Klamath River, Oregon and California, Bioassessment Studies in Relation to Hydropower Relicensing.

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Macroinvertebrate Studies
Klamath Hydroelectric Project
Fall 2002, Spring 2003 Studies

- Stream and macroinvertebrate (MI) and bivalve sampling for over 80 miles of the Klamath River to assess:
  - MI composition and condition
  - relation to water quality/flow/habitat conditions
    - Dams, peaking operations.
  - presence of T/E/S species
  - food resource quality/quantity
  - baseline bivalve distribution, abundance, and diversity.

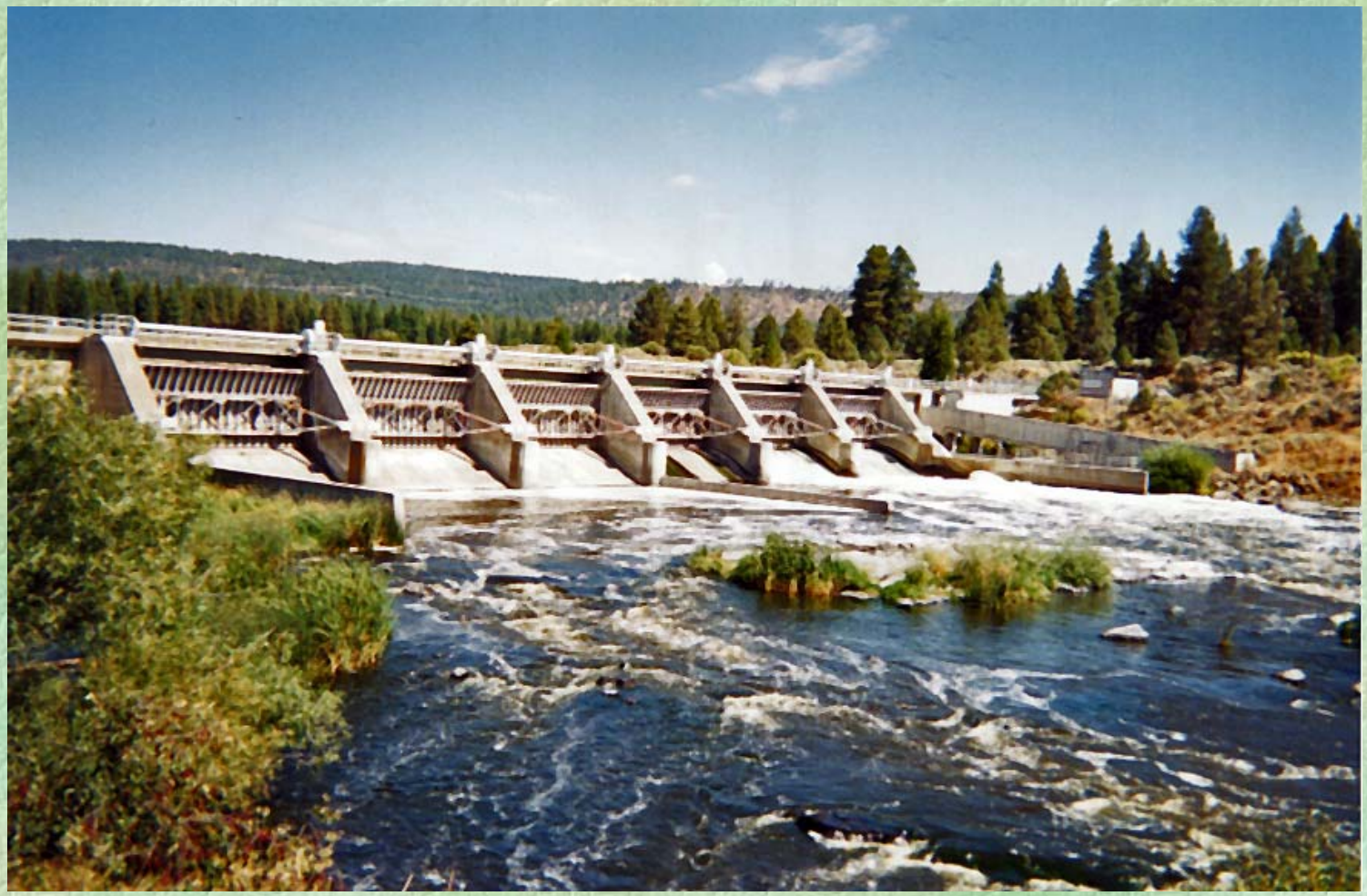
Study Areas Sampled

Area	Reaches	Sampling	
		Fall 2002	Spring 2003
Link River	2	X	
Keno Dam to J.C. Boyle Reservoir	2	X	X
J.C. Boyle Bypass Reach	3	X	X
J.C. Boyle Full Flow (or Peaking) Reach	6	X	X
Copco 2 Bypass Reach	2	X	
Fall Creek	6	X	
Klamath River Between Iron Gate Dam and the Shasta River	6	X	X
Total	**27**		**17**

Macroinvertebrate and Bivalve Sampling Program.

- Fall 2002 sampling of MI species throughout system, including reservoirs.
- Spring 2003 sampling of MI species on mainstem river.
- Summer 2003 sampling of bivalves in Keno reach, Boyle fullflow, and reach below Irongate.

Klamath Falls, Keno Dam
Keno reach: (boulder, cobble)



Below Boyle Reservoir; RBP Methodology “Challenge” for the Peaking Reach

Klamath River near I-5
Below Irongate Res.: boulder/cobble/sand

Additional Sampling: J.C. Boyle Peaking Reach

- Varial (daily-drying) zone: 4 composite samples at 4 transects (during high flow)
- Drift samples (16)
  - 3 zones in channel: mid-channel, low-flow margin, high-flow margin
  - various flows: steady low, up-ramp, steady high, down-ramp
- Bivalve study reach

Drift nets at low flow
Peaking reach

Sampling Methods

- California Stream Bioassessment Procedures (CSBP) for wadeable streams, riffles, modified for local conditions.
- “Standard” field protocols for bivalve surveys.

Analysis Methods

- California Bioassessment Lab methods
- Data Analysis: Metrics per CSBP/CLBP and ODEQ/SWRCB input

Example Metrics: Structure/Community balance/FFGs

- Taxa richness = # of species.
- Invertebrate density (#/m^2)
- EPT = Mayfly (E), stonefly (P), and caddisfly (T) species (generally indicative of clean water conditions).
- % Dominance = Dominant species as % of total.
- % Tolerance = Tolerant species as % of total
- Shannon Diversity Index = Incorporates richness and #
- Hilsenhoff Biotic Index = Weights species abundances by individual tolerance values.

Example Metrics (con.)

- Functional feeding groups = Abundance of “guilds” of species such as grazers, collectors, filterers, predators, etc…
- Tolerance Values, % tolerant, % intolerant
- % long-lived taxa

“Standard” RBP kick net sampling

Difficult Sampling in many areas

Klamath River, middle and lower reaches.

Bivalve Surveys:
Applying “Cutting Edge” Technology to Bioassessment.

(Bed area, sizes, counts, density estimates)
Using view buckets and snorkeling

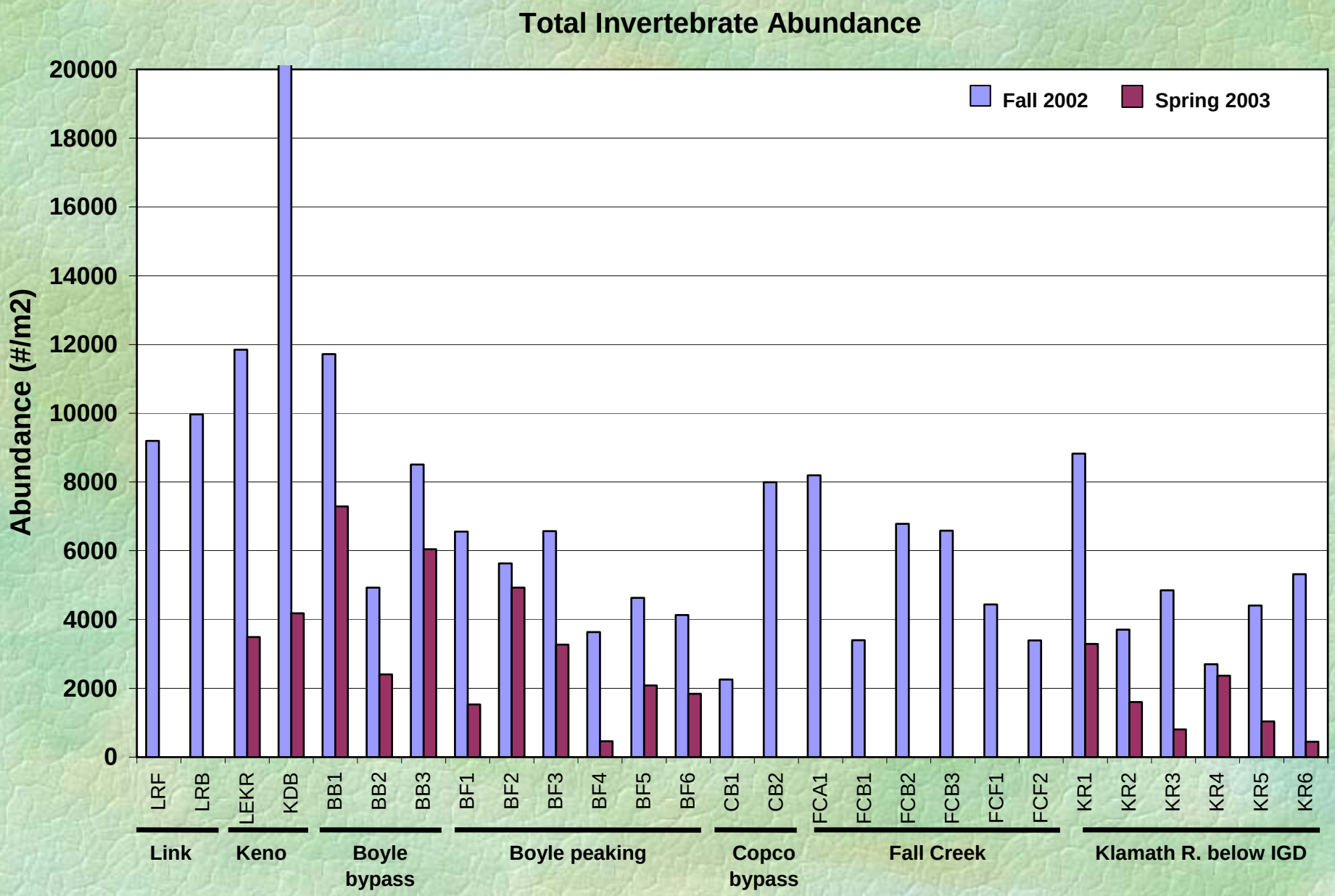
Klamath River Study Area
Dominant Macroinvertebrate Taxa

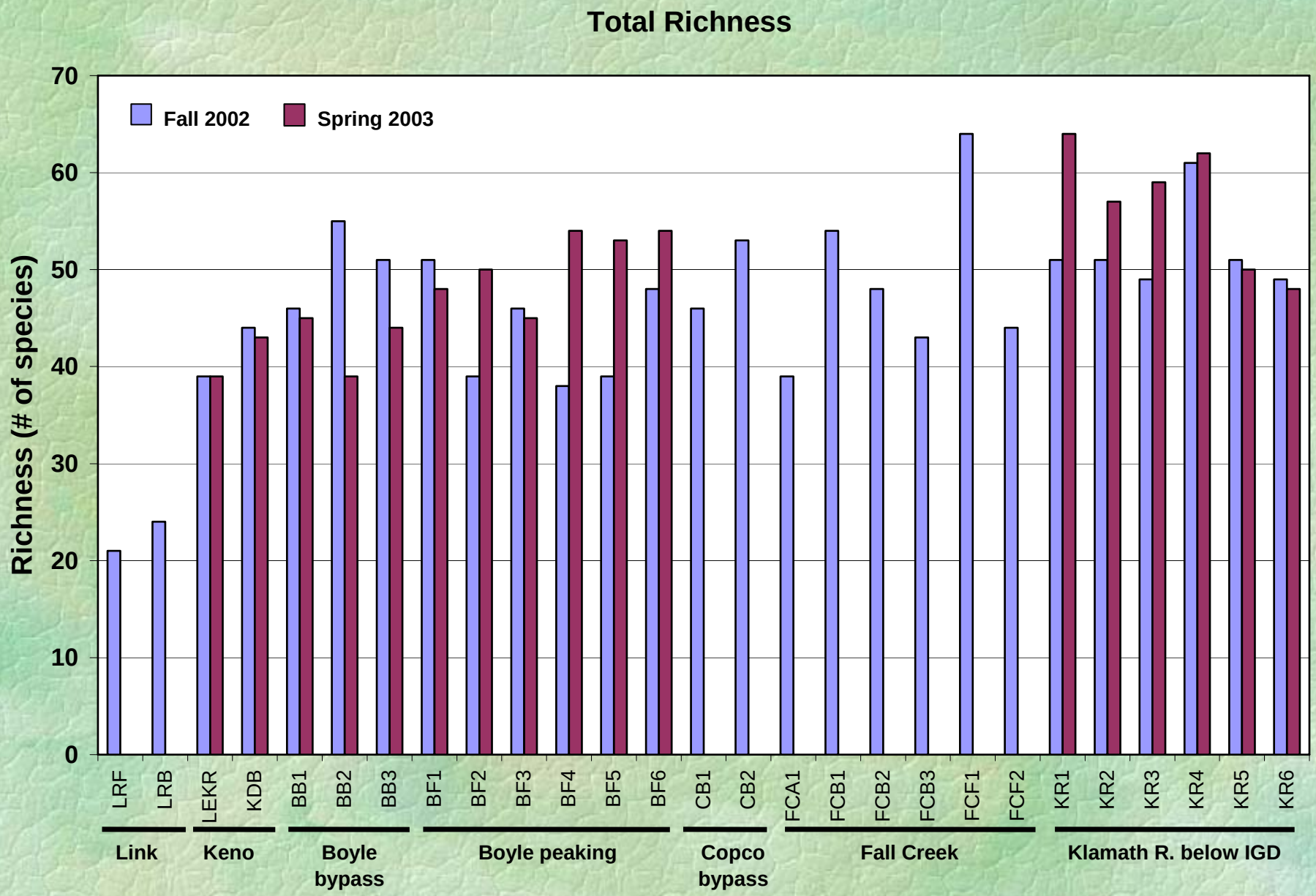
- Keno Reach:
  - Fall 2002 -*Hydropsyche sp*.(caddis), *Cricotopus sp*. (midge)
  - Spring 2003 - *Baetis tricaudatus* (mayfly), *Simulium sp*. (blackfly), *Hydropsyche sp*.(caddis)
- Boyle bypass reach:
  - Fall 2002 - *Simulium sp*. (blackfly), *Hydroptila sp*. (caddis), *Amiocentrus aspilus* (caddis)
  - Spring 2003 - *Baetis tricaudatus* (mayfly), *Simulium sp*. (blackfly), *Amiocentrus aspilus* (stonefly)

Klamath River Study Area
Dominant Macroinvertebrate Taxa

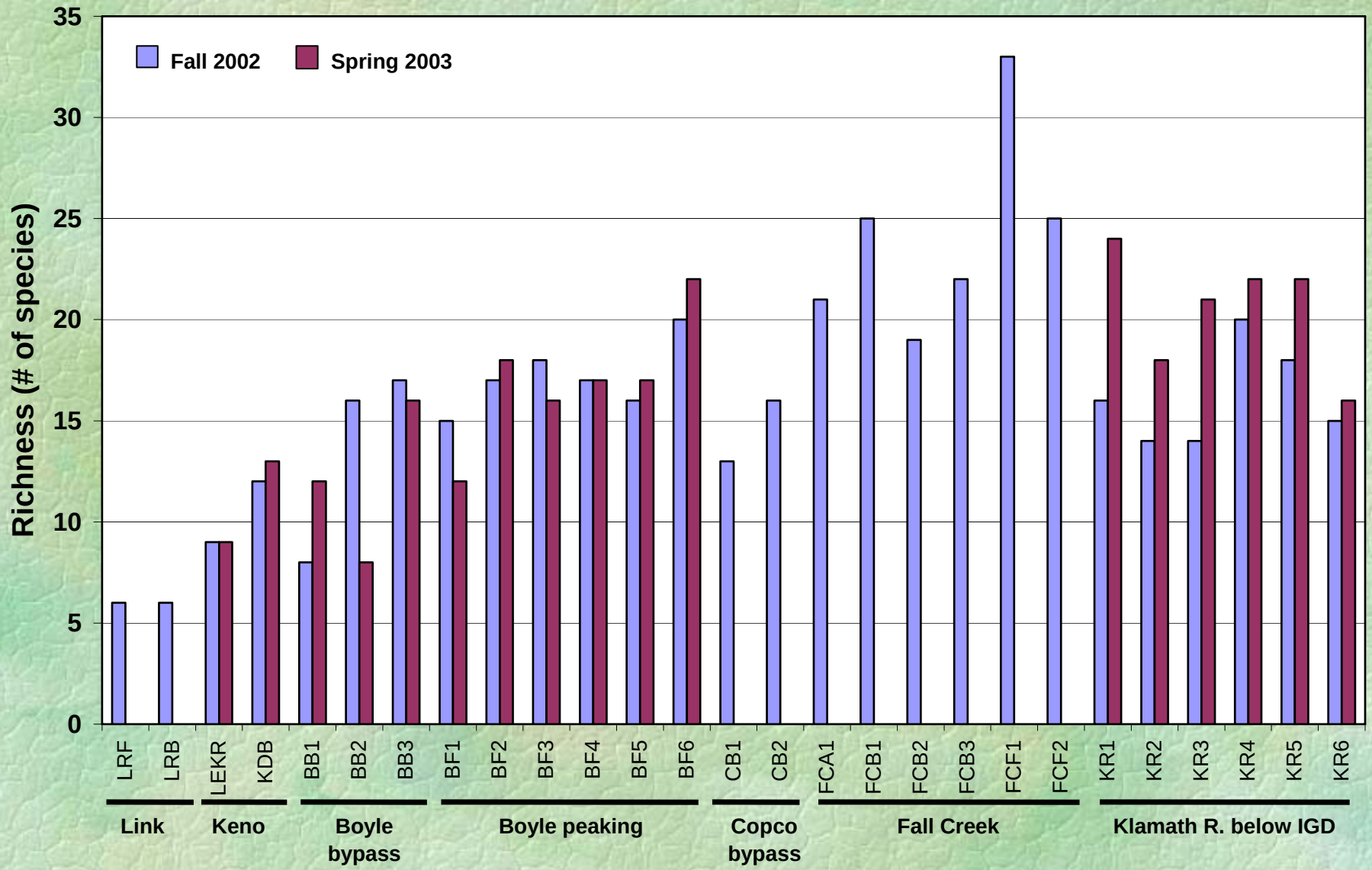
- Boyle peaking reach:
  - Fall 2002 - *Hydropsyche sp.*(caddis), *Acentrella sp.* (mayfly), *Zaitzevia sp.* (beetle)
  - Spring 2003 - *Epeorus albertae* (mayfly), *Acentrella sp.* (mayfly), *Orthocladius* (midge)
- KR below Iron Gate:
  - Fall 2002 - *Simulium sp.* (blackfly), *Zaitzevia sp.* (beetle), *Rheotanytarsus sp.* (midge), *Acentrella sp.* (mayfly)
  - Spring 2003 - *Baetis tricaudatus* (mayfly), *Simulium sp.* (blackfly), *Acentrella sp.* (mayfly), *Hydropsyche sp.*(caddis)

The River Continuum revealed….

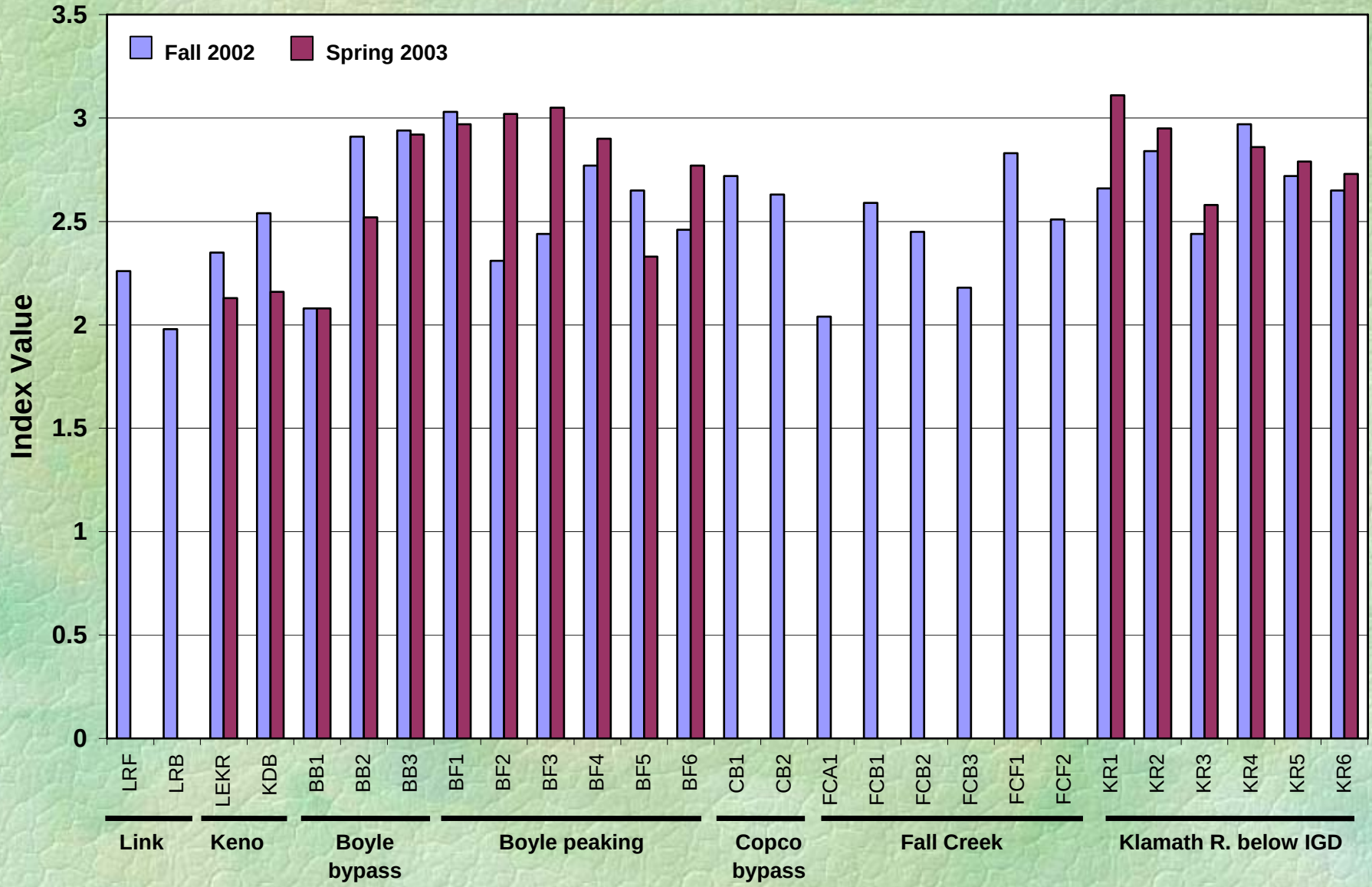



Total Richness
Fall 2002
Spring 2003
Richness (# of species)
70
60
50
40
30
20
10
0
LRF
LRB
LEKR
KDB
BB1
BB2
BB3
BF1
BF2
BF3
BF4
BF5
BF6
CB1
CB2
FCA1
FCB1
FCB2
FCB3
FCF1
FCF2
KR1
KR2
KR3
KR4
KR5
KR6
Link
Keno
Boyle bypass
Boyle peaking
Copco bypass
Fall Creek
Klamath R. below IGD

EPT Richness



Shannon Diversity Index



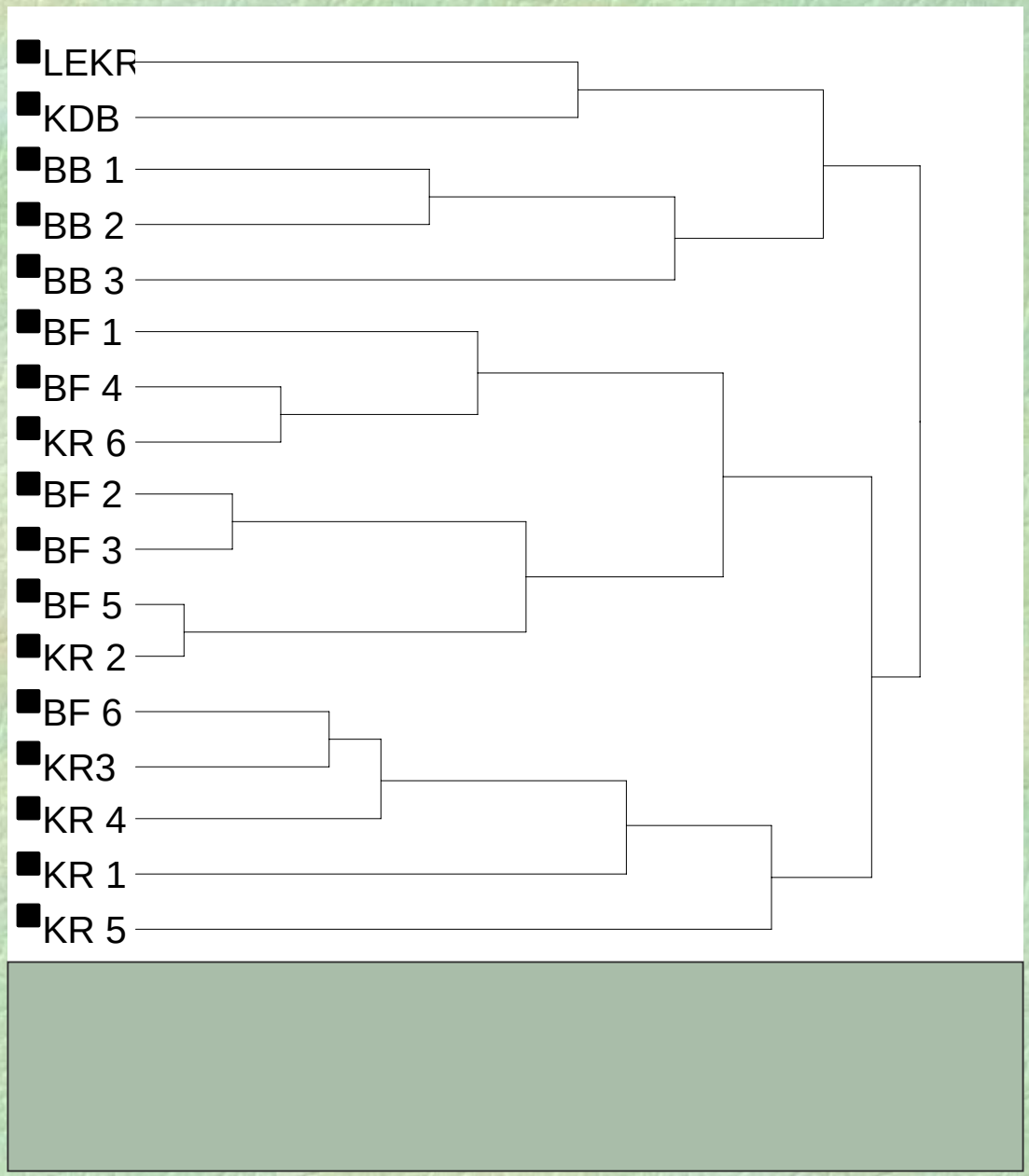
Taxa richness metrics, Spring 2003

Keno

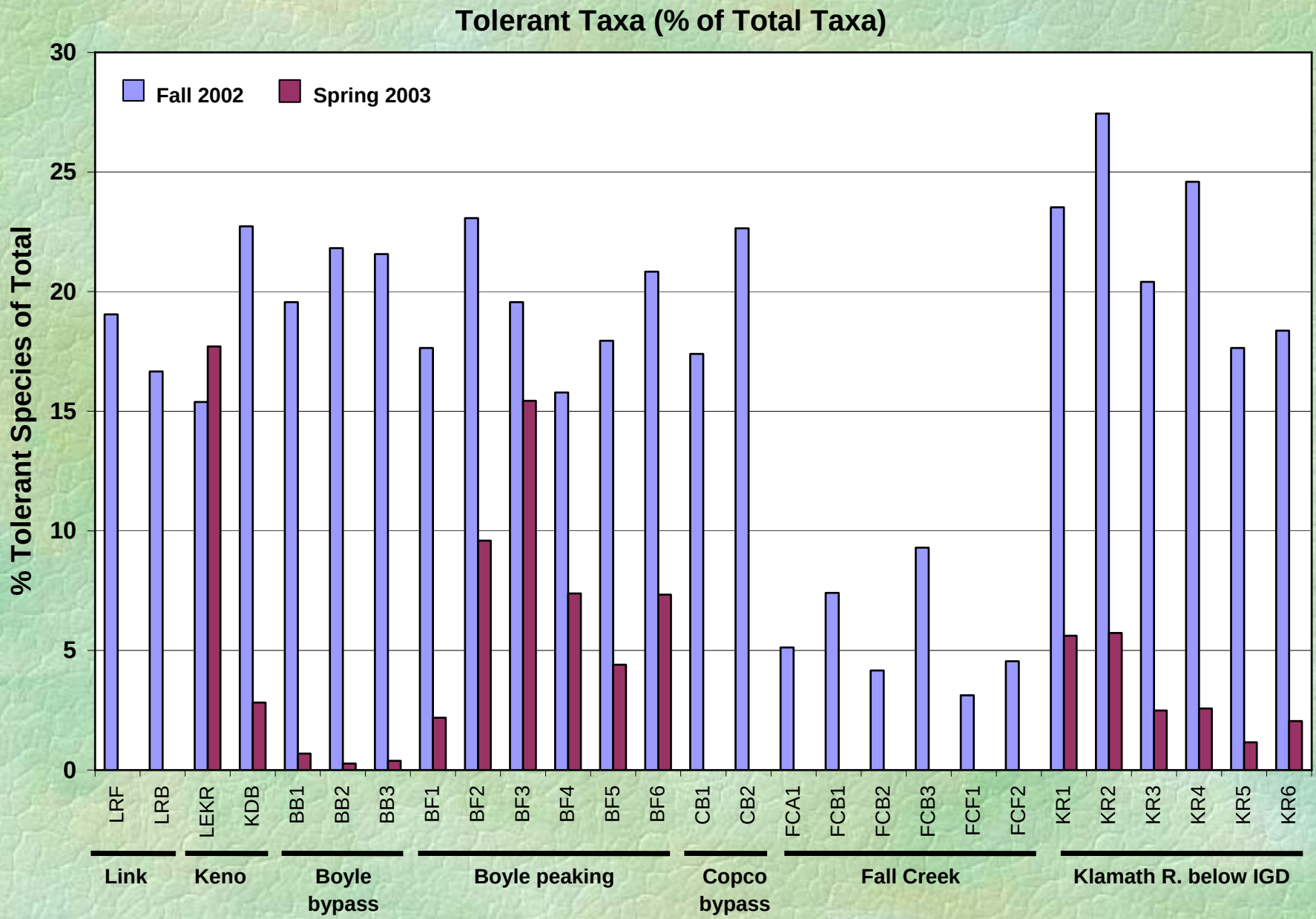
Bypass

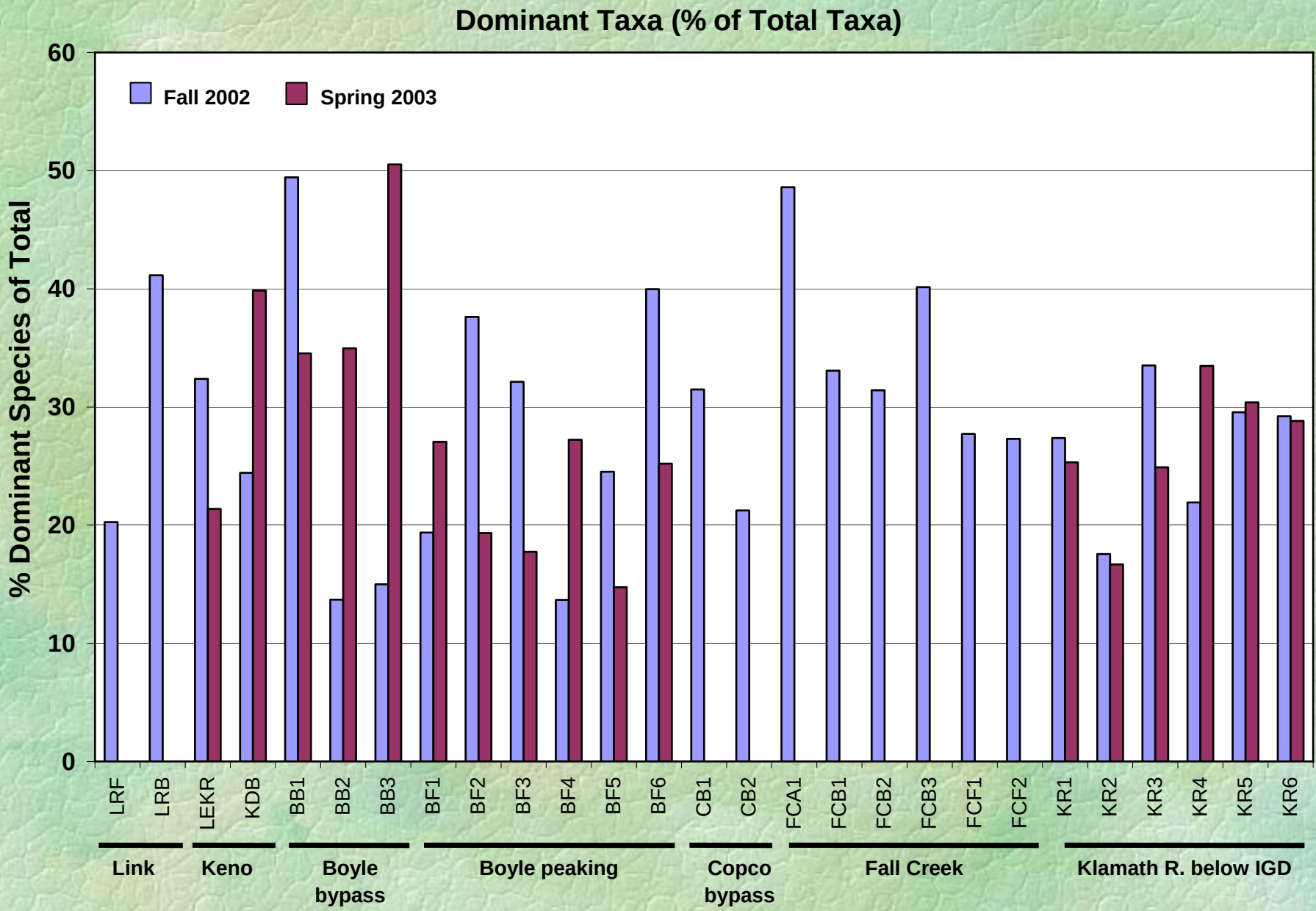
Peaking

Lower river

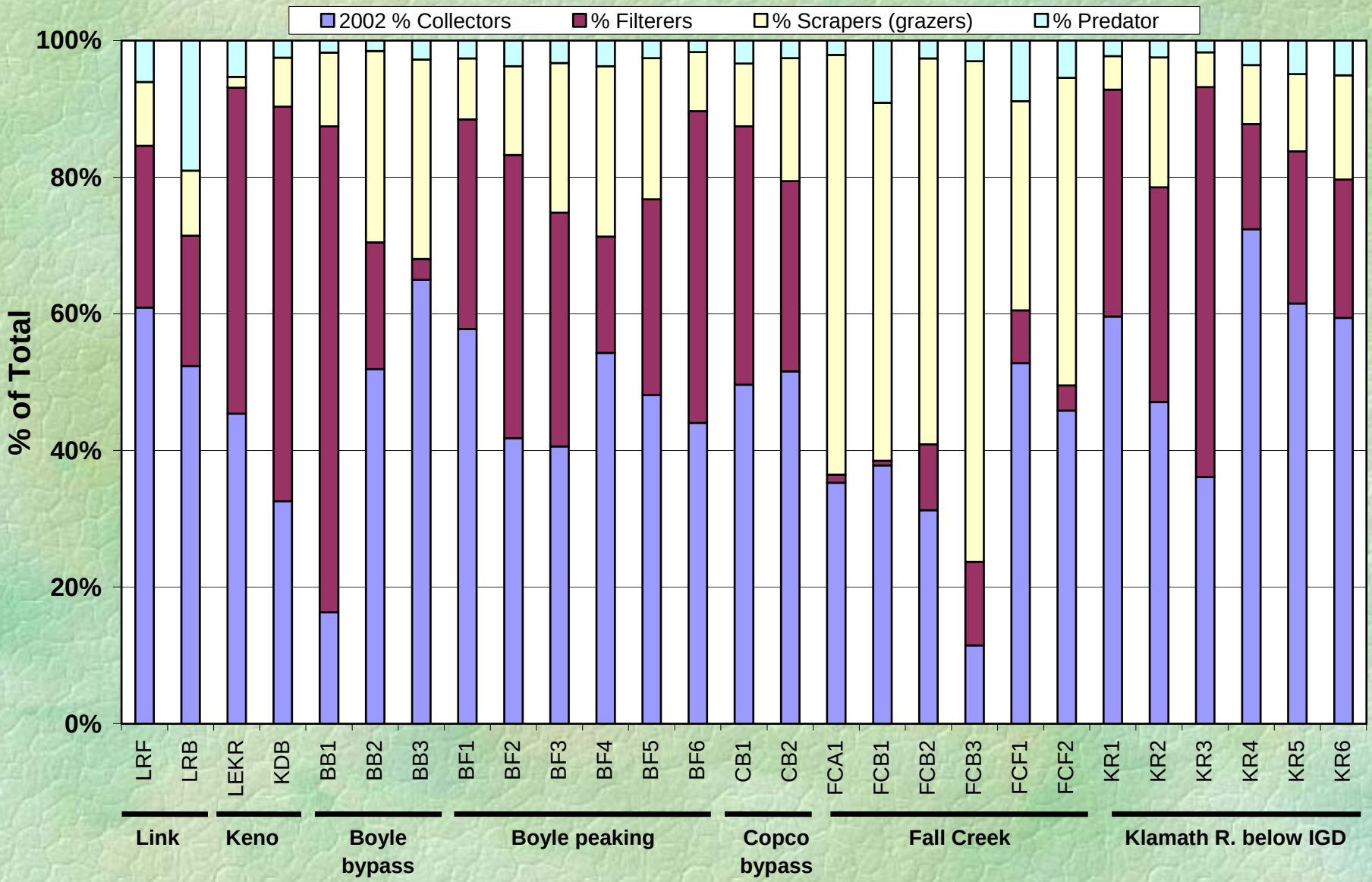


Seasonal differences are non-trivial




Dominant Taxa (% of Total Taxa)
Fall 2002
Spring 2003
% Dominant Species of Total
60
50
40
30
20
10
0
LRF
LRB
LEKR
KDB
BB1
BB2
BB3
BF1
BF2
BF3
BF4
BF5
BF6
CB1
CB2
FCA1
FCB1
FCB2
FCB3
FCF1
FCF2
KR1
KR2
KR3
KR4
KR5
KR6
Link
Keno
Boyle bypass
Boyle peaking
Copco bypass
Fall Creek
Klamath R. below IGD

Functional Feeding Groups - Fall 2002



Statistically Different Metrics: Mixed Results

(Improved Conditions by Metric by Reach)			
Comparing Boyle Bypass to Peaking Reach		**Comparing Above and Below Reservoir**	
Bypass Reach	**Peaking Reach**	**Above Iron Gate and Copco Reservoirs**	**Below Iron Gate Reservoir**
Intolerant taxa richness	EPT index and taxa richness	EPT taxa richness	% Hydropsychidae
HBI score	%Dominant taxa	%Intolerant taxa	%Baetidae
Long-lived taxa	Taxa richness	EPT index	
	Shannon diversity		

Statistical Evaluation of Physical Habitat: Changes over 80 miles of river.

- Significant Changes in Habitat: Riparian vegetation, Flow, Substrate.
- Moving downstream: Fines increased, cobble increased, bedrock decreased, mid-reach peak in boulders. Temperature increased.

Rare Species/Species of Concern

- Three caddisfly USFWS Species of Concern, not encountered.
  - Cascades apatanian caddisfly, Schuh's homoplectran caddisfly, Bilobed rhyacophilan caddisfly
- Mollusks
  - Listed species found in Fall Crk, Boyle fullflow and bypass, below Irongate, and in Boyle Res.(California floater and montane peaclam are forest service sensitive, Oregon floater is Oregon Natural Heritage Program (ONHP) sensitive, Gonidia and Margaritifera are Frest and Johannes recommended sensitive.)
- Polychaete worm:
  - *Manayunkia speciosa* was found in low abundance in drift samples (possible host for salmon and trout parasite, *Ceratomyxa shasta*).

Large Clams and Mussels. (high range of densities)

Species	Habitat	Reach	Station/RM	mean #/m^2	range #/m^2
Western ridgemussel (*Gonidia angulata*)	low-gradient riffles; sandy to gravelly substrate	Below Irongate	KRB-1/179.2	16.5	**0-72**
			KRB-3/185.6	0.5	n/a
			KRB-4/180.6	6.8	n/a
			KRB-5/178.6	3.4	**0-56**
		Above Boyle Res.	KRB-7/228.2	35	n/a
		peaking	KRB-8/205.3	1.8	n/a
Oregon floater (*Anodonta oregonensis*)	calm water areas; silty to fine-sand substrate	Below Irongate	KRB-2/189.8	2.0	n/a
			KRB-3/185.6	0.1	n/a
			KRB-4/180.6	0.1	n/a
		Below Keno Dam	KRB-6/233.3	14.6	**0-20**
		Above Boyle Res.	KRB-7/228.2	6	n/a

Overall Results Indicate:

- Varying habitat and flow conditions throughout study reaches.
- Varying RBP results:
  - increased diversity moving downstream
  - upper river = highest abundance but lowest diversity
  - Boyle reach varial zone: very low abundance/diversity
- Comparable values to other California and Oregon streams.
- Mollusks distributed by habitat types. Locally abundant.

Using BMI results:
Further questions.

- Physical/geomorphological/flow effects of such projects are well known and not in question.
- We see: Punctuated effects of dams and operations overlain on the larger scale continuum of the BMI community.
- What are the project-caused effects?
- How much change is important?
- What constitutes impaired?
- What is the relative risk due to various stressors?
- BMI? or just the fish?