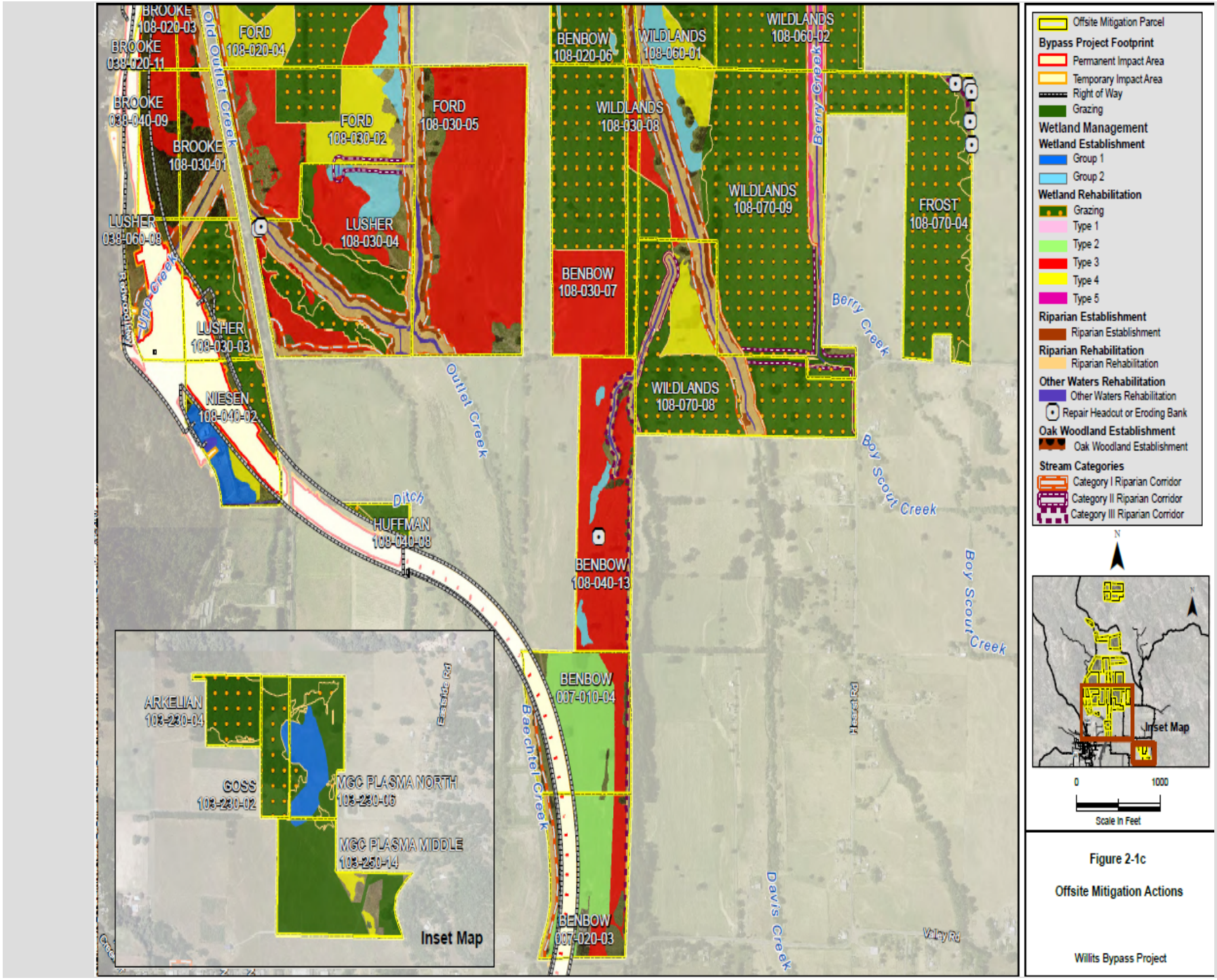

Figure 2-1c

Offsite Mitigation Actions

Willits Bypass Project

Watershed Characteristics

- Drainage basin 67 sq miles (43,063 acres)
- 11 named streams in project area!
- Former lacustrine setting
- Intermittent/ephemeral

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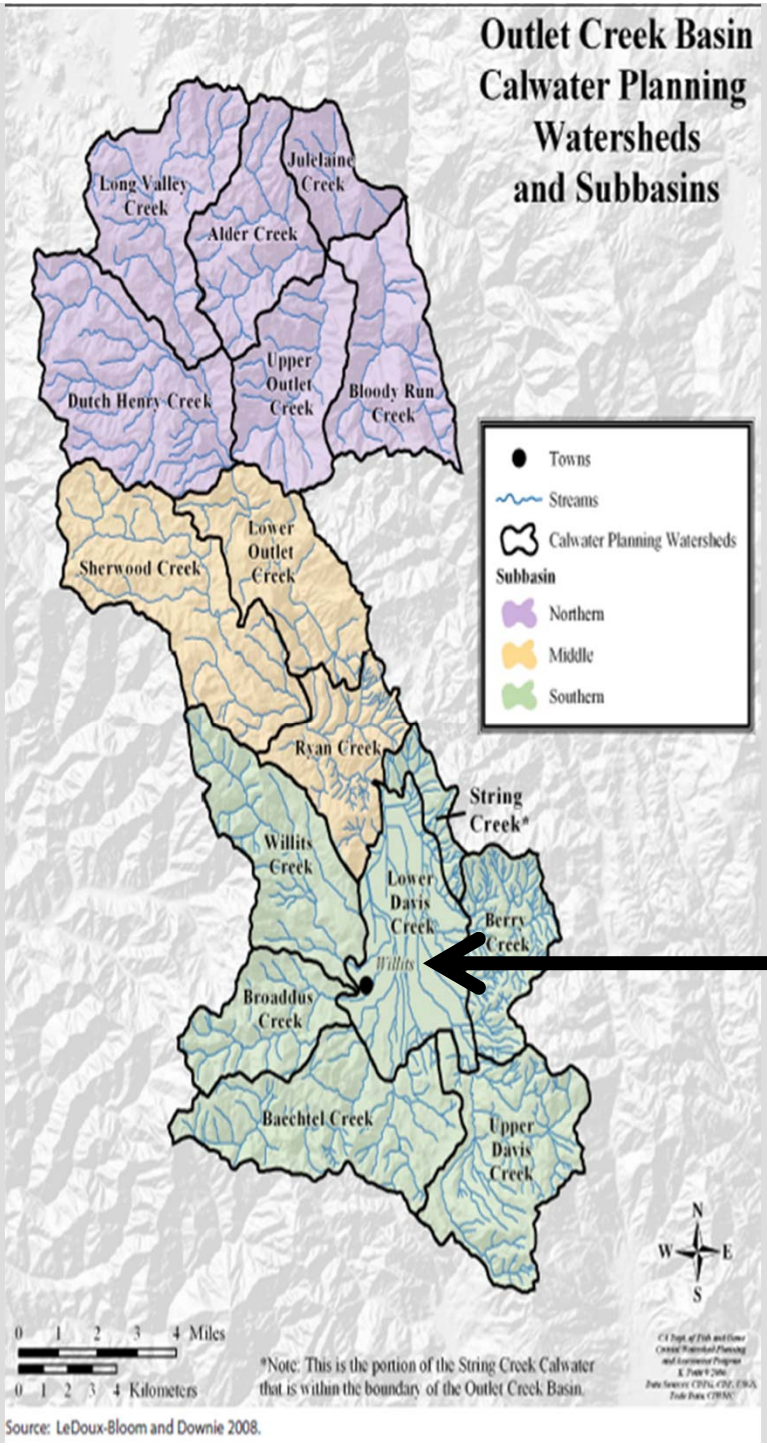

Source: LeDoux-Bloom and Downie 2008.

Outlet Creek basin w/in Little Lake Valley

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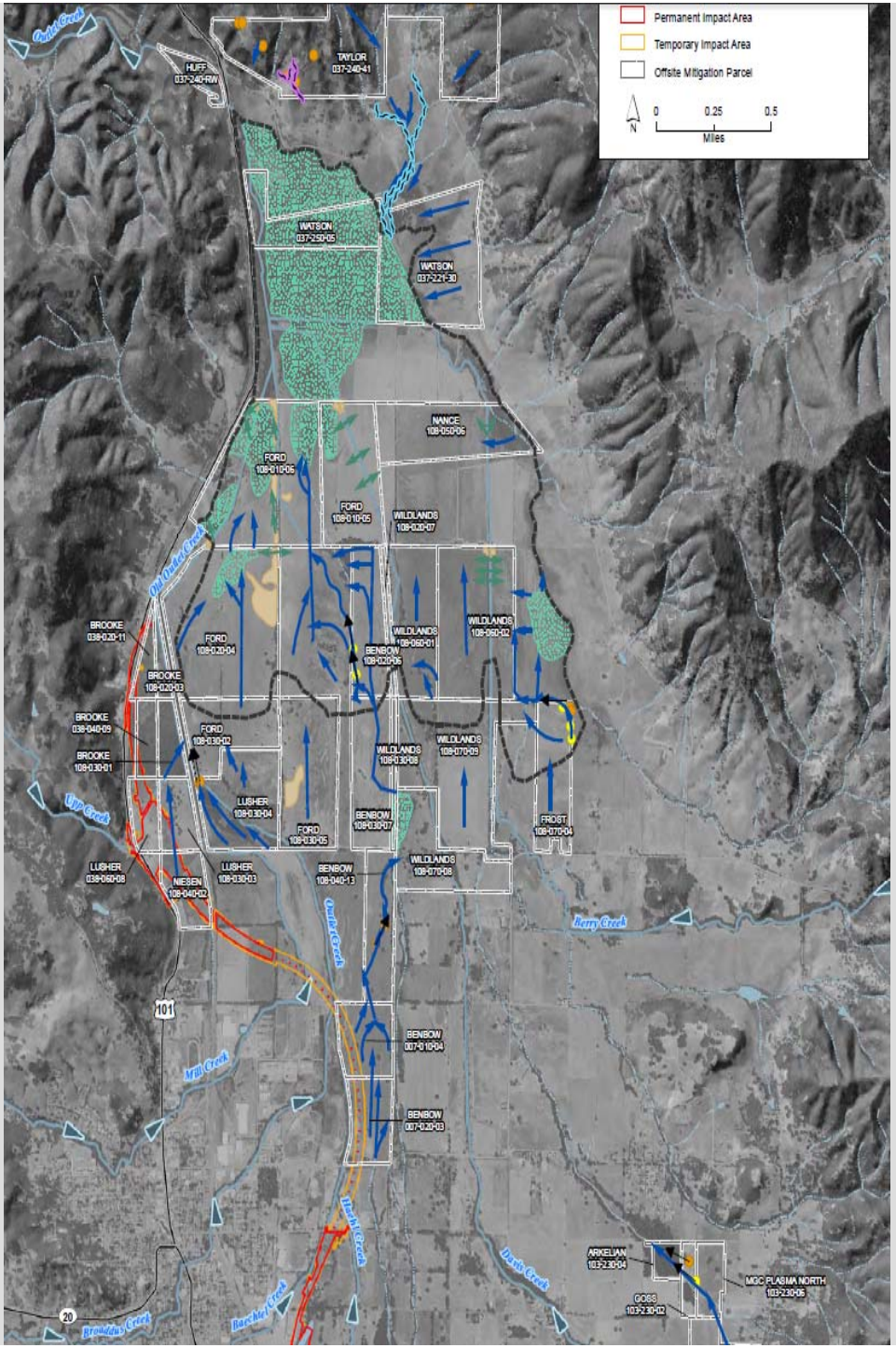
Many flow patterns

Many channels

Former lake



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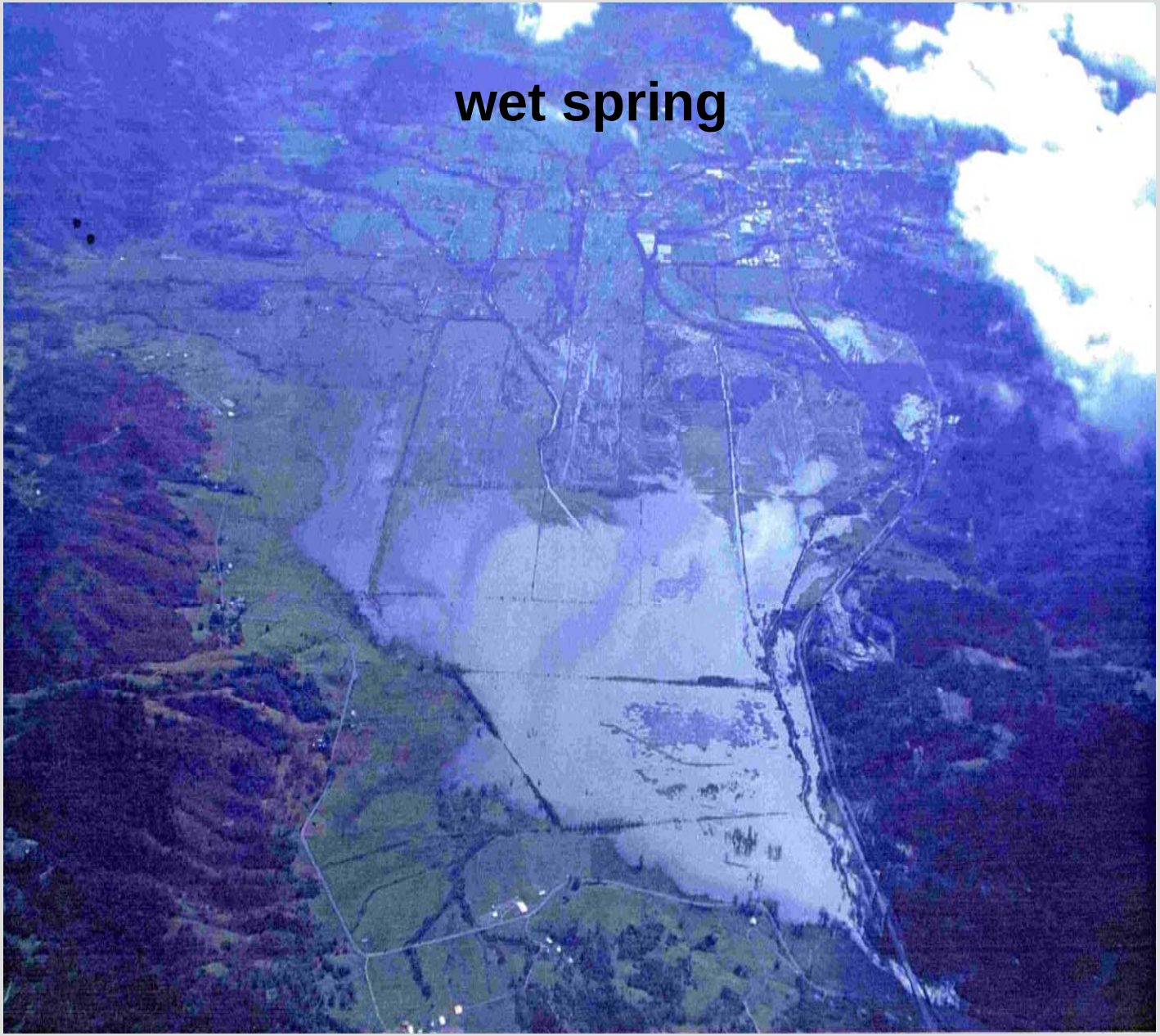

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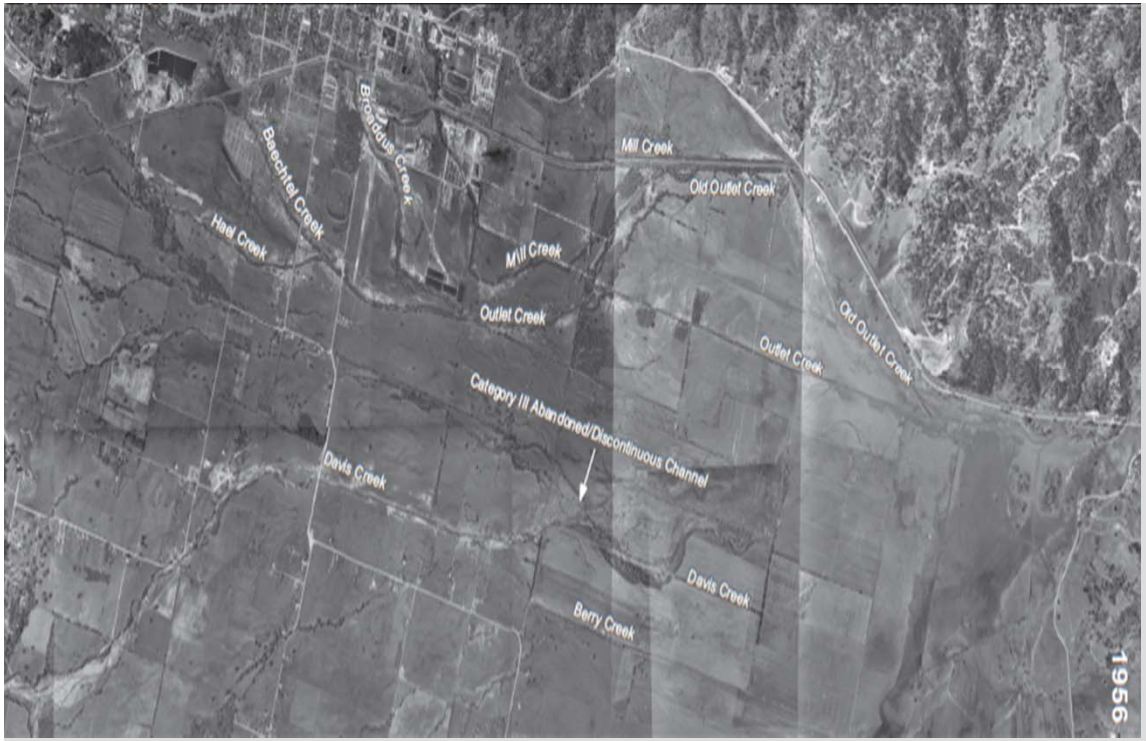

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2005

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Lower Davis Creek

Haehl Creek near Baechtel Creek confluence

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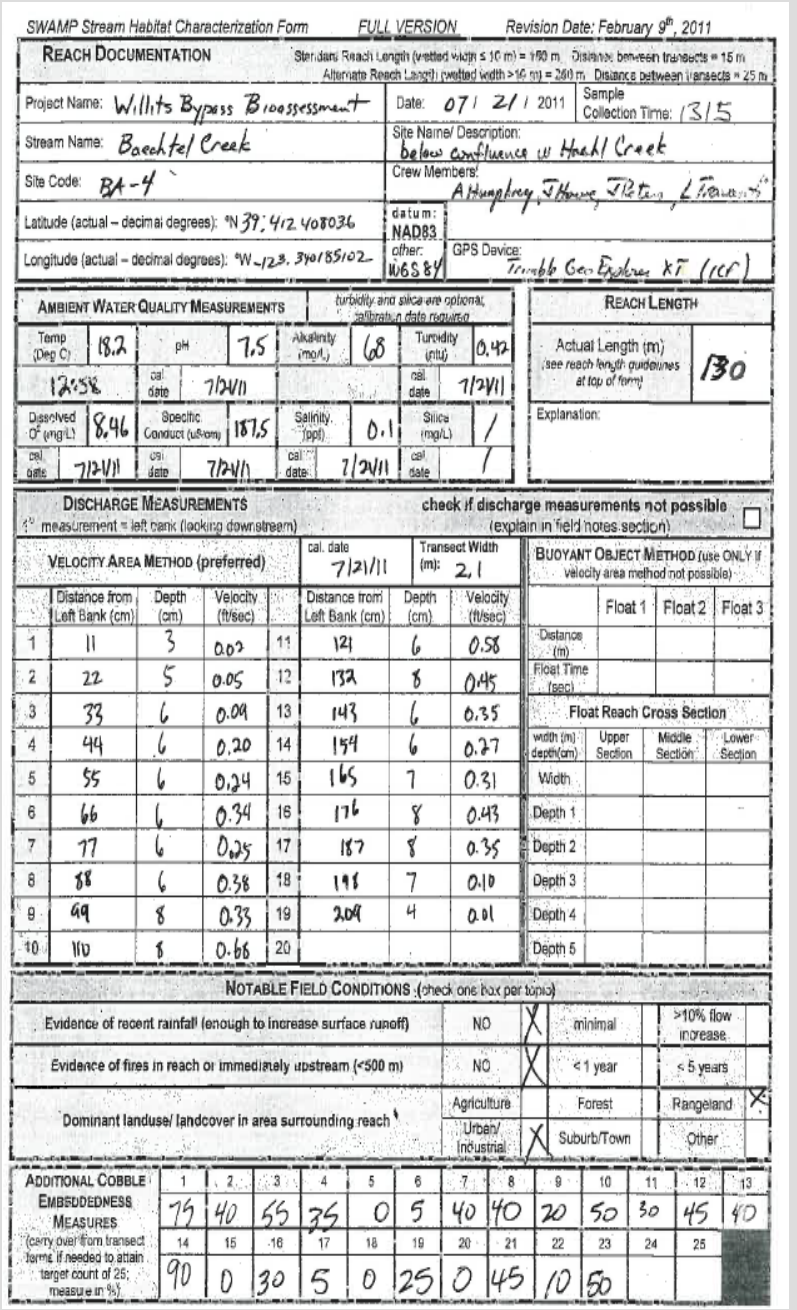
PHAB Data

- Standard methods
- WQ
- Reach conditions
- Slope
- RBP habitat parameters
- Main/inner transects



SWAMP Stream Habitat Characterization Form — FULL VERSION — Revision Date: February 9th, 2011

REACH DOCUMENTATION

Standard Reach Length (wetted width ≤ 10 m) = 150 m. Distance between transects = 15 m.
Alternate Reach Length (wetted width > 10 m) = 250 m. Distance between transects = 25 m.

Project Name: Willits Bypass Bioassessment	Date: 07 / 21 / 2011 — Sample Collection Time: 1315
Stream Name: Baechtel Creek	Site Name/ Description: below confluence w Haehl Creek
Site Code: BA-4	Crew Members: A Humphrey, J Hawes, J Peters, L Fransen
Latitude (actual – decimal degrees): °N 39.412408036	datum: NAD83
Longitude (actual – decimal degrees): °W -123.340185102	other: WGS84 — GPS Device: Trimble Geo Explorer XT (ICF)

AMBIENT WATER QUALITY MEASUREMENTS (turbidity and silica are optional; calibration data required)

Temp (Deg C)	18.2	pH	7.5	Alkalinity (mg/L)	68	Turbidity (ntu)	0.42
cal time	12:58	cal date	7/21/11			cal date	7/21/11
Dissolved O2 (mg/L)	8.96	Specific Conduct (uS/cm)	187.5	Salinity (ppt)	0.1	Silica (mg/L)	/
cal date	7/21/11	cal time	7/21/11	cal date	7/21/11	cal date	/

REACH LENGTH

Actual Length (m) (see reach length guidelines at top of form): 130

Explanation:

DISCHARGE MEASUREMENTS

1st measurement = left bank (looking downstream)

check if discharge measurements not possible (explain in field notes section) ☐

VELOCITY AREA METHOD (preferred) — cal. date 7/21/11 — Transect Width (m): 2.1

	Distance from Left Bank (cm)	Depth (cm)	Velocity (ft/sec)		Distance from Left Bank (cm)	Depth (cm)	Velocity (ft/sec)
1	11	3	0.03	11	121	6	0.58
2	22	5	0.05	12	132	8	0.45
3	33	6	0.09	13	143	6	0.35
4	44	6	0.20	14	154	6	0.27
5	55	6	0.24	15	165	7	0.31
6	66	6	0.34	16	176	8	0.43
7	77	6	0.25	17	187	8	0.35
8	88	6	0.38	18	198	7	0.10
9	99	8	0.33	19	209	4	0.01
10	110	8	0.66	20			

BUOYANT OBJECT METHOD (use ONLY if velocity area method not possible)

	Float 1	Float 2	Float 3
Distance (m)			
Float Time (sec)			

Float Reach Cross Section

width (m) depth(cm)	Upper Section	Middle Section	Lower Section
Width			
Depth 1			
Depth 2			
Depth 3			
Depth 4			
Depth 5			

NOTABLE FIELD CONDITIONS (check one box per topic)

Evidence of recent rainfall (enough to increase surface runoff)	NO	X	minimal		>10% flow increase	
Evidence of fires in reach or immediately upstream (<500 m)	NO	X	< 1 year		< 5 years	
Dominant landuse/ landcover in area surrounding reach	Agriculture		Forest		Rangeland	X
	Urban/ Industrial	X	Suburb/Town		Other	

ADDITIONAL COBBLE EMBEDDEDNESS MEASURES (carry over from transect forms if needed to attain target count of 25; measure in %)

1	2	3	4	5	6	7	8	9	10	11	12	13
75	40	55	35	0	5	40	40	20	50	30	45	40
14	15	16	17	18	19	20	21	22	23	24	25	
90	0	30	5	0	25	0	45	10	50			

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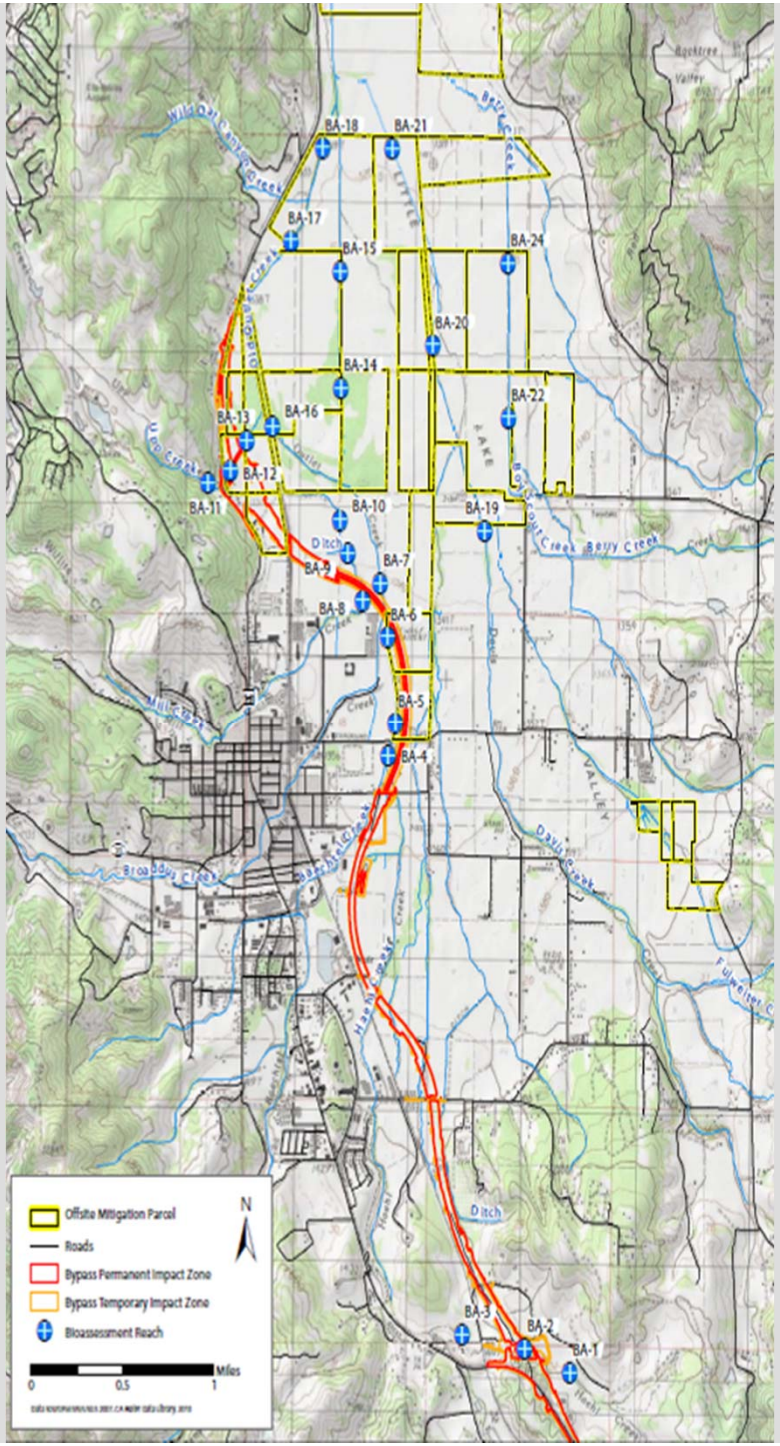
Bioassessment Site Locations



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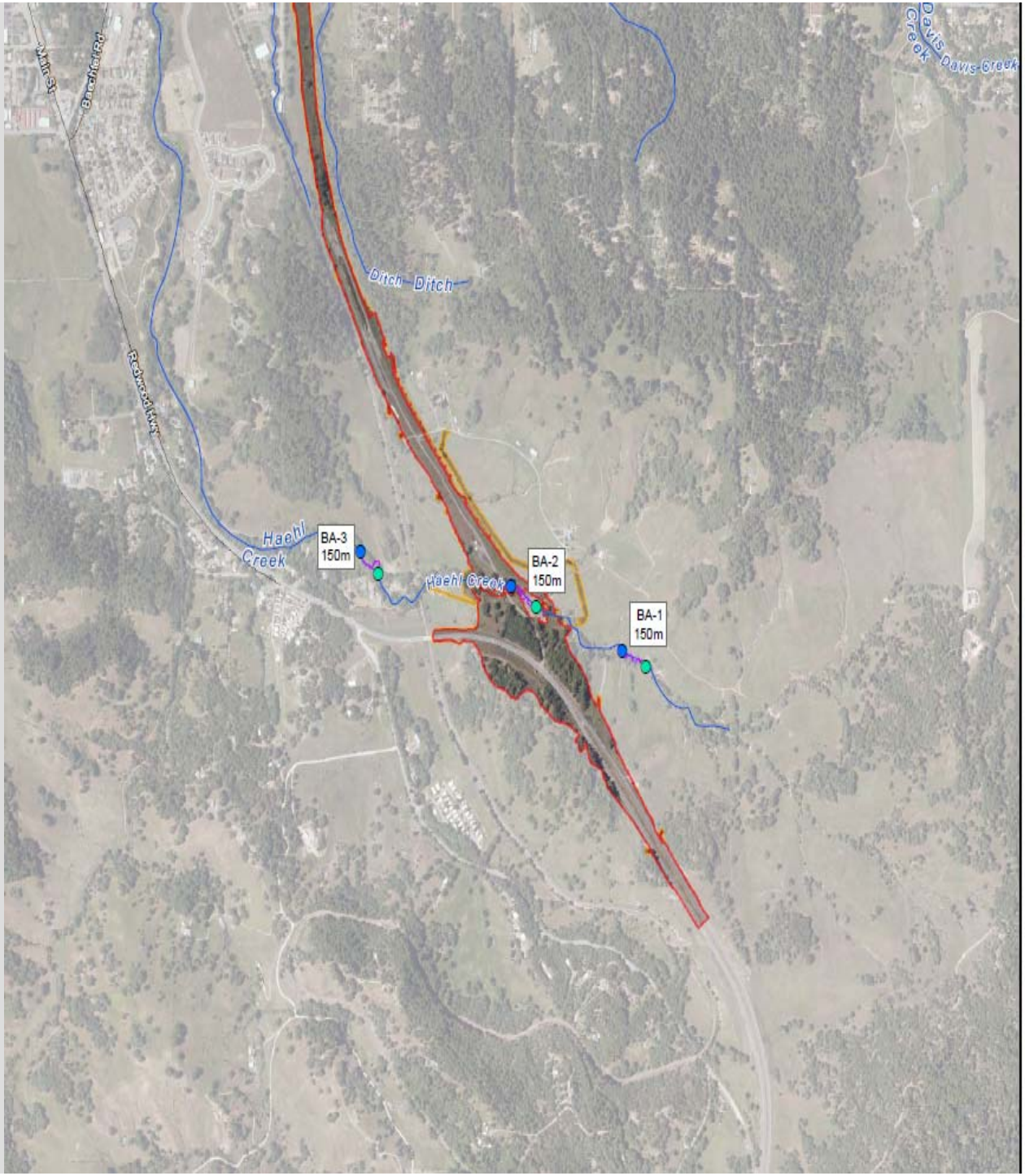
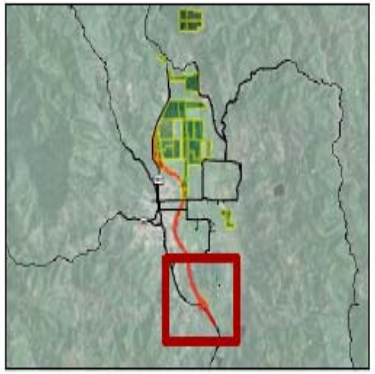


Offsite Mitigation Parcels
Permanent Impact Area
Temporary Impact Area
Streams

Bioassessment Site

Bioassessment Reach
Downstream Point
Upstream Point
BA-1 150m Bioassessment Reach # and Length (Meter)



N

0 1000

Scale in Feet

Figure 2c
Bioassessment Sites
Willits Bypass Project

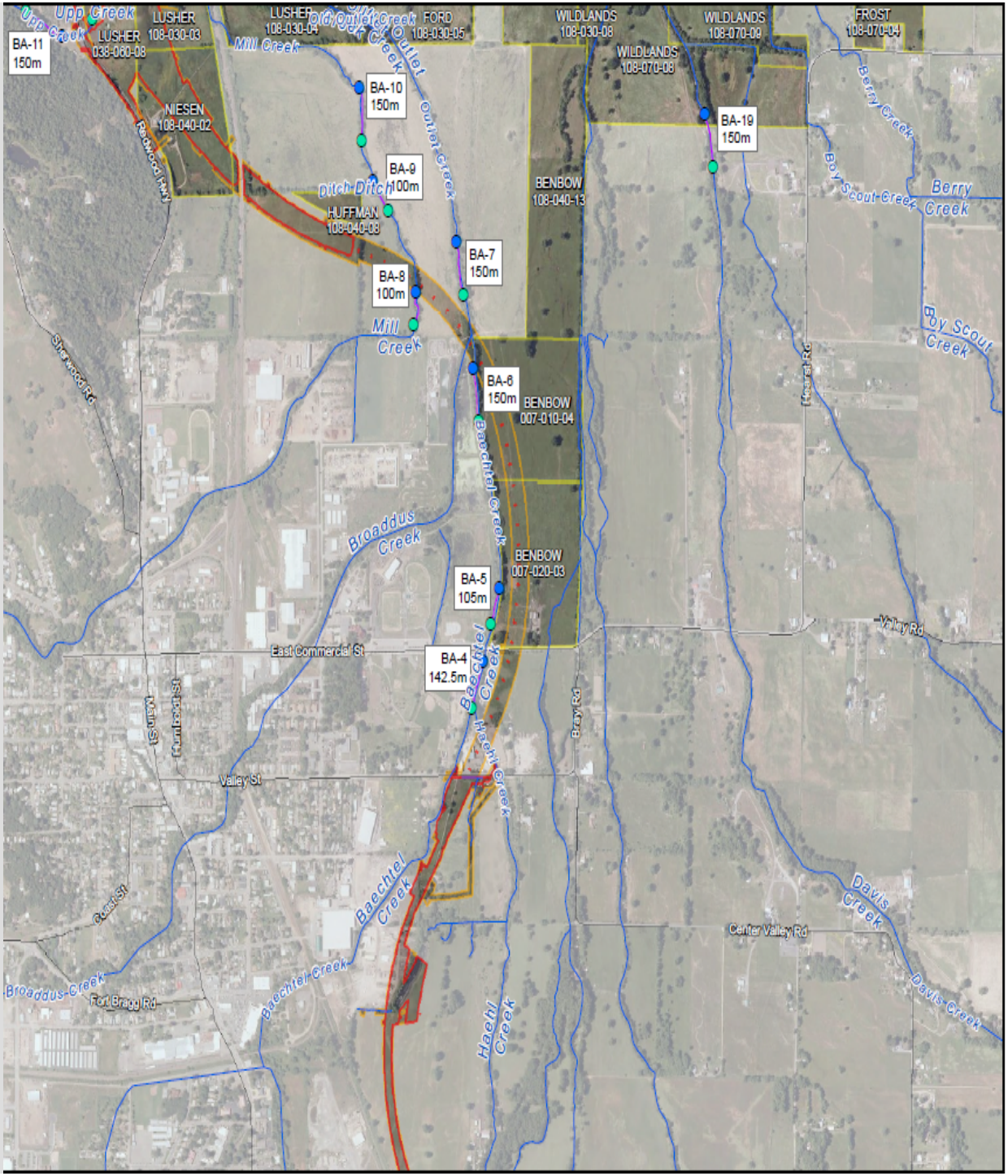


Figure 2b

Bioassessment Sites
Willits Bypass Project

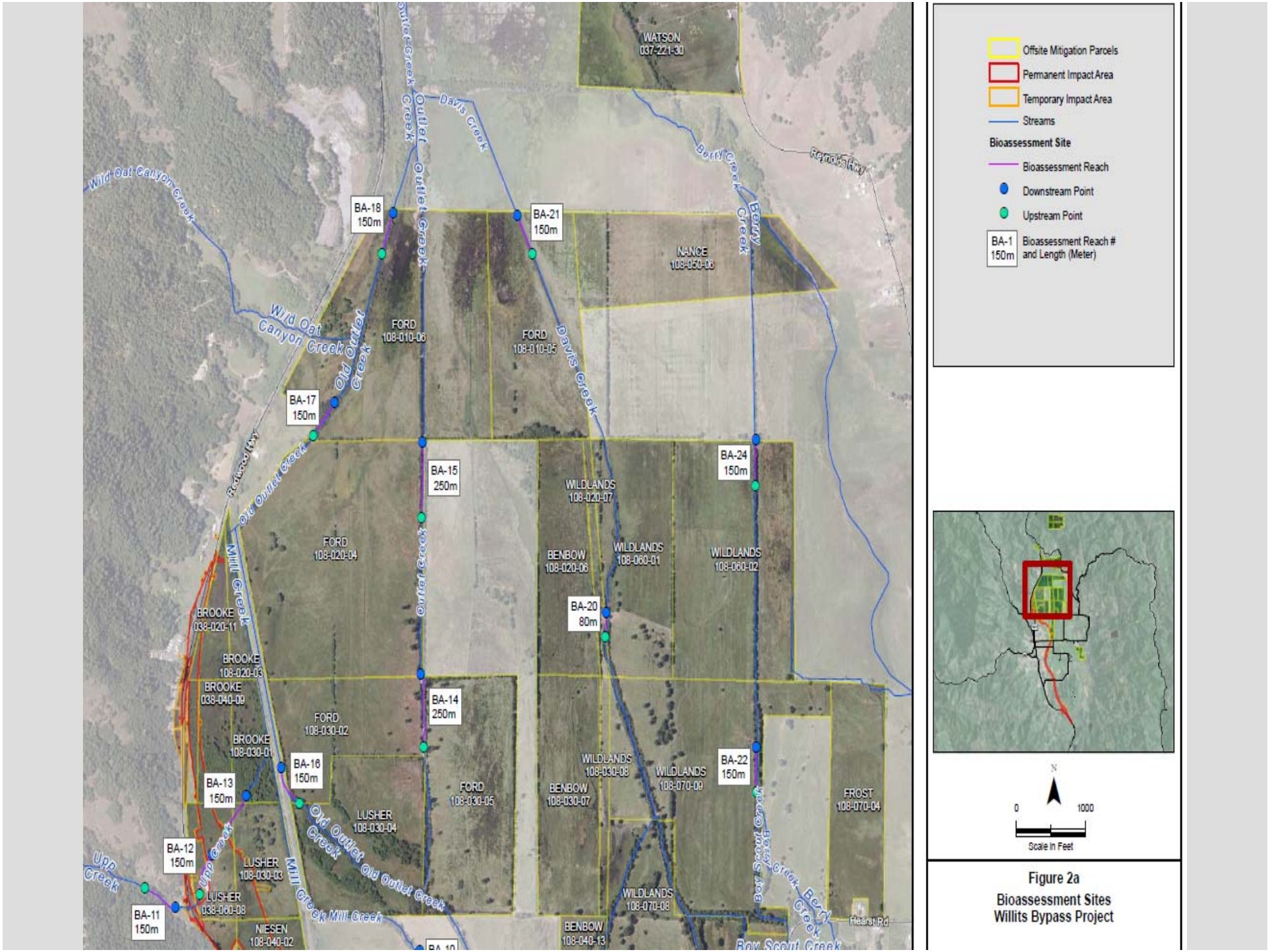
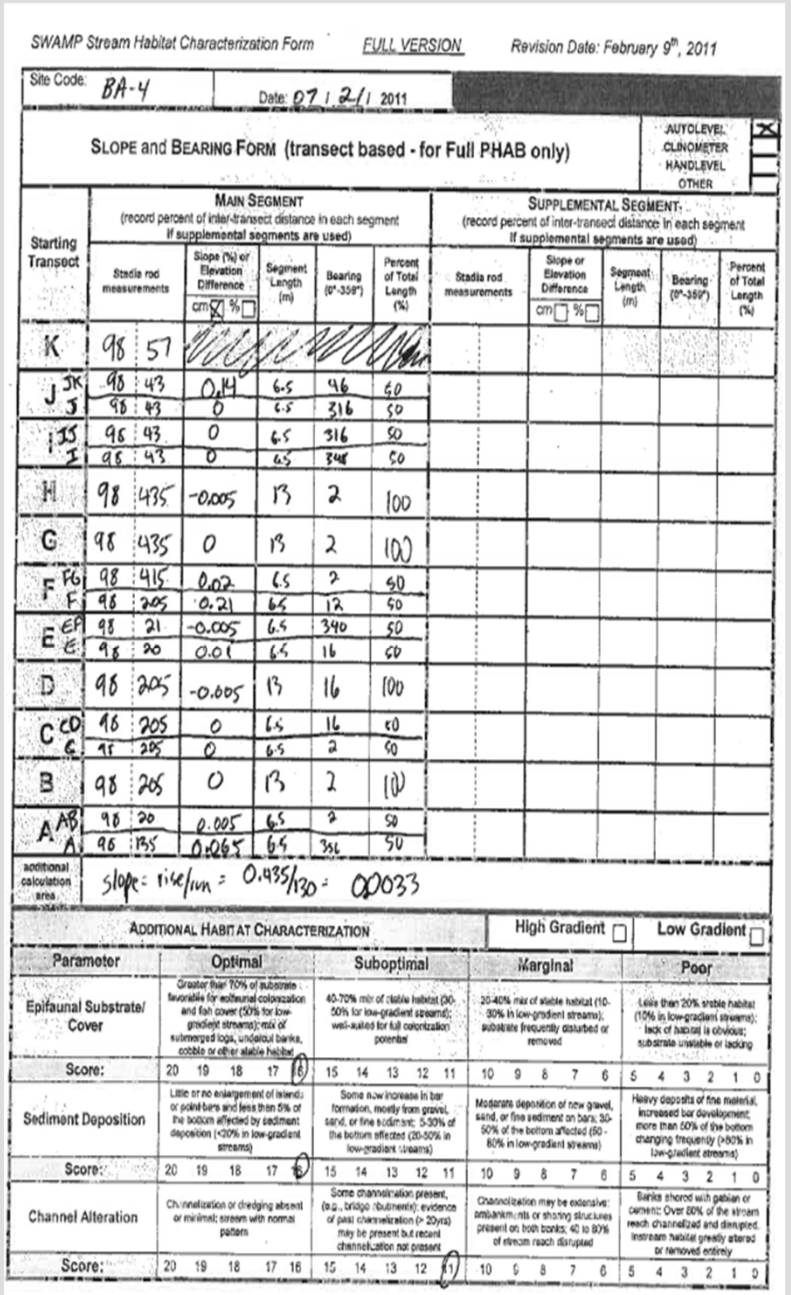


Figure 2a
Bioassessment Sites
Willits Bypass Project

PHAB Results

- Typical low-gradient (< 1%) valley floor streams that flow through depositional substrates
- Highly channelized/incised
- Fine substrates and homogenous habitats (plane-bed)



SWAMP Stream Habitat Characterization Form — FULL VERSION — Revision Date: February 9th, 2011

Site Code: BA-4 Date: 07 / 21 / 2011

SLOPE and BEARING FORM (transect based - for Full PHAB only)

AUTOLEVEL [X] CLINOMETER [ ] HANDLEVEL [ ] OTHER [ ]

Starting Transect	Main Segment (record percent of inter-transect distance in each segment if supplemental segments are used)					Supplemental Segment (record percent of inter-transect distance in each segment if supplemental segments are used)				
	Stadia rod measurements		Slope (%) or Elevation Difference cm [X] % [ ]	Segment Length (m)	Bearing (0°-359°)	Percent of Total Length (%)	Stadia rod measurements	Slope or Elevation Difference cm [ ] % [ ]	Segment Length (m)	Bearing (0°-359°)	Percent of Total Length (%)
K	98	57									
JK	98	43	0.44	6.5	96	50					
J	98	43	0	6.5	316	50					
IJ	98	43	0	6.5	316	50					
I	98	43	0	6.5	348	50					
H	98	435	-0.005	13	2	100					
G	98	435	0	13	2	100					
FG	98	415	0.02	6.5	2	50					
F	98	205	0.21	6.5	12	50					
EF	98	21	-0.005	6.5	340	50					
E	98	20	0.01	6.5	16	50					
D	98	205	-0.005	13	16	100					
CD	98	205	0	6.5	16	50					
C	98	205	0	6.5	2	50					
B	98	205	0	13	2	100					
AB	98	20	0.005	6.5	2	50					
A	98	135	0.065	6.5	356	50					

additional calculation area: slope: rise/run = 0.435/130 = .0033

ADDITIONAL HABITAT CHARACTERIZATION — High Gradient [ ] Low Gradient [ ]

Parameter	Optimal	Suboptimal	Marginal	Poor
Epifaunal Substrate/ Cover	Greater than 70% of substrate favorable for epifaunal colonization and fish cover (50% for low-gradient streams); mix of submerged logs, undercut banks, cobble or other stable habitat	40-70% mix of stable habitat (30-50% for low-gradient streams); well-suited for full colonization potential	20-40% mix of stable habitat (10-30% in low-gradient streams); substrate frequently disturbed or removed	Less than 20% stable habitat (10% in low-gradient streams); lack of habitat is obvious; substrate unstable or lacking
Score:	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% of the bottom affected by sediment deposition (<20% in low-gradient streams)	Some new increase in bar formation, mostly from gravel, sand, or fine sediment; 5-30% of the bottom affected (20-50% in low-gradient streams)	Moderate deposition of new gravel, sand, or fine sediment on bars; 30-50% of the bottom affected (50 - 80% in low-gradient streams)	Heavy deposits of fine material, increased bar development; more than 50% of the bottom changing frequently (>80% in low-gradient streams)
Score:	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern	Some channelization present, (e.g., bridge abutments); evidence of past channelization (> 20yrs) may be present but recent channelization not present	Channelization may be extensive; embankments or shoring structures present on both banks; 40 to 80% of stream reach disrupted	Banks shored with gabion or cement; Over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely
Score:	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

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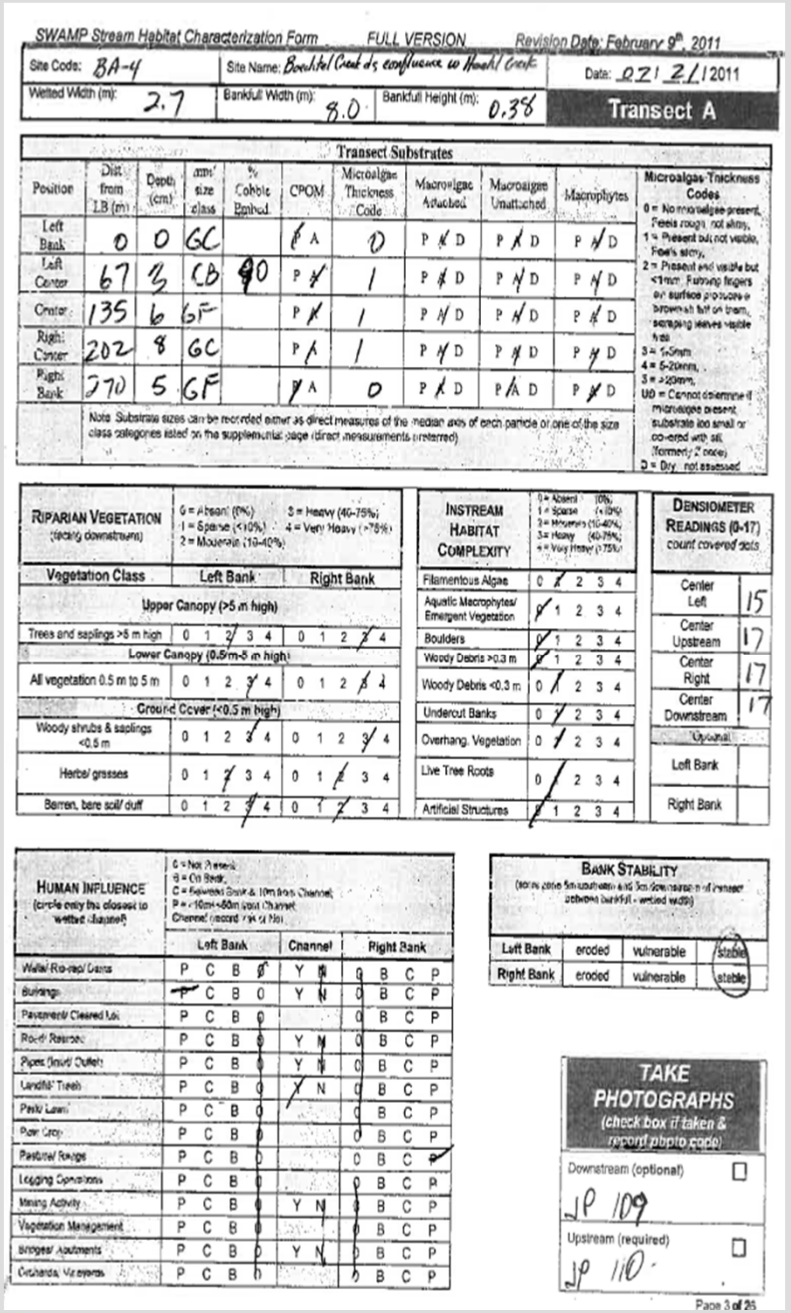
PHAB Results

- Grazing…sediment easily mobilized
- Riparian veg cover varies but generally high
- RBP habitat parameter scores generally low
- “Flashy” regime



SWAMP Stream Habitat Characterization Form — FULL VERSION — Revision Date: February 9th, 2011

Site Code: BA-4 | Site Name: Bouldin Creek d/s confluence w/ Hewitt Creek | Date: 02/21/2011

Wetted Width (m): 2.7 | Bankfull Width (m): 8.0 | Bankfull Height (m): 0.38 | Transect A

Transect Substrates

Position	Dist. from LB (m)	Depth (cm)	Dom size class	% Cobble Embed	CPOM	Microalgae Thickness Code	Macroalgae Attached	Macroalgae Unattached	Macrophytes
Left Bank	0	0	GC		P A	0	P A D	P A D	P A D
Left Center	67	3	CB	90	P A	1	P A D	P A D	P A D
Center	135	6	GF		P A	1	P A D	P A D	P A D
Right Center	202	8	GC		P A	1	P A D	P A D	P A D
Right Bank	270	5	GF		P A	0	P A D	P A D	P A D

Note: Substrate sizes can be recorded either as direct measures of the median axis of each particle or one of the size class categories listed on the supplemental page (direct measurements preferred)

Microalgae Thickness Codes
0 = No microalgae present. Feels rough, not slimy.
1 = Present but not visible. Feels slimy.
2 = Present and visible but <1mm. Running fingers on surface produces a brownish tint on them, scraping leaves visible mat.
3 = 1–5mm
4 = 5–20mm
5 = >20mm
UD = Cannot determine if microalgae present, substrate too small or covered with silt. Formerly Z code.
D = Dry, not assessed

Riparian Vegetation (facing downstream)
0 = Absent (0%) 3 = Heavy (40–75%)
1 = Sparse (<10%) 4 = Very Heavy (>75%)
2 = Moderate (10–40%)

Vegetation Class	Left Bank	Right Bank
Upper Canopy (>5 m high)		
Trees and saplings >5 m high	0 1 2 3 4	0 1 2 3 4
Lower Canopy (0.5m-5 m high)		
All vegetation 0.5 m to 5 m	0 1 2 3 4	0 1 2 3 4
Ground Cover (<0.5 m high)		
Woody shrubs & saplings <0.5 m	0 1 2 3 4	0 1 2 3 4
Herbs/ grasses	0 1 2 3 4	0 1 2 3 4
Barren, bare soil/ duff	0 1 2 3 4	0 1 2 3 4

Instream Habitat Complexity
0 = Absent (0%) 1 = Sparse (<10%) 2 = Moderate (10–40%) 3 = Heavy (40–75%) 4 = Very Heavy (>75%)

Filamentous Algae	0 1 2 3 4
Aquatic Macrophytes/ Emergent Vegetation	0 1 2 3 4
Boulders	0 1 2 3 4
Woody Debris >0.3 m	0 1 2 3 4
Woody Debris <0.3 m	0 1 2 3 4
Undercut Banks	0 1 2 3 4
Overhang. Vegetation	0 1 2 3 4
Live Tree Roots	0 1 2 3 4
Artificial Structures	0 1 2 3 4

Densiometer Readings (0-17) count covered dots

Center Left	15
Center Upstream	17
Center Right	17
Center Downstream	17
Optional	
Left Bank	
Right Bank	

Human Influence (circle only the closest to wetted channel)
0 = Not Present
1 = On Bank
C = Between Bank & 10m from Channel
P = >10m <50m from Channel
Channel (record Y/N if No)

	Left Bank	Channel	Right Bank
Walls/ Rip-rap/ Dams	P C B 0	Y N	0 B C P
Buildings	P C B 0	Y N	0 B C P
Pavement/ Cleared Lot	P C B 0		0 B C P
Roads/ Railroad	P C B 0	Y N	0 B C P
Pipes (Inputs/ Outfalls)	P C B 0	Y N	0 B C P
Landfills/ Trash	P C B 0	Y N	0 B C P
Parks/ Lawns	P C B 0		0 B C P
Row Crops	P C B 0		0 B C P
Pastures/ Range	P C B 0		0 B C P
Logging Operations	P C B 0		0 B C P
Mining Activity	P C B 0	Y N	0 B C P
Vegetation Management	P C B 0		0 B C P
Bridges/ Abutments	P C B 0	Y N	0 B C P
Orchards/ Vineyards	P C B 0		0 B C P

Bank Stability
(stream zone 5m upstream and 5m downstream of transect between bankfull - wetted width)

Left Bank	eroded	vulnerable	stable
Right Bank	eroded	vulnerable	stable

TAKE PHOTOGRAPHS (check box if taken & record photo code)

Downstream (optional) ☐ JP 109

Upstream (required) ☐ JP 110

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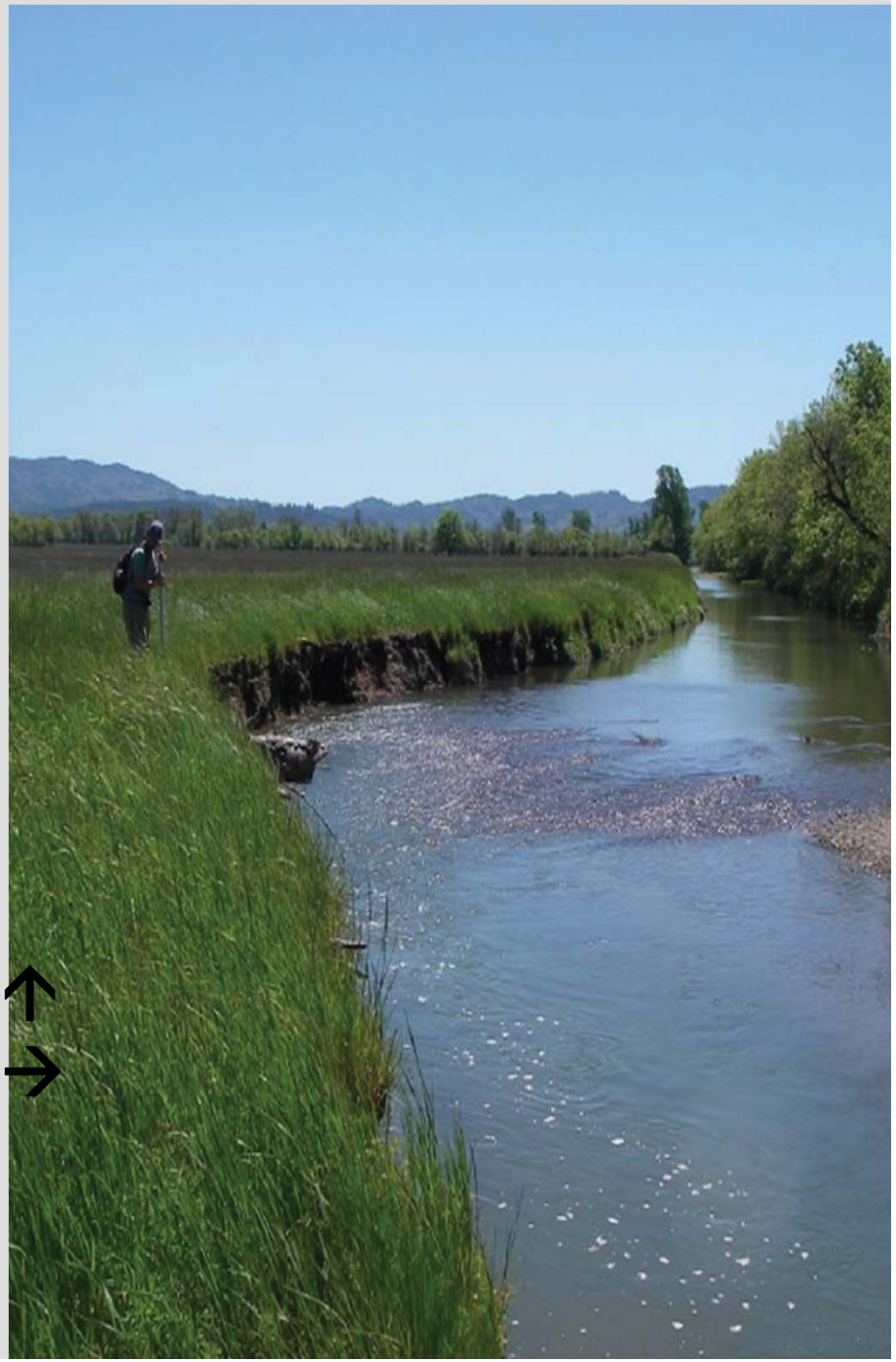

Lower Outlet Creek **2010 ↑**

2012 →

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PHAB Results and Canopy Cover Task

Table 4-6. Comparison of Canopy Cover Solar Pathfinder Results to Bioassessment Sampling Reach Densiometer Results.

Canopy Cover Sub-Reach	Bioassessment Sampling Reach	Reach-Wide (Average) Densiometer Reading (%)	Effective Shade (%)	
			July	August
CC-1	BA-2	82.1	86.79	87.98
CC-2	*(no nearby applicable bioassessment sampling reach for comparison)*			
CC-3	BA-4[a]	87.9	81.99	84.81
CC-4	BA-5	66.0	91.22	90.03
CC-5	BA-6	82.5	82.3	94.1
CC-6	*(no nearby applicable bioassessment sampling reach for comparison)*			
CC-7a	BA-12/BA-13[b]	27.4/32.3	7.83	8.48
CC-7b	*(no nearby applicable bioassessment sampling reach for comparison)*			
CC-8	*(no nearby applicable bioassessment sampling reach for comparison)*			
CC-9	BA-16	89.8	98.74	98.19
CC-10	BA-17	64.2	63.25	60.04
CC-11	BA-18	84.5	86.03	87.06
CC-12	*(no nearby applicable bioassessment sampling reach for comparison)*			
CC-13	*(no nearby applicable bioassessment sampling reach for comparison)*			
CC-14	BA-14	48.6	72.86	74.44
CC-15	BA-15	50.3	67.55	66.09
CC-16	*(no nearby applicable bioassessment sampling reach for comparison)*			
CC-17	*(no nearby applicable bioassessment sampling reach for comparison)*			
CC-18	*(no nearby applicable bioassessment sampling reach for comparison)*			
CC-19	*(no nearby applicable bioassessment sampling reach for comparison)*			
CC-20	BA-19	29.5	41.88	46.17
CC-21	*(no nearby applicable bioassessment sampling reach for comparison)*			
CC-22	BA-20	29.3	60.21	58.79
CC-23a	BA-21[c]	0	0	0
CC-23b	BA-21[c]	0	0	0.05
CC-24a	BA-21[d]	0	0	0
CC-24b	BA-21	0	0	0
CC-25	BA-22	68.9	86.72	82.62
CC-26	*(no nearby applicable bioassessment sampling reach for comparison)*			
CC-27	BA-24	96.5	89.6	88.33
CC-28	*(no nearby applicable bioassessment sampling reach for comparison)*			

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PHAB Results and Canopy Cover Task

- Riparian veg cover varies but generally high (densiometer)
- Riparian veg cover varies but generally high (solar pathfinder)
- **SWAMP WORKS**

Lower Berry Creek

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PHAB Results and Geomorphology Task

- Substrate composition and embeddedness
- Bankfull width and depth
- Slope
- Sinuosity
- **SWAMP WORKS**

Wild Oat Canyon Creek

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Middle Davis Creek

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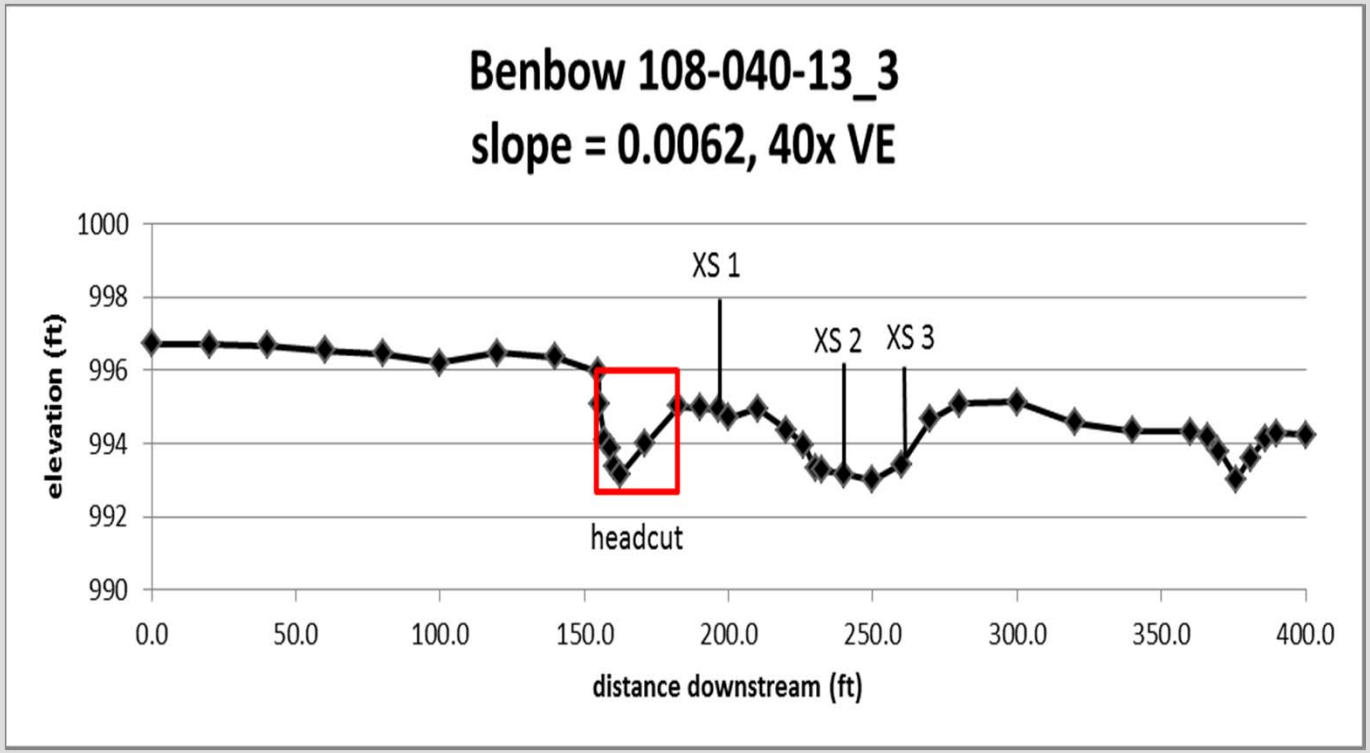

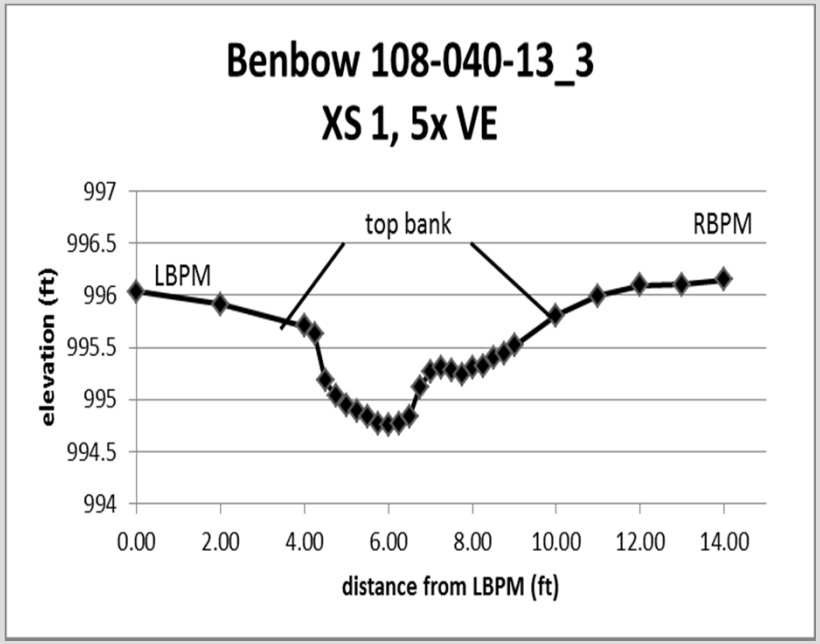

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Methods

- **Field Collections**
  - 23 Reaches on Eight Non-Perennial Streams Surveyed in 2010-2011
    - Spring and Summer Survey Periods
  - SWAMP Protocols – BMI (Ode 2007)
    - Reach Adjustments/Non-Wadeable Habitats
    - PHAB
  - SWAMP Protocols – Algae (Fetscher, *et al* 2010)
- **Laboratory Processing**
  - ECORP Laboratory/EcoAnalysts
- **QA/QC**
  - CDFG – Chico Laboratory

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Methods

- **SWAMP Database Input**
- **Data Analyses**
  - **BMI**
    - **Selection of Appropriate B-IBI(s) – Nor-Cal? / So-Cal?**
    - **Use of Selected Un-Modified Community Metrics**
      (Based on initial summer results)
      - SDI, Simpson Index
      - % Diptera
      - % Oligochaetes
      - Tolerance Indices
      - % Dominant Taxa
      - % Chironomidae
      - Tolerance Value
      - Functional Feeding Groups

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Methods

- **Algae**
  - **Selection of Analysis Tools**
  - **Use of Selected Metrics** (Based on Initial Summer Data Results)
    - Community Composition : Soft Bodied Algae vs. Diatoms
    - Quantitative Diatom Metrics
      - SDI
      - % Dominant Taxa
      - % Pollution Tolerant (Based on Pollution Class)
      - % Motile (Siltation Index)
      - Eutraphentic Species (Based on Trophic Class)
    - Chlorophyll a and AFDM
    - Quantitative Soft-Bodied Algal Collections
    - Qualitative Collections

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Results / Discussion

- **PHAB - BMI - Algae**
- **Reaches and Seasons Surveyed and Evaluated**
  - 23 Reaches in Spring (wet)
  - 16 Reaches in Both Summers (wet)
    - PHAB Data Only Collected at Dry Sites
- **Selected Results for 6 Reaches on 5 Non-Perennial Streams**

Baechtel Creek / Outlet Creek, Old Outlet Creek, Davis Creek, Upp Creek

  - Representative of Range of:
    - Stream Habitats
    - Channel Characteristics / PHAB
    - Potential Sources of Effects on Habitat and Biota
    - Utilization by Anadromous Salmonids

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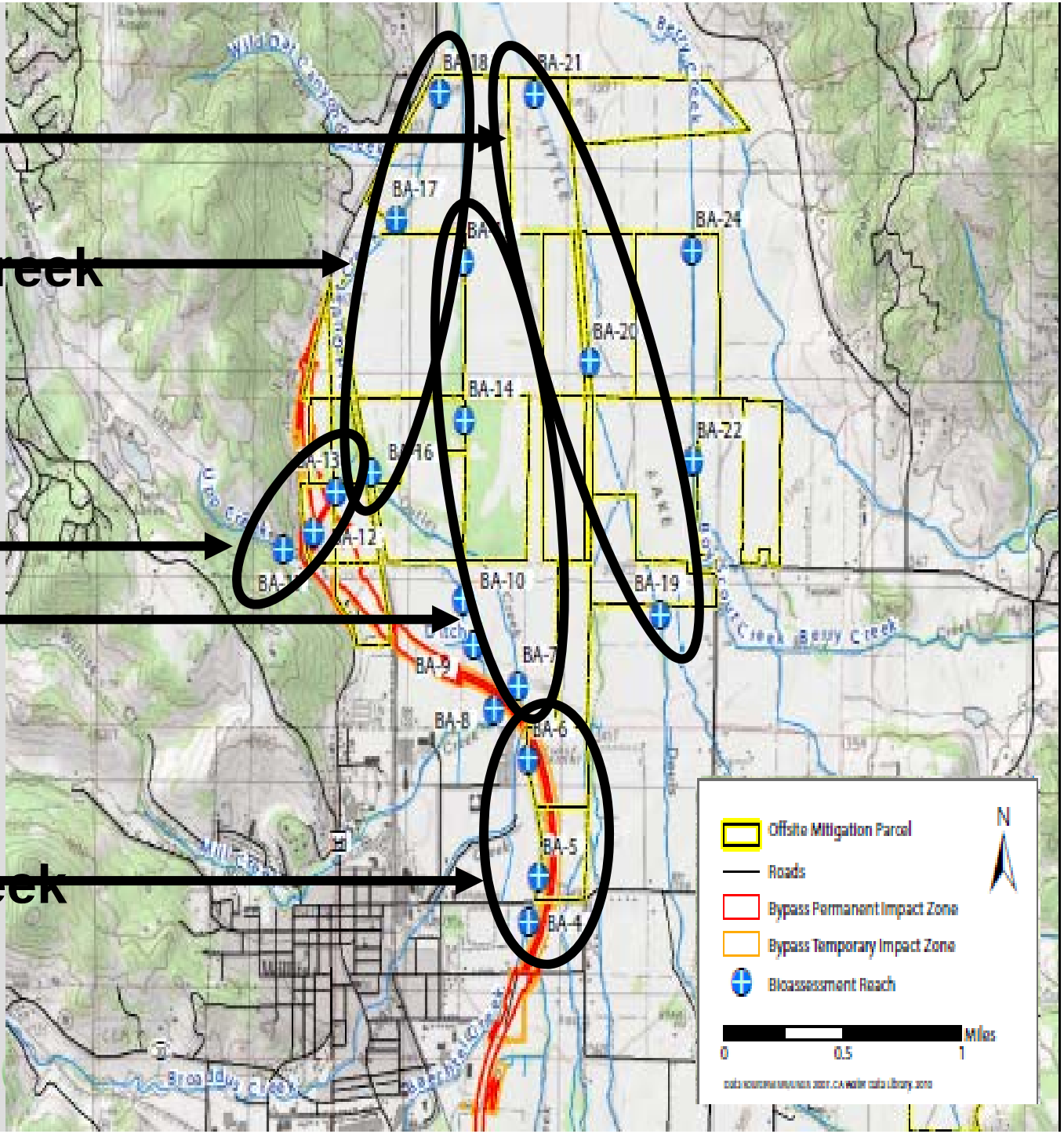
Davis Creek

Old Outlet Creek

Upp Creek

Outlet Creek

Baechtel Creek



Results / Discussion

- **Results Presented by Reach**
  - Comparison of PHAB, BMI, and Algae
  - BMI Data Provided for:
    - B-IBIs
      - Nor-Cal
      - So-Cal
    - Selected Un-Modified Metrics:
      - SDI
      - % Dominant Taxa / % Chironomidae / % Oligochaeta
      - Tolerance Value
      - Tolerance Indices

Results / Discussion

Algal Data Provided for:

- Quantitative Diatoms (metrics based on initial summer sampling results)
  - SDI
  - % Dominant Taxa
  - % Motile / % Eutraphentic
  - % Pollution Tolerant
- Quantitative Soft-Bodied Algae
  - % of community
- Chlorophyll a

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Results / Discussion

Diatoms

- Valuable indicators of stream ecosystem conditions
- Respond quickly and predictably to changes in stream chemistry and habitat quality
- Species' sensitivities and tolerances to environmental conditions are consistently and reliably related to gradients of human disturbances
- Taxonomically diverse and geographically ubiquitous
- Sensitive to substratum conditions and pollutants
- Excellent indicators of water quality conditions, sensitive to:
  - Nutrient and organic enrichment – Nitrogen / Phosphorus
  - Water temperature, conductivity
  - Water velocity
  - Dissolved oxygen, pH, and more

Results / Discussion

- **Baechtel Creek (Reach BA-4)**
  - Migration Corridor for Anadromous Salmonids
  - Adjacent to Horse Pasture, City Corporate Yard

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Baechtel Creek (BA-4)

Habitat / Flow	BMI - Summer	2010	2011	Algae - Summer
Dominant substrates:	Nor-Cal B-IBI	42	48	Diversity: high 2010, moderately low 2011
coarse gravel / sand	So-Cal B-IBI	43	46	Dominant Taxon: *Nitzschia inconspicua* (40%)
Dominant habitat:	Both IBIs in 'Fair Condition'			Motile species: 57%
glide and pool	Dominant Taxa: *Sigara* sp./*Gumaga* sp. (caddisfly) 40%			Eutraphentic species: 80%
Flow: < 0.5 cfs	2010 Low SDI / high Simpson's Index			% Pollution Tolerant species: low
	2011 Higher SDI / increased TR			
	Tolerant Organisms: ~ 25% both summers			

Habitat / Flow	BMI - Spring	2011	Algae - Spring
Dominant substrates:	Nor-Cal B-IBI	58	Diversity: moderately low
coarse gravel / sand	So-Cal B-IBI	59	Dominant Taxa: *Nitzschia* sp. 65%
Flow: 9 cfs	Both IBIs in upper 'Fair Condition'		Motile species: > 90%
	Co-Dominant Taxa:		Eutraphentic species: 50%
	Unidentified stonefly 24% and Unidentified mayfly 14%		% Pollution Tolerant species: low

Results / Discussion

- **Outlet Creek (Reach BA-7)**
  - Migration Corridor for Anadromous Salmonids
  - Adjacent to City of Willits Wastewater Treatment Facility and Outfall

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Outlet Creek (BA-7)

Habitat/Flow	BMI - Summer	2010	2011	Algae - Summer
Dominant substrates:	Nor-Cal B-IBI	30	40	Diversity: High 2010, moderately low 2011
fine / coarse gravel	So-Cal B-IBI	37	43	2010 Dominant Taxa: *Nitzschia* sp.
Dominant habitat:	IBIs 'Poor Condition' 2010, 'Fair Condition' 2011			2010 Motile species: 50%, eutraphentic species 62%
glide and pool	Dominant Taxa:			2011 Dominant Taxon: *Nitzschia inconspicua*
Flow:< 0.5 cfs & 1 cfs	2010 Chironomidae 81%, *Micropsectra* / *Tanytarsus* sp.			2011 Motile species: 60%, eutraphentic species 90%
	2011 Chironomidae 43%, Oligochaeta / *Tanytarsus* sp.			% Pollution Tolerant species: low
	SDI high 2010, decreased value in 2011			

Habitat/Flow	BMI - Spring	2011	Algae - Spring
Dominant substrates:	Nor-Cal B-IBI	41	Diversity: high and fairly evenly distributed
fine / coarse gravel	So-Cal B-IBI	53	Co-Dominant Taxa:
Flow: 13 cfs	IBI in 'Fair Condition'		*Nitzschia inconspicua* & 3 species of *Navicula*
			Motile species: 60%, eutraphentic

Results / Discussion

- **Outlet Creek (Reach BA-14)**
  - Migration Corridor for Anadromous Salmonids
  - Adjacent to Pasture Land/ Cattle Grazing (cattle not excluded from stream)

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Outlet Creek (BA-14)

Habitat/Flow	BMI - Summer	2010	2011	Algae - Summer
Dominant substrates:	Nor-Cal B-IBI	32	19	Diversity: Moderate - high 2010, mod. low 2011
mixed gravel / hardpan	So-Cal B-IBI	37	23	2010 Dominant Taxa:
				~20% non-motile and motile species (2 reps)
Dominant habitat:	IBI in 'Poor Condition'			
	2010 Rep 2 for SoCal IBI in 'Fair Condition'			2010 Motile species: 45%, eutraphentic: 62%
glide and pool				
Flow: < 0.25 cfs - < 1 cfs	Dominant Taxa:			2010 % Pollution Tolerant species: low
				2011 Dominant Taxa: *Nitzschia inconspicua* 33%
	2010 Oligochaeta 33%			
	2010 Chironomidae 42% of community			2011 Motile species: 80%, eutraphentic: 90%
	2011 Chironomidae 54% of community			2011 % Pollution Tolerant species: low
	SDI moderately low in both summers			Chlorophyll a slightly elevated (77 mg/m2)

Habitat/Flow	BMI - Spring	2011	Algae - Spring
Dominant substrates:	Nor-Cal B-IBI	45	Diversity: high and evenly distributed

Results / Discussion

- **Old Outlet Creek (Reach BA-**

  - Salmonids not Observed

  - Adjacent to Pasture Land/ Cattle Grazing (cattle not excluded from stream)

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Old Outlet Creek (BA-18)

Habitat/Flow	BMI - Summer	2010	2011	Algae - Summer
Dominant substrates: sand and fines Dominant habitat: glide and pool Flow: ~ 1 cfs	Nor-Cal B-IBI	24	19	Diversity: High in 2010, moderate in 2011 Co-Dominant Taxa: *Navicula* sp. and *Nitzschia* sp. Motile species: 50%; eutraphentic species: 70% % Pollution Tolerant species: low
	So-Cal B-IBI	29	20	
	IBIs in 'Poor Condition' 2010, 'Very Poor' 2011 Dominant Taxa: 2010 Chironomidae 83%, *Tanytarsus* sp. 2011 Chironomidae 75%, *Tanytarsus* sp. Oligochaeta ~ 15% both summers			

Habitat/Flow	BMI - Spring	2011	Algae - Spring
Dominant substrates: Sand and hardpan Flow: 5 cfs (delayed sampling)	Nor-Cal B-IBI	11	Diversity: Moderate Dominant Taxon: *Nitzschia inconspicua* > 40% Motile species: 77%; eutraphentic species: 83% % Pollution Tolerant species: low
	So-Cal B-IBI	16	
	IBIs in 'Poor Condition' Dominant Taxa:		

Results / Discussion

- **Davis Creek (Reach BA-19)**
  - Migration Corridor for Anadromous Salmonids
  - Within Cattle Ranch (cattle not excluded from stream)

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Davis Creek (BA-19)

Habitat/Flow	BMI - Summer		2010	2011	Algae - Summer
Dominant substrates:		Nor-Cal B-IBI	54	59	Diversity: Moderate to high, relatively even distribution
coarse gravel		So-Cal B-IBI	76	79	2010 Dominant Taxa: *Achnanthes minutissima* 15%
Dominant habitat: glide	IBIs 'Fair Condition' and 'Good Condition'				2010 Motile species : 33%, eutraphentic species: 67%
Flow: < 1 cfs	Dominant Taxa: Chironomidae 47% - 50%				2011 Dominant Taxa: *Rhoicosphenia abbreviata* 27%
	Similar SDI, Simpson's Index				2011 Motile species: 34%, eutraphentic species: 67%
					% Pollution Tolerant species: low both summers

Habitat/Flow	BMI - Spring		2011	Algae - Spring
Dominant substrates:		Nor-Cal B-IBI	63	Diversity: Moderately high
coarse gravel		So-Cal B-IBI	76	Dominant Taxa: *Nitzschia inconspicua* 28%
Flow: ~ 17 cfs	IBIs in 'Good Condition'			Motile species: 55%, eutraphentic species: 55%
	Dominant Taxa: Unidentified			

Results / Discussion

- **Upp Creek (Reach BA-12)**
  - Migration Corridor/Rearing/ Spawning(?) for Anadromou Salmonids
  - Adjacent to Pasture Land/ Cattle and Horse Grazing

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Upp Creek (BA-12)

Habitat/Flow	BMI - Spring 2011		Algae - Spring
Dominant substrates:	Nor-Cal B-IBI	56	Diversity: Moderately low, uneven distribution
coarse/fine gravels and hardpan	So-Cal B-IBI	70	Dominate Taxon: *R. abbreviata* 36%
Dominant habitat:	IBIs in 'Fair Condition' and 'Good Condition'		Motile species: 13%: eutraphentic species: 66%
pool, riffle and glide	Dominant Taxa: Oligochaeta 19%		% Pollution Tolerant species: low
Flow: ~ 2 cfs	Mayfly taxa: 33% of community		Chlorophyll a: low
	Moderate SDI, most balanced community		

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Benthic Macroinvertebrates

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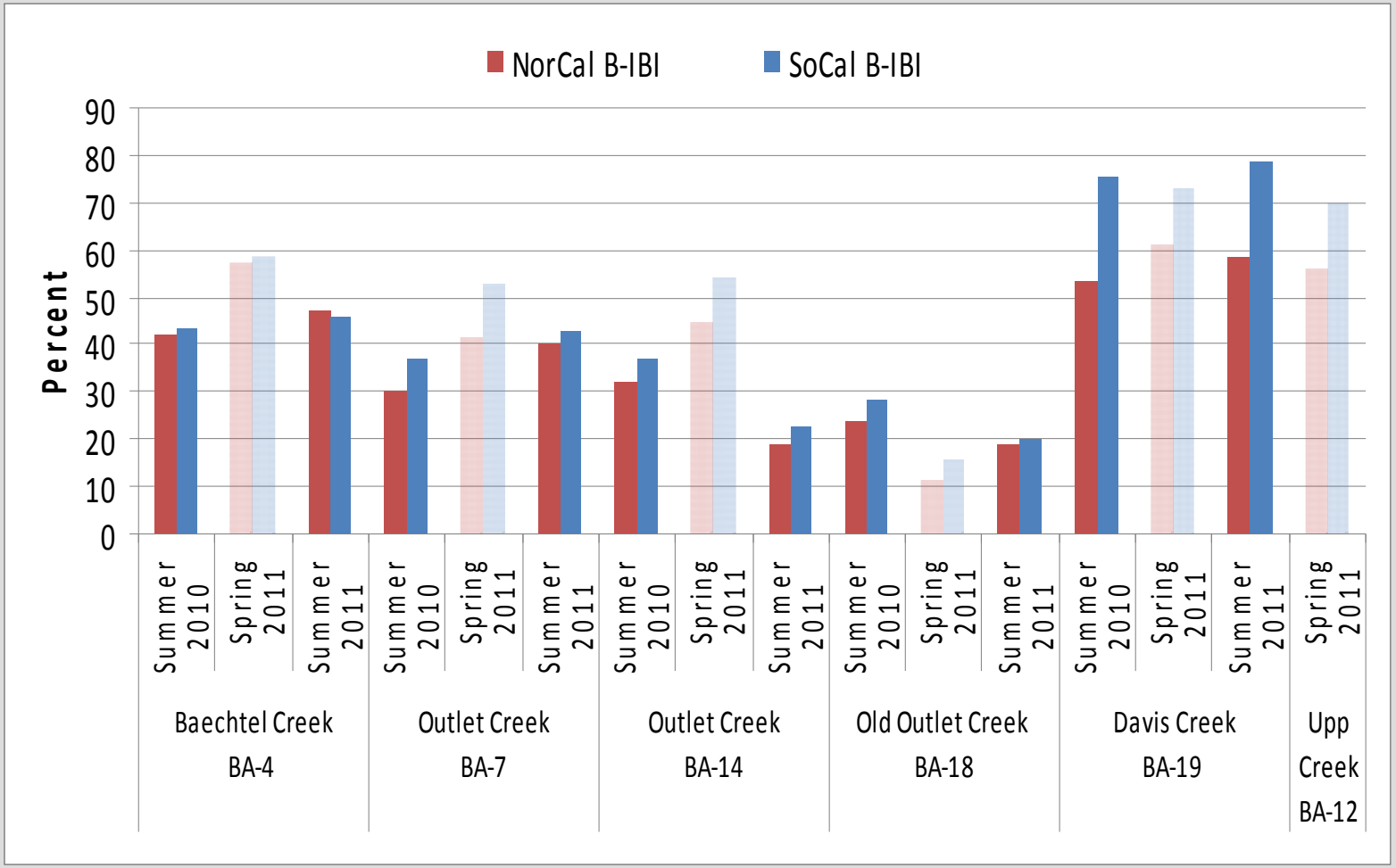
Indices of Biological Integrity



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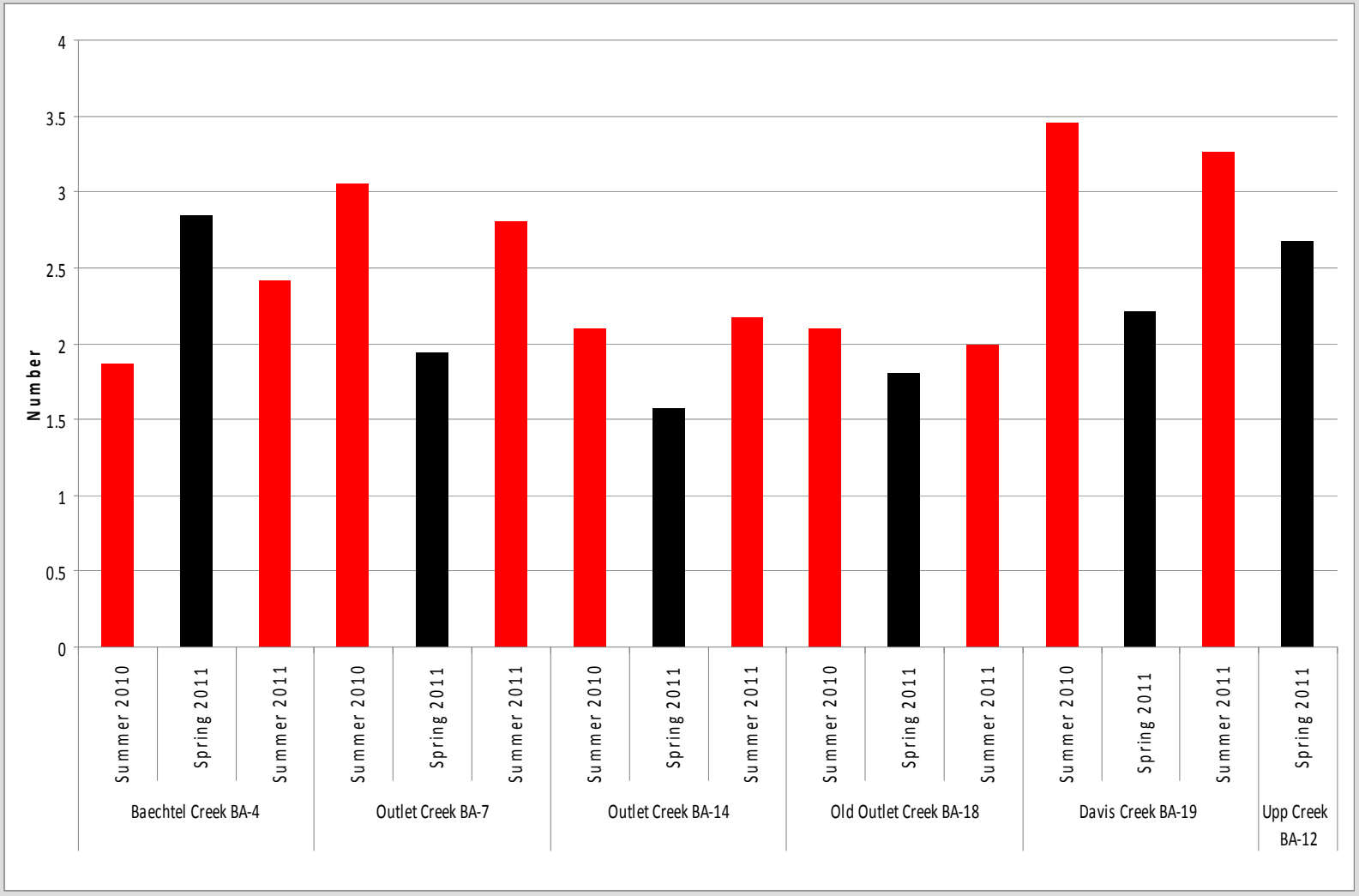
Shannon Diversity Index



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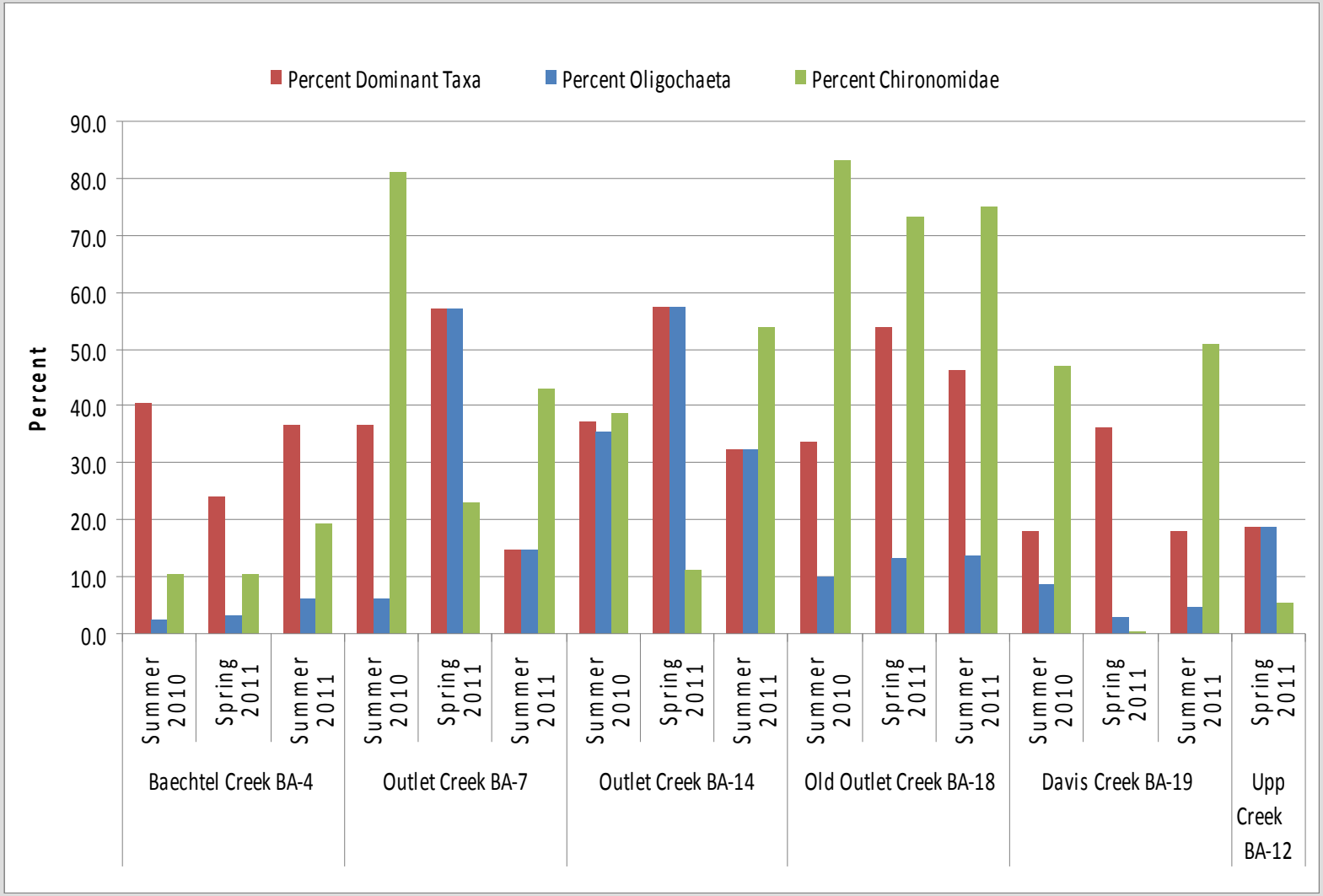
Dominant Taxa, Oligochaeta and Chironomidae



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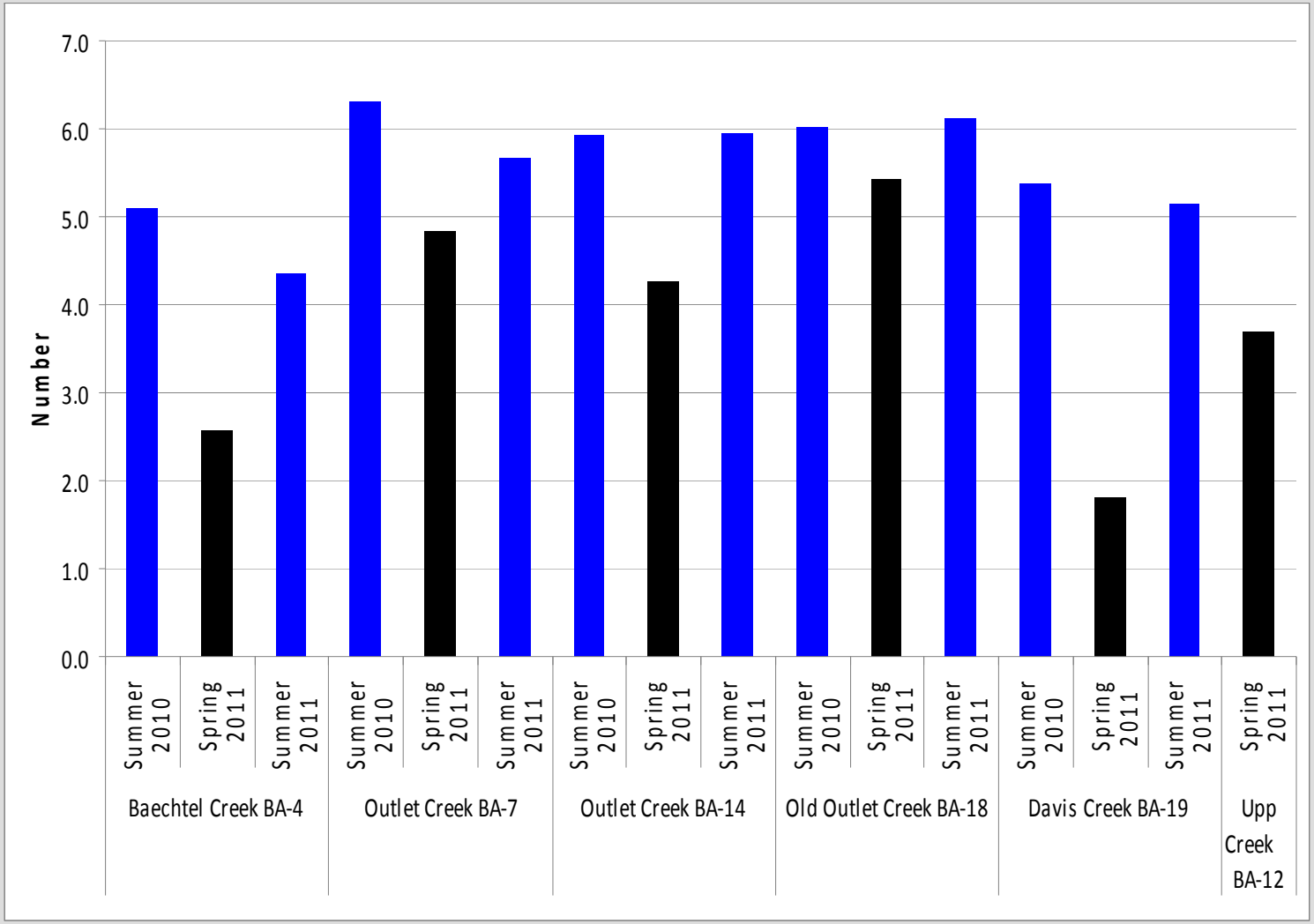
Tolerance Value



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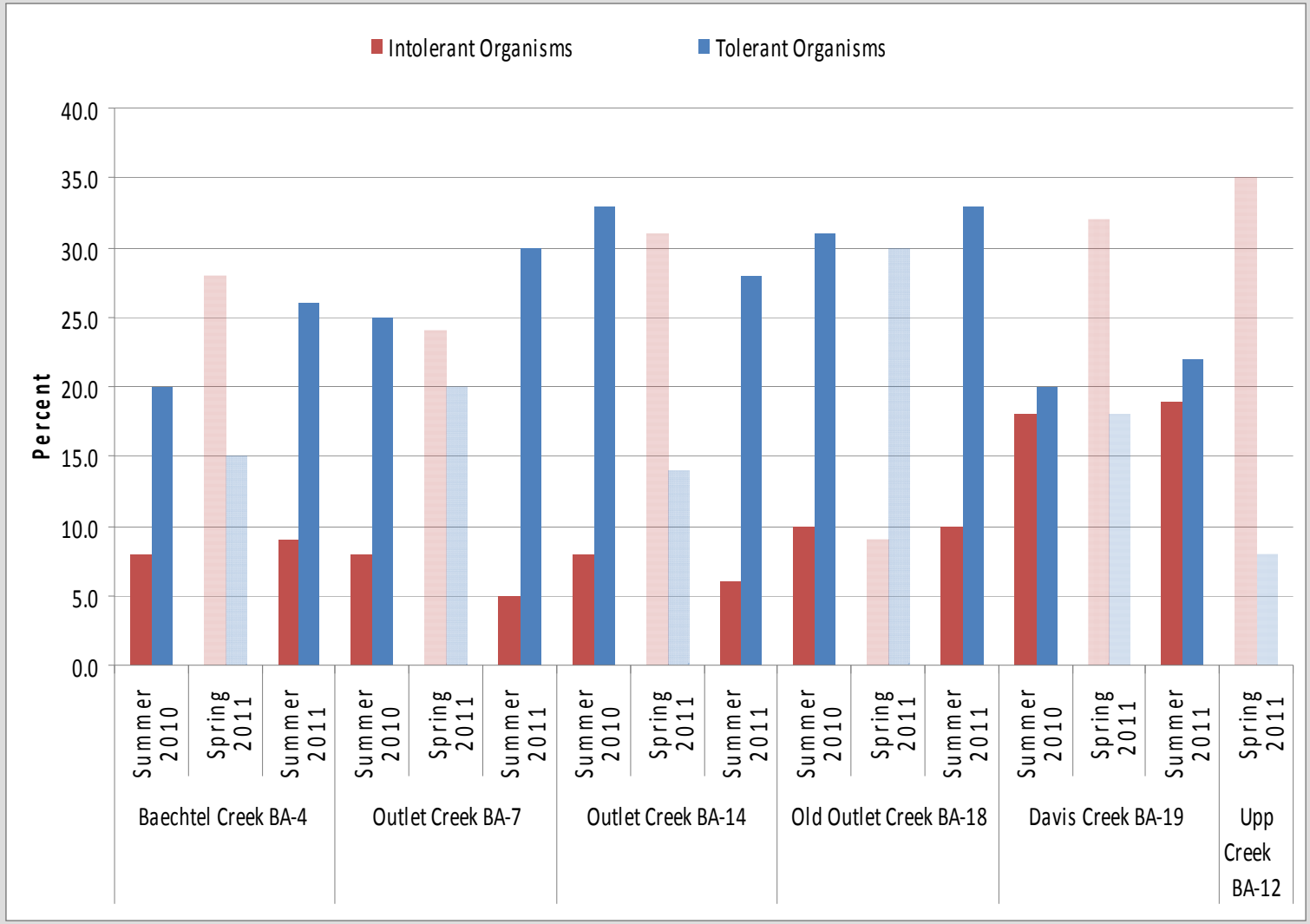
Tolerance Indices



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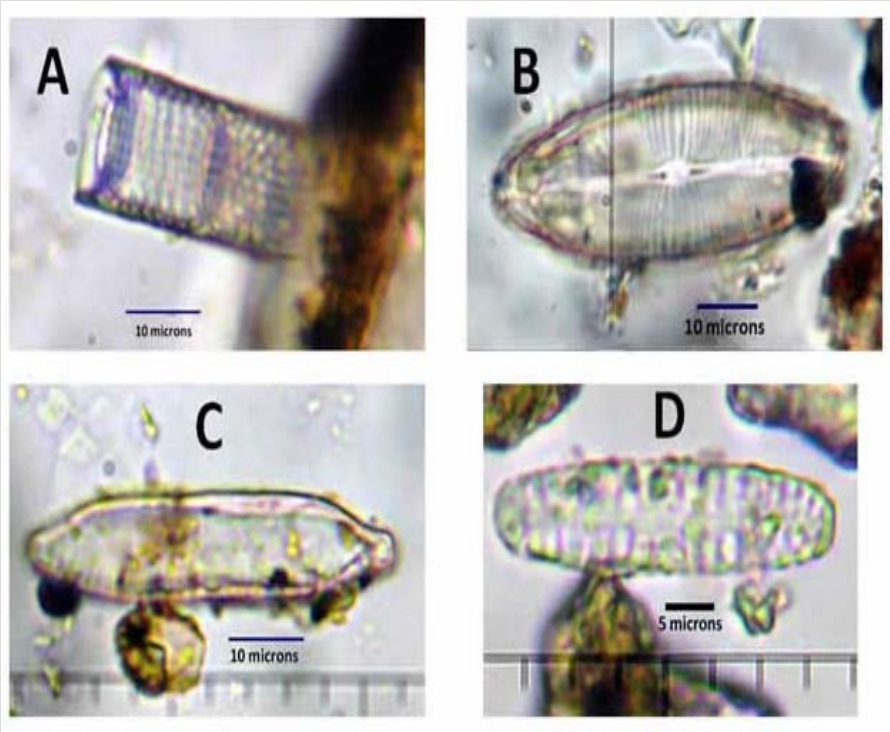
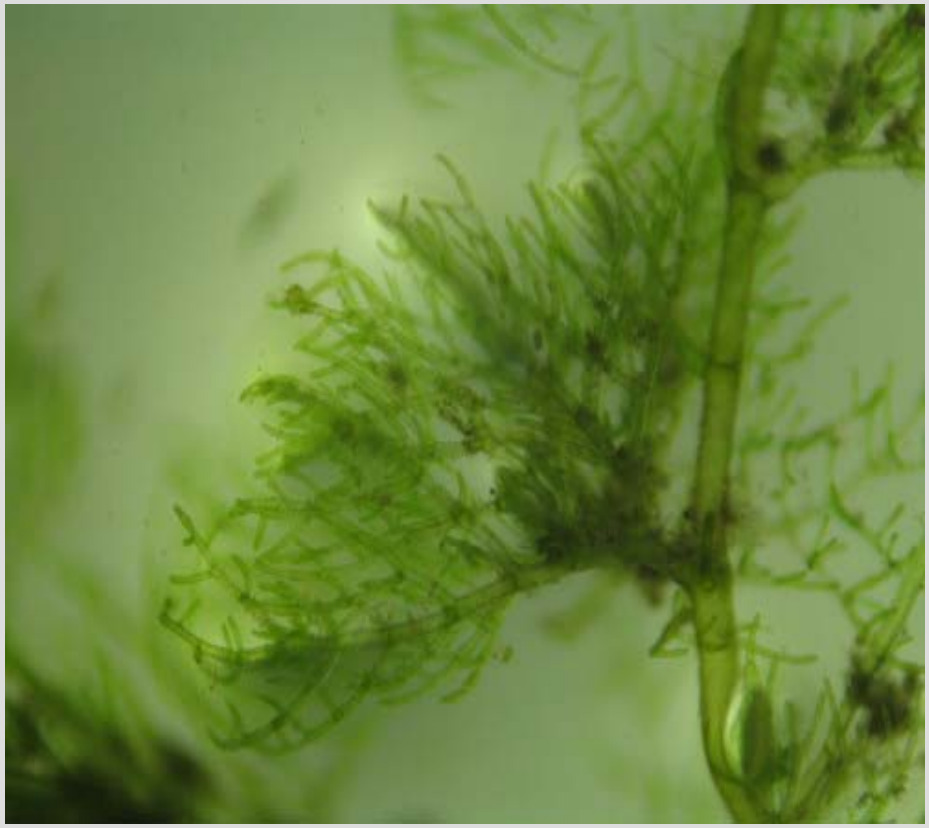
Freshwater Algae

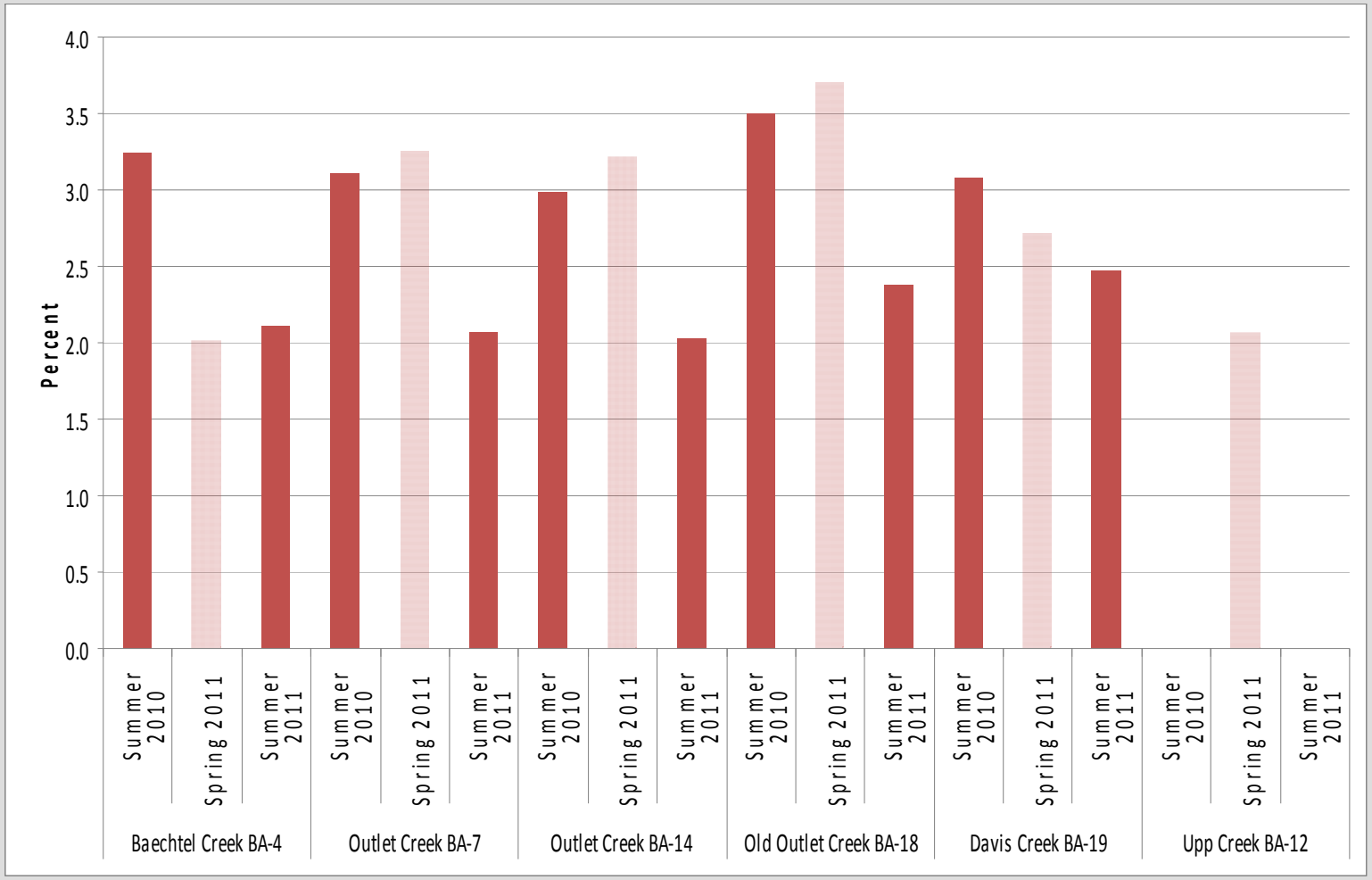


A. Aulacoseira; B. Navicula; C. Nitzschia; and D. Rossithidium



Diatom Shannon Diversity Index*

* **Based on 600 count**



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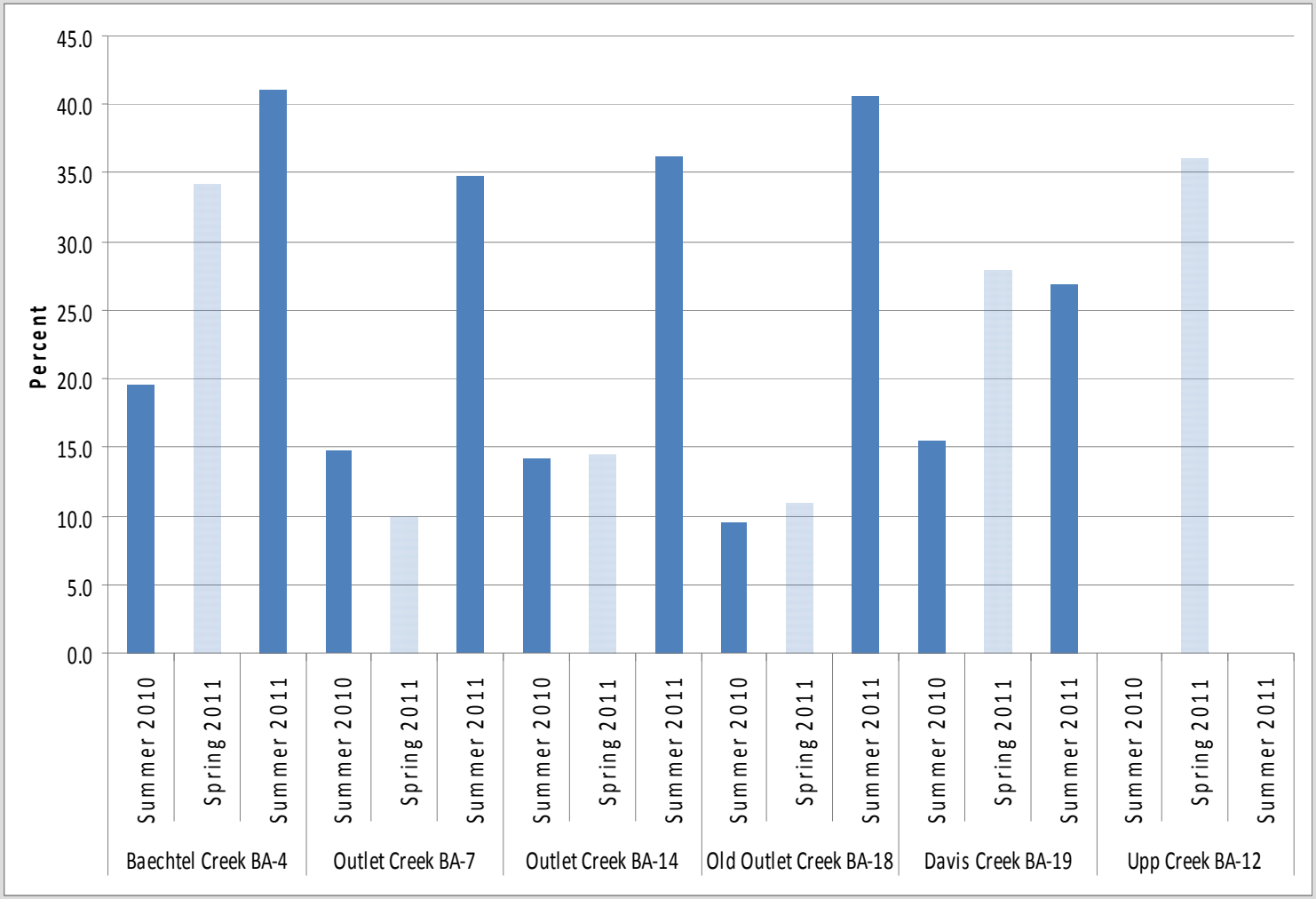
Diatom Percent Dominant Taxon*

* Based on 600 count



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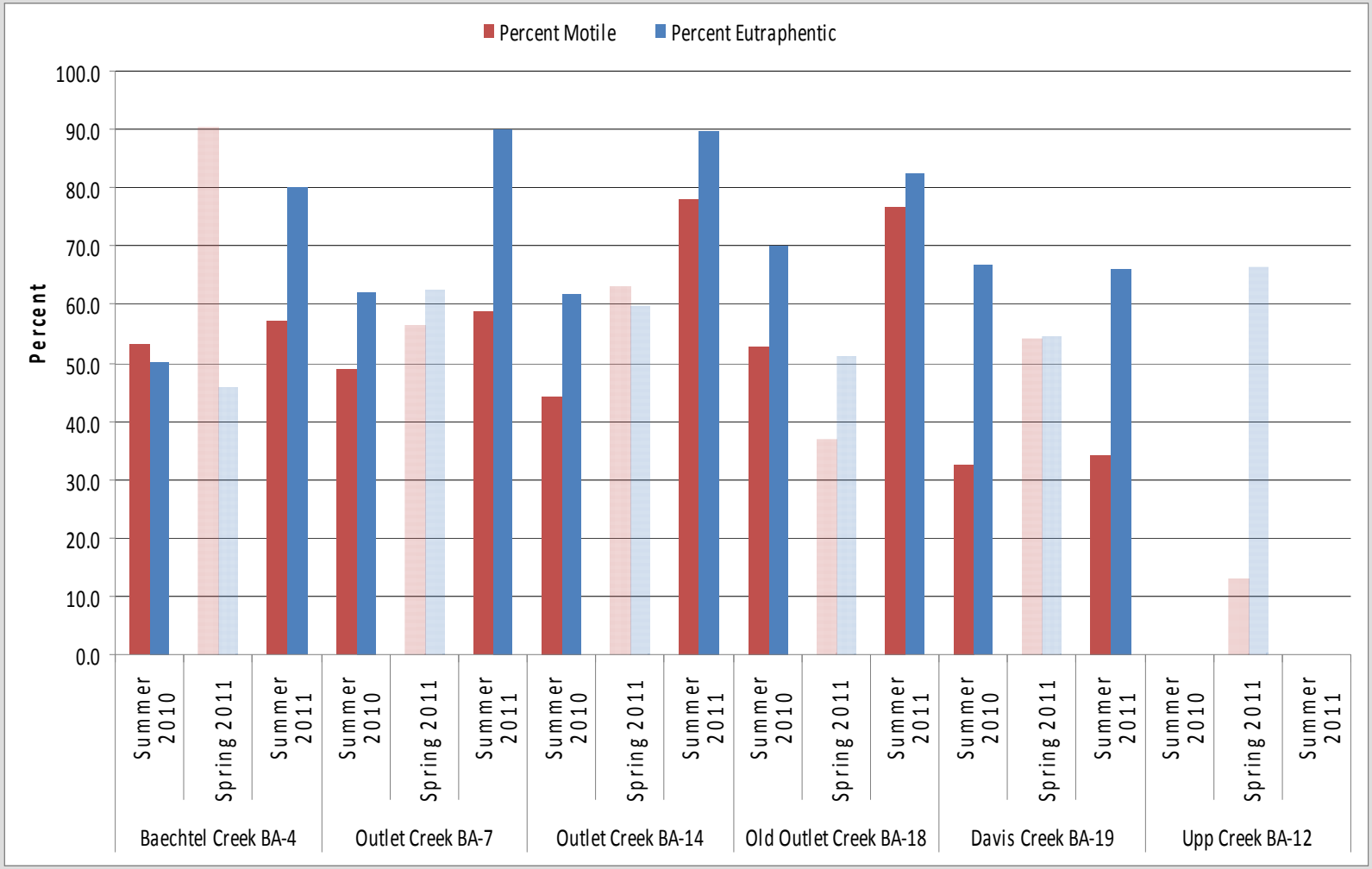
Percent Motile and Percent Eutraphentic Diatoms*

* Based on 600 count



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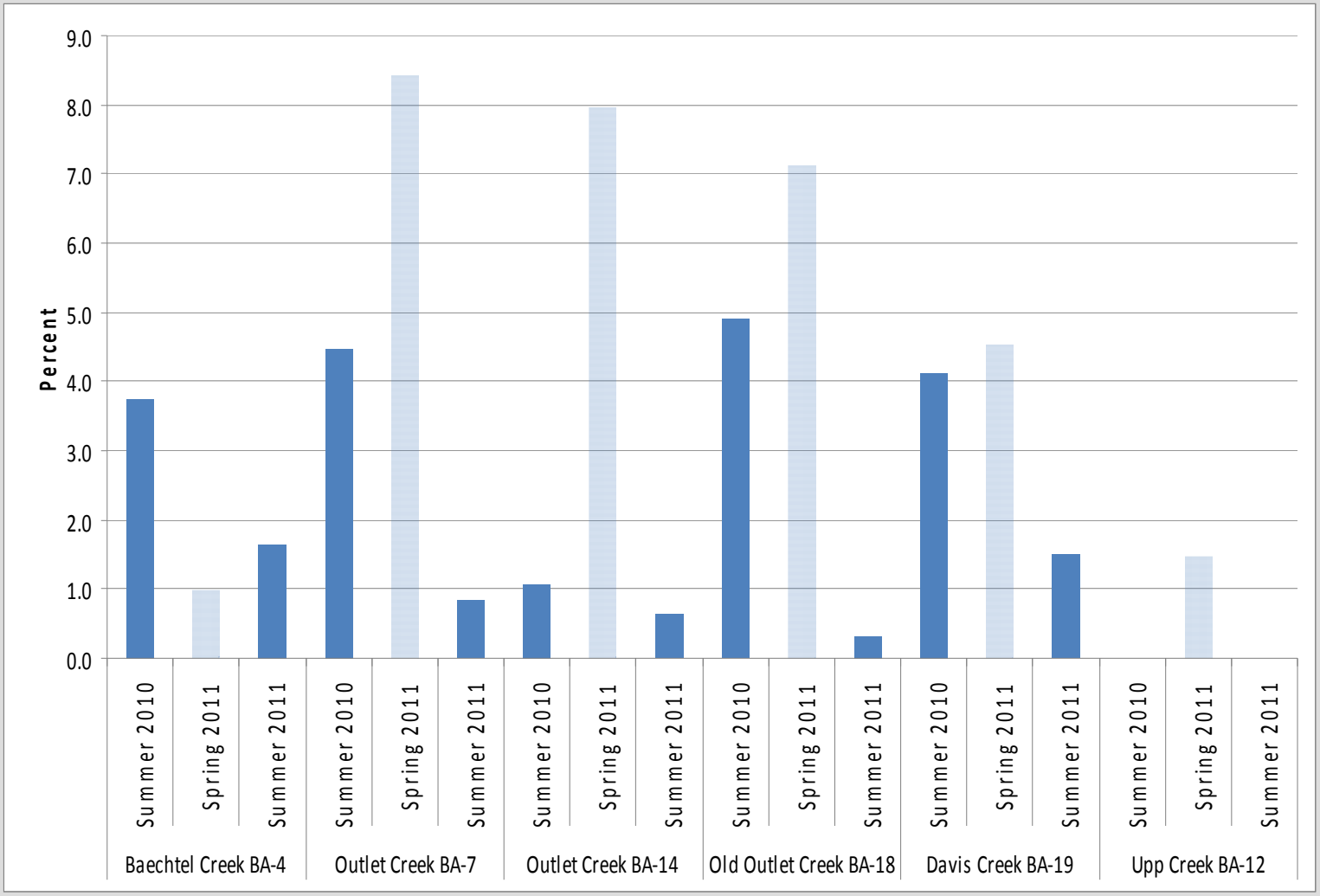
Percent Pollution Tolerant Diatoms*

* Based on 600 count



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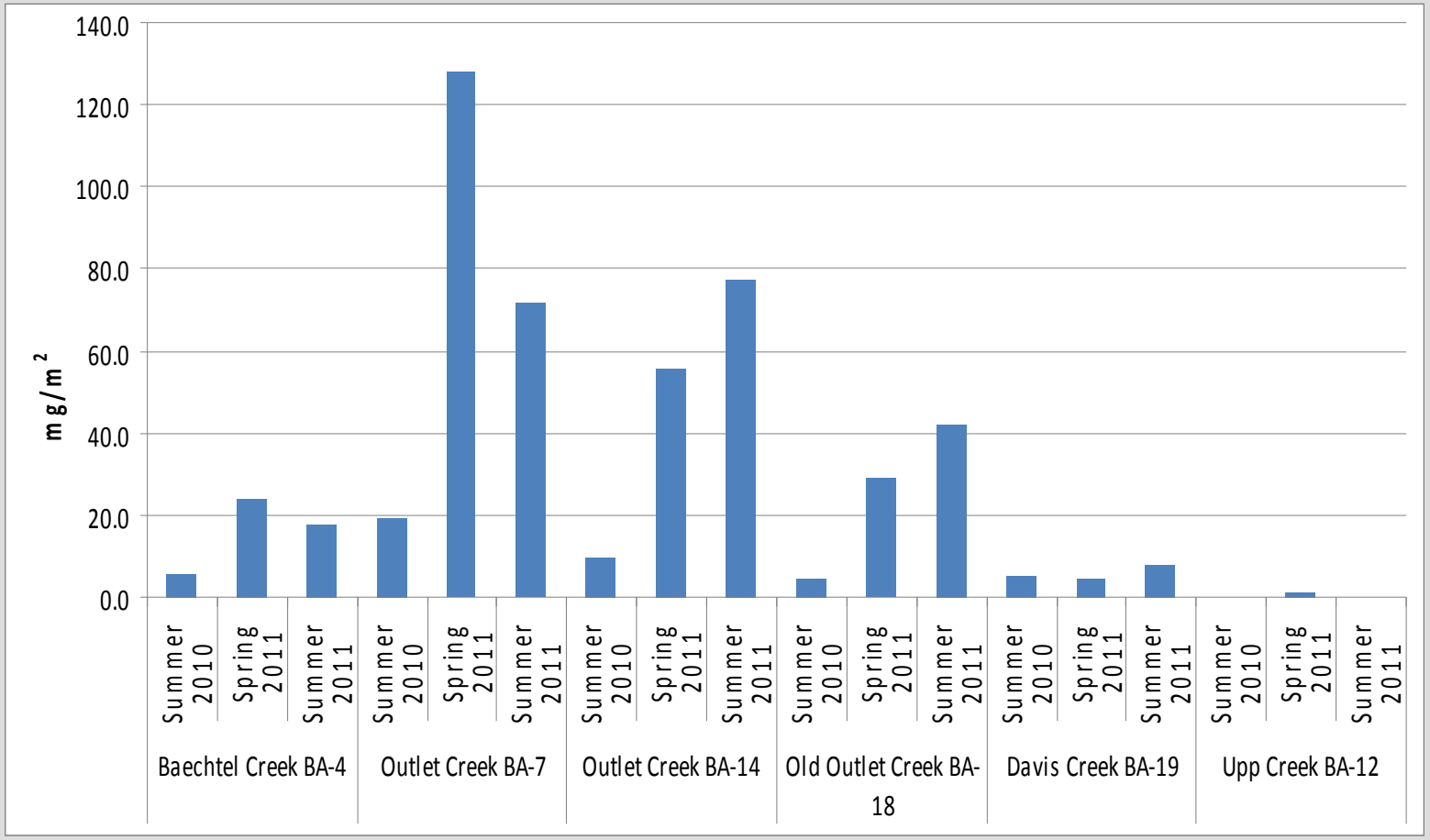
Chlorophyll a values*

*< 75 mg/m2 = unenriched (Lohman, et. al., 1992)

>100 mg/m2 = moderately enriched (Tetra Tech, 2006)

>150 mg/m2 = highly enriched



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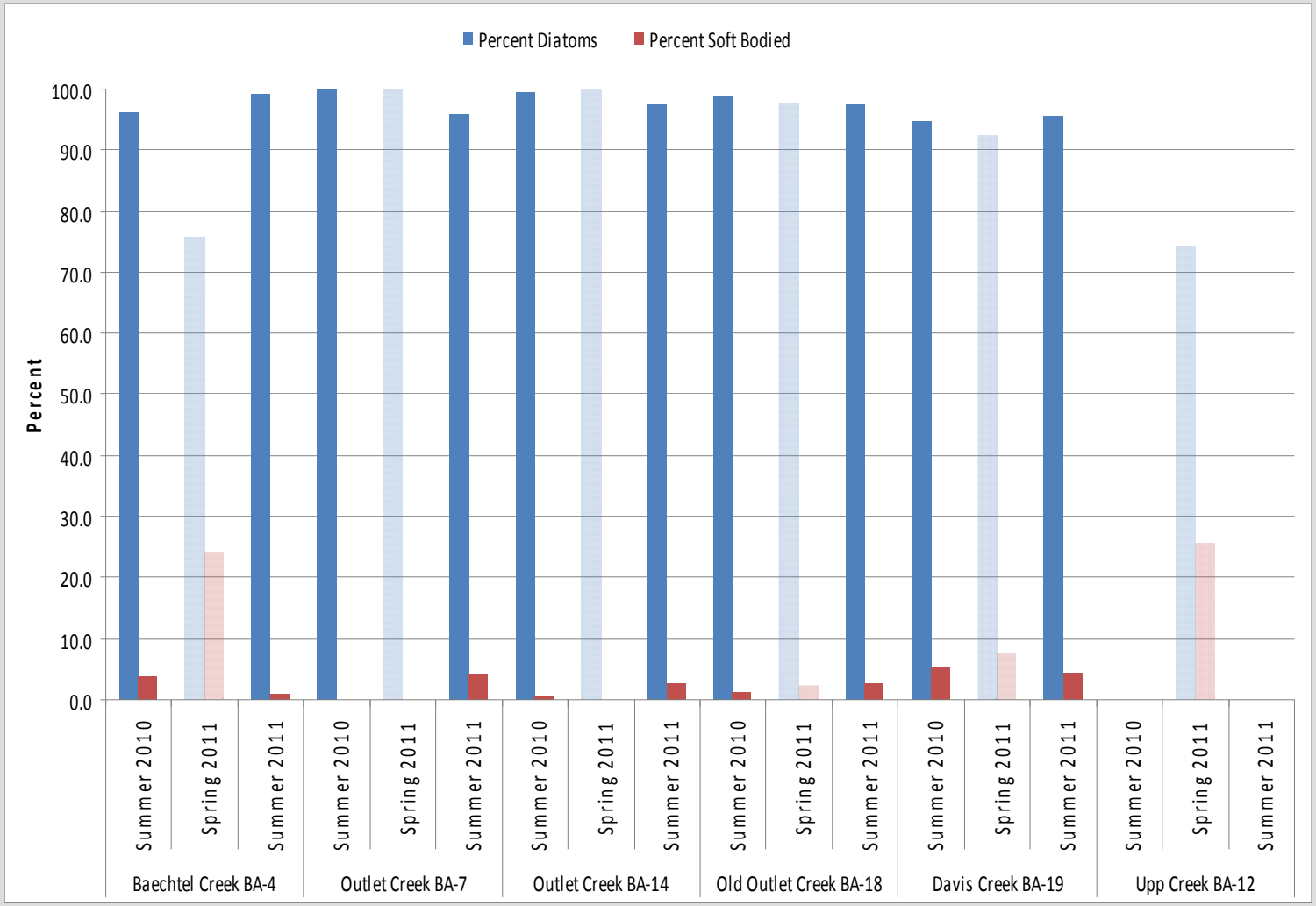
Quantitative Soft-Bodied Algae Sample Results*

* Based on 300 count



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Summary

- During summer, substrate composition, streamflow pattern, and nutrient input were the primary characteristics influencing benthic communities
  - Substrates composed primarily of fine gravel, sand, fines
- Higher summer 2011 flows = improved community metrics relative to summer 2010, except for reaches with active grazing
- BMI
  - So-Cal B-IBI appeared to better represent seasonal benthic communities: inclusion of non-perennial streams, Percent Tolerant Taxa metric (high at most reaches)
  - Nor-Cal and So-Cal B-IBIs more similar at reaches with singular habitat type (pool / glide), increased flows, low-velocities
  - Un-modified metrics provided additional information relative to community composition not reflected in the IBIs, non-distinct taxa excluded

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Summary

- Algae (summer)
- Diatoms dominated most communities
  - Most reaches dominated by tolerant taxa adapted to unfavorable conditions
  - Reaches with easily mobilized substrates dominated by motile diatom genera
    - Associated with degraded stream conditions & poor water quality
  - Reaches with coarser substrates had higher % of non-motile taxa
  - Reaches with nutrient input (livestock grazing, wastewater treatment facility outfall) = high % of eutraphentic diatoms
  - Pollution Tolerant species present at many reaches – generally lower % in summer
  - Soft-bodied algae – low TR, low #s – species tolerant of degraded conditions
  - Chlorophyll a values generally highest at most reaches during summer 2011 likely associated with increased nutrient input during spring runoff

Summary

- During spring, increased streamflow (relative to both summers), substrate mobility, and water quality - appear to be the primary characteristics influencing benthic communities
- BMI
  - Both B-IBI values generally improved
  - Substantial increases in Percent Intolerant Organisms
  - Percent Tolerant Organisms generally decreased
  - SDI values at reaches downstream of nutrient input areas were lower than summer values
  - Chironomids decreased / oligochaetes increased at most reaches
  - Un-modified metrics provided additional information relative to community composition not reflected in B-IBIs

Summary

- Algae (spring)
  - Diatoms dominated communities at all reaches
  - Percent Motile species variable, lowest values recorded at some reaches
  - Percent Dominant Taxa values variable relative to summer
  - Percent eutraphentic diatoms generally elevated at most reaches
  - Highest Chlorophyll a values recorded at most reaches, some values elevated
  - Soft-bodied algae more numerous, Taxa Richness similar to summer

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