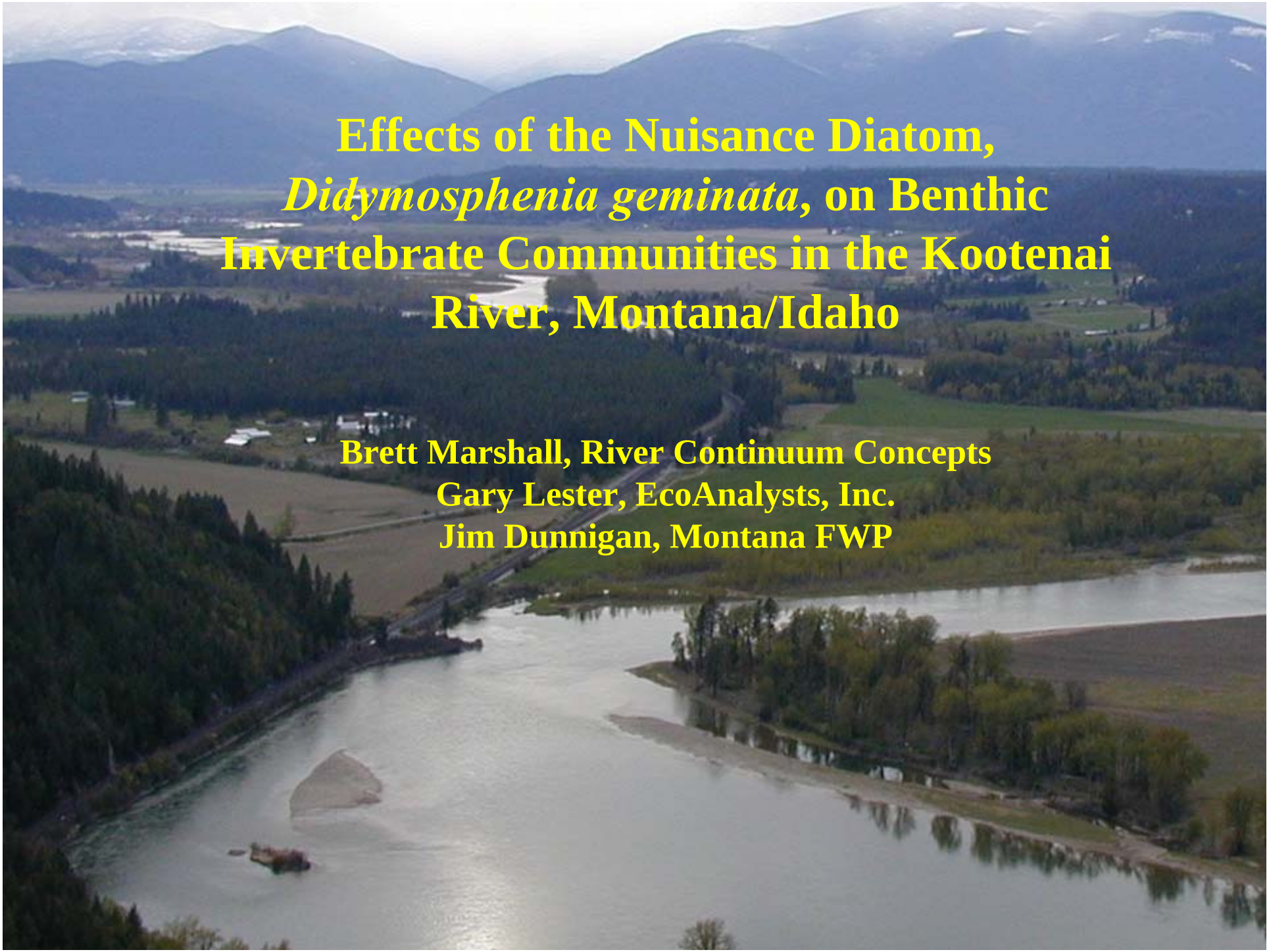
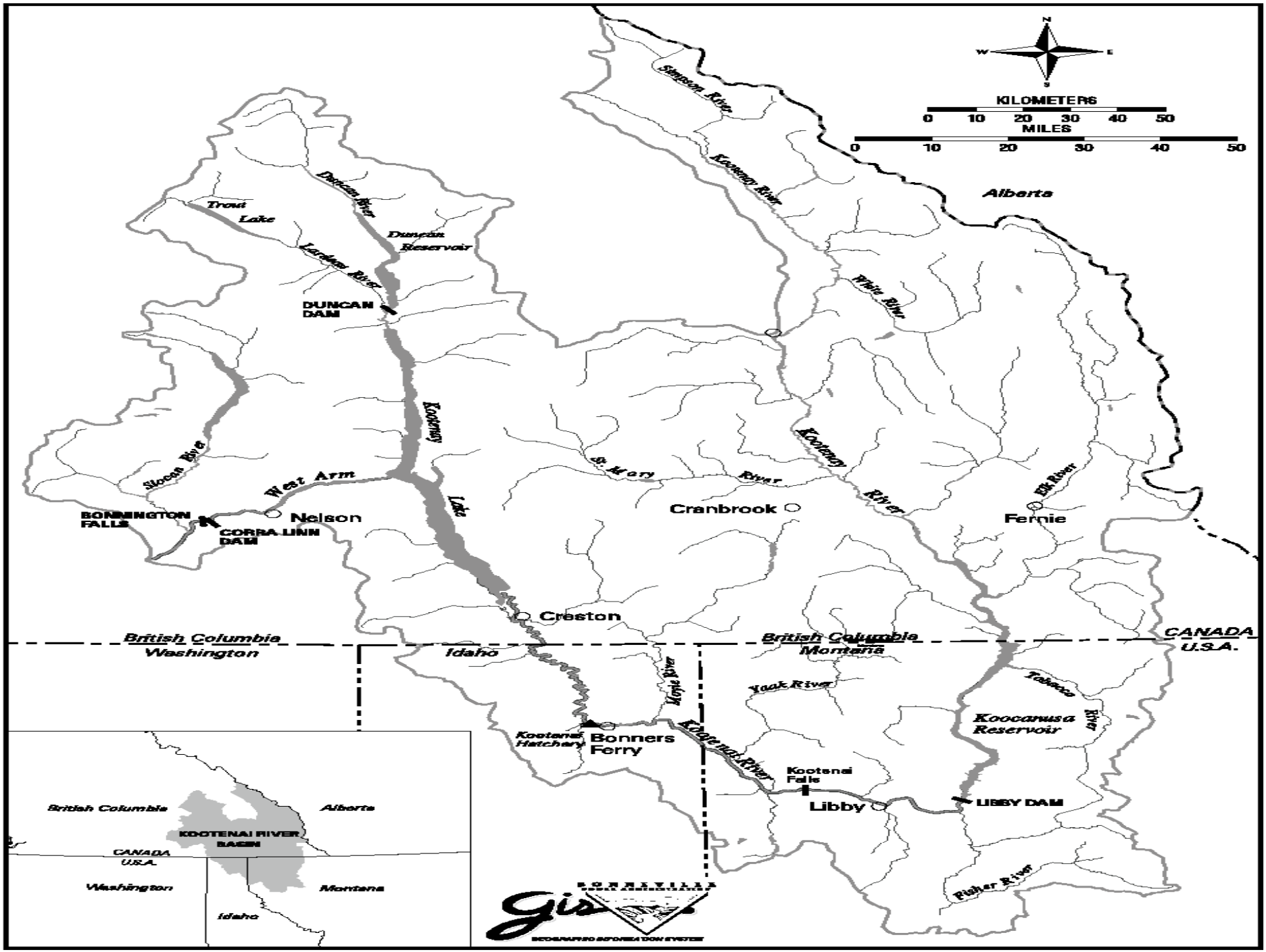


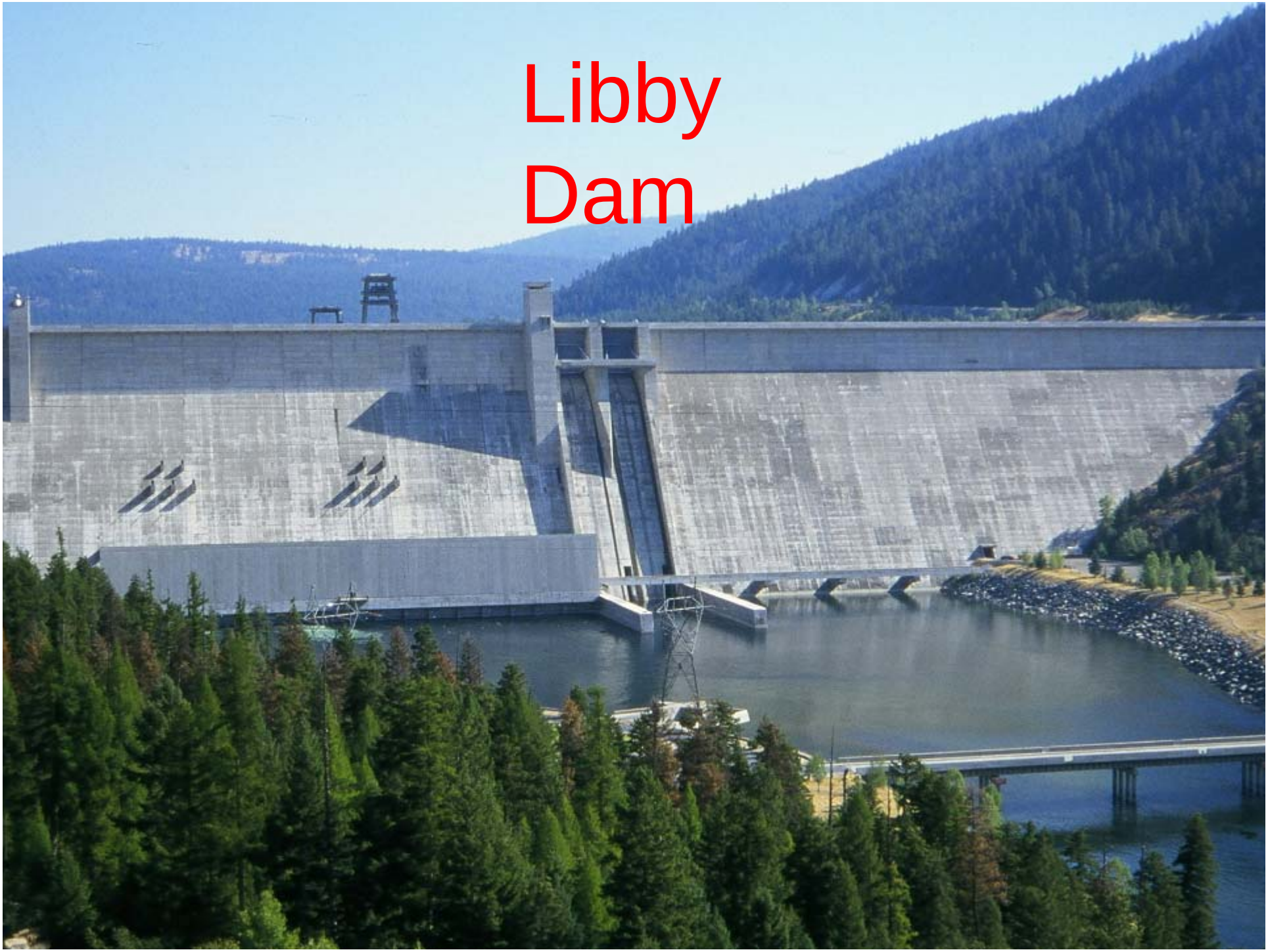
Effects of the Nuisance Diatom, *Didymosphenia geminata*, on Benthic Invertebrate Communities in the Kootenai River, Montana/Idaho

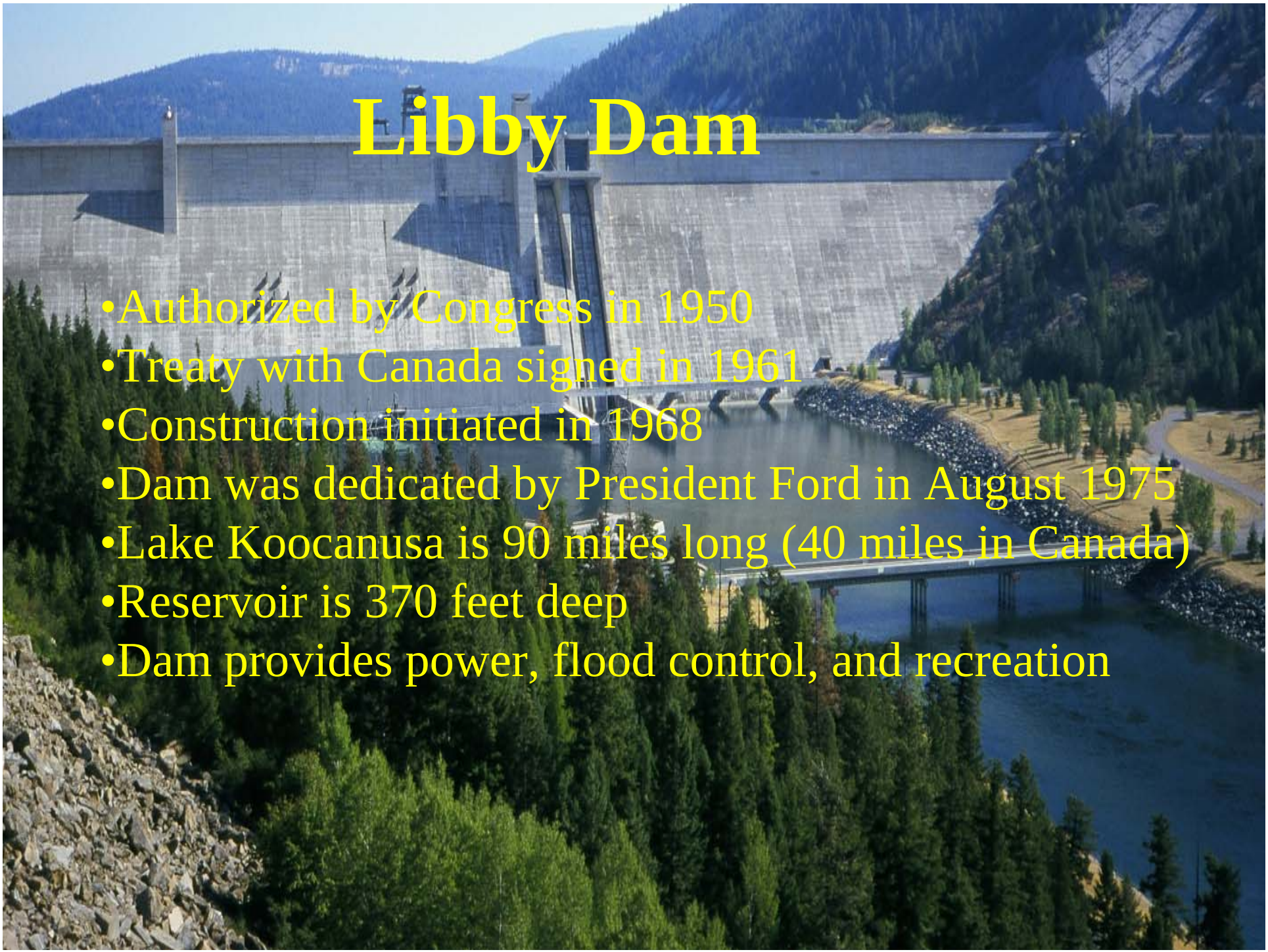
Brett Marshall, River Continuum Concepts
Gary Lester, EcoAnalysts, Inc.
Jim Dunnigan, Montana FWP

Overview of Presentation

- Background regarding Kootenai River
- Introduction to Didymo (a.k.a “rocksnot”)
- *Didymosphenia geminata* study results


KILOMETERS
0 10 20 30 40 50
MILES
0 10 20 30 40 50
Simpson River
Kootenay River
Alberta
Trout Lake
Duncan River
Duncan Reservoir
Lardeau River
DUNCAN DAM
White River
Kootenay Lake
Slocan River
West Arm
BONNINGTON FALLS
CORRA LINN DAM
Nelson
St. Mary River
Kootenay River
Elk River
Cranbrook
Fernie
Creston
British Columbia
Washington
Idaho
British Columbia
Montana
CANADA
U.S.A.
Yaak River
Tobacco River
Koocanusa Reservoir
Kootenai Hatchery
Bonners Ferry
Kootenai River
Kootenai Falls
Libby
LIBBY DAM
Fisher River
British Columbia
Alberta
KOOTENAI RIVER BASIN
CANADA
U.S.A.
Washington
Montana
Idaho


Libby
Dam



Libby Dam

- Authorized by Congress in 1950
- Treaty with Canada signed in 1961
- Construction initiated in 1968
- Dam was dedicated by President Ford in August 1975
- Lake Koocanusa is 90 miles long (40 miles in Canada)
- Reservoir is 370 feet deep
- Dam provides power, flood control, and recreation


•Dam acts as a sediment transport barrier
•Reservoir acts as a nutrient sink
•Dam operations result in an unnatural hydrograph
•Floodplain wetlands disconnected by dikes and flood control

RESULT:
Trophic collapse due to "cultural oligotrophication"

Collapse of native fish populations including:

- Kootenai River white sturgeon (endangered)
- Burbot
- Westlope cutthroat trout
- Rainbow trout
- Kokanee

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Didymosphenia geminata

- A large diatom (>1.0mm) with a mucopolysaccharide stalk visible to the naked eye.
- Forms large, dense mats resembling cotton fibers or toilet paper.
- Little forage value to invertebrates (low in lipids and proteins)
- Visually unappealing - Large mats senesce and slough off, floating downriver

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D. geminata

- Reported as nuisance across North America and around the world (USA, CAN, NZ, Poland)
- Eastern states inlude NY (Delaware R.), VT (Connecticut R., White R., Battenkill), VA (Smith R., Jackson R.), AR (White R.)
- Unlike most algae, blooms in **low-nutrient conditions**
- Typically, adult trout leave the infested areas

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D. geminata

- Algae typically blooms to nuisance levels in oligotrophic, high quality water
- Usually associated with stable, ***clear*** flow below dams, but not always
- Can survive up to 2 months at 9 degrees C, under low light and damp conditions
- A single cell can cause a new infestation

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Biosecurity New Zealand Photo

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Kootenai River Study - MTFWP

- Blooms of Didymo below Libby Dam started in late 1990's, interfering with local fishery
- In November 2004 MTWFP issued a request for proposals for the Investigation of the Macrozoobenthos Ecology of the Kootenai River
- In February 2005 EcoAnalysts was awarded the contract for the study.

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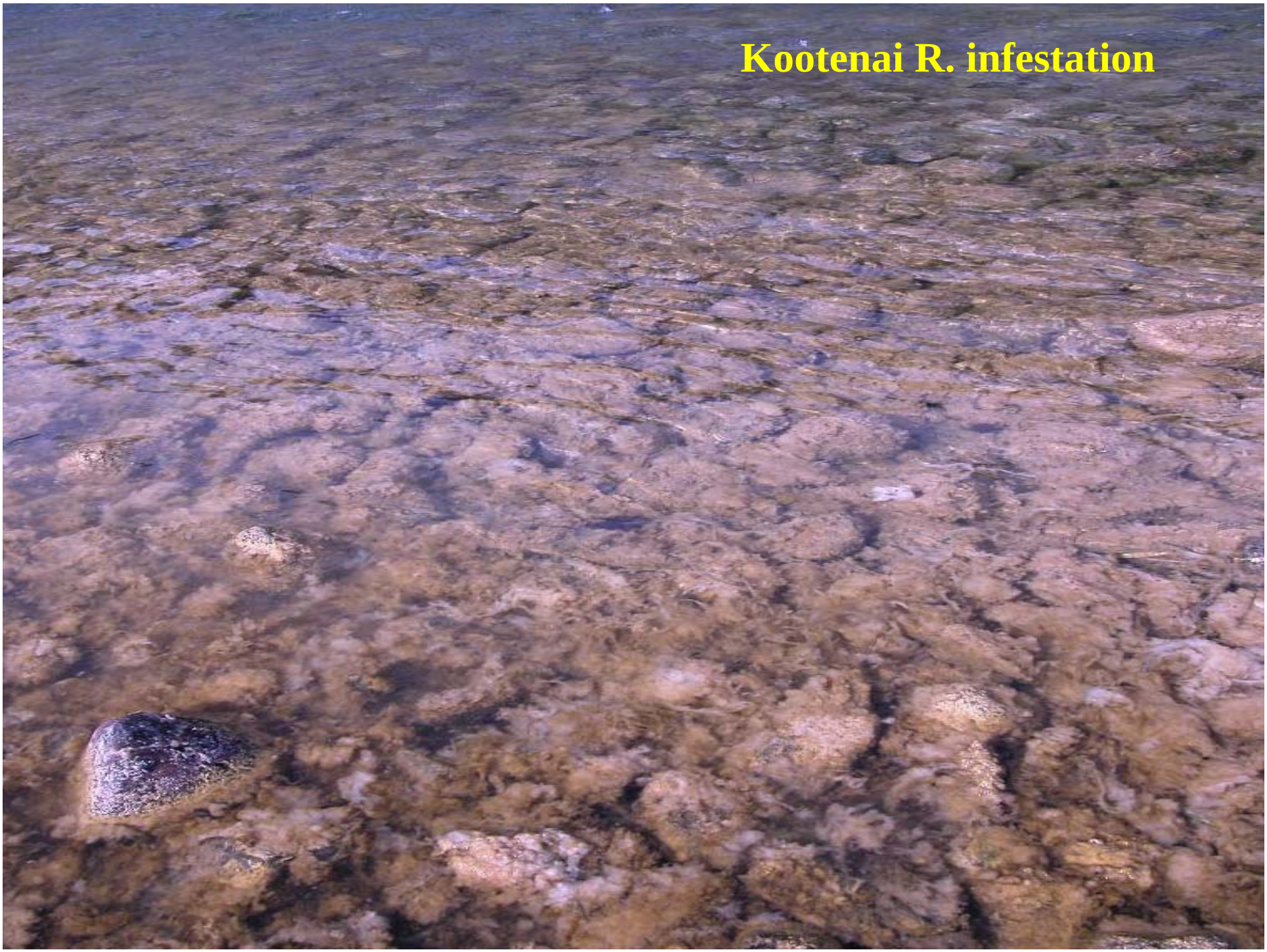
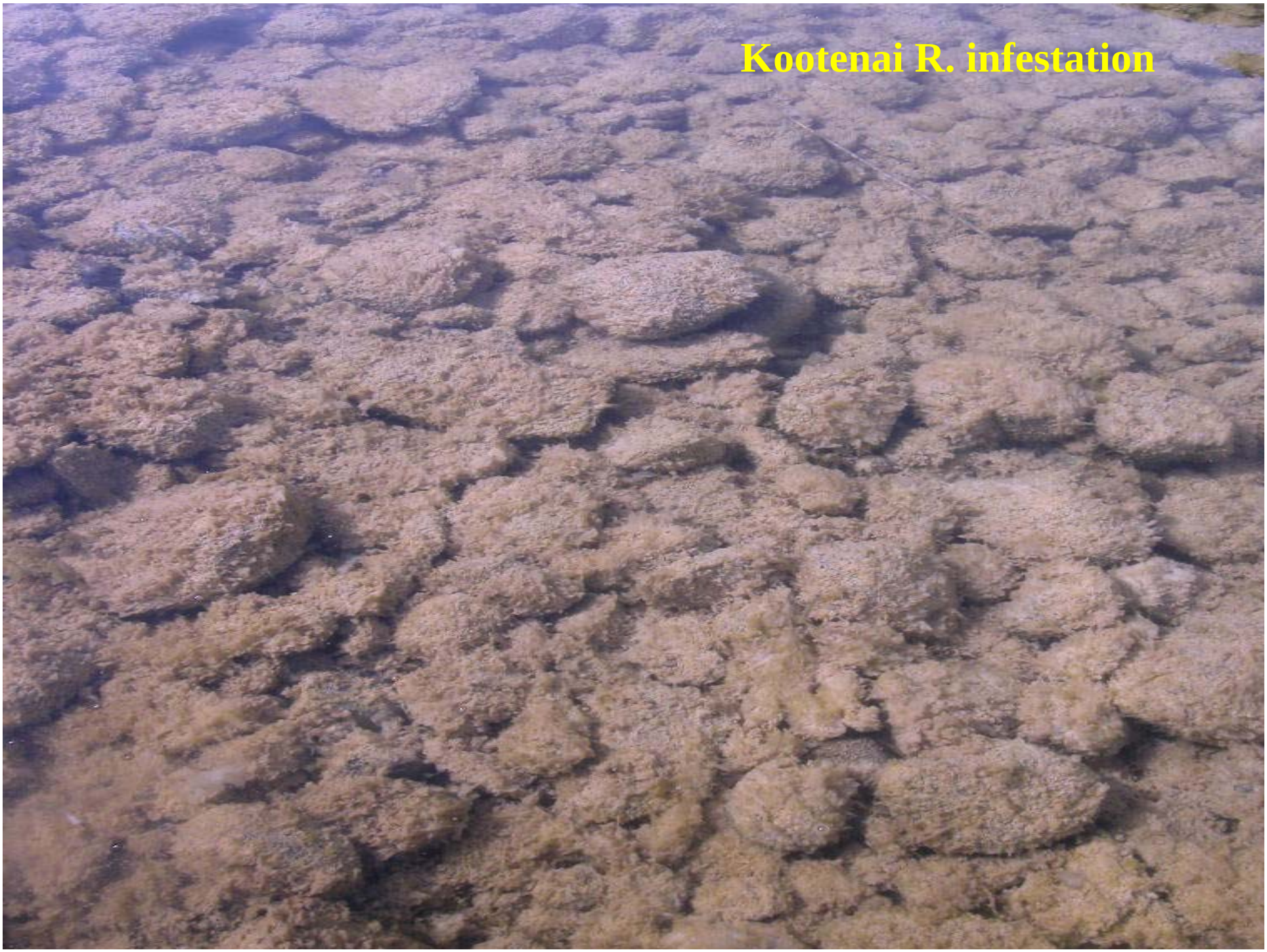
Kootenai R. infestation


Kootenai R. infestation


Kootenai R. infestation


Kootenai R. infestation


Kootenai R. infestation


Kootenai R. infestation


D. geminata
J. Eichman, EcoAnalysts

Field Methods

- Sampling at five sites
- Sampling occurred in April, September and October in 2005
- 5 replicates per site for macroinvertebrates (three analyzed), using modified slack sampler - used specific velocity criteria
- Quantitative scrapes for algae biomass within each sampling unit (3 scrapes/benthic sample, 9 total for each site)
- Qualitative substrate composition/embeddedness

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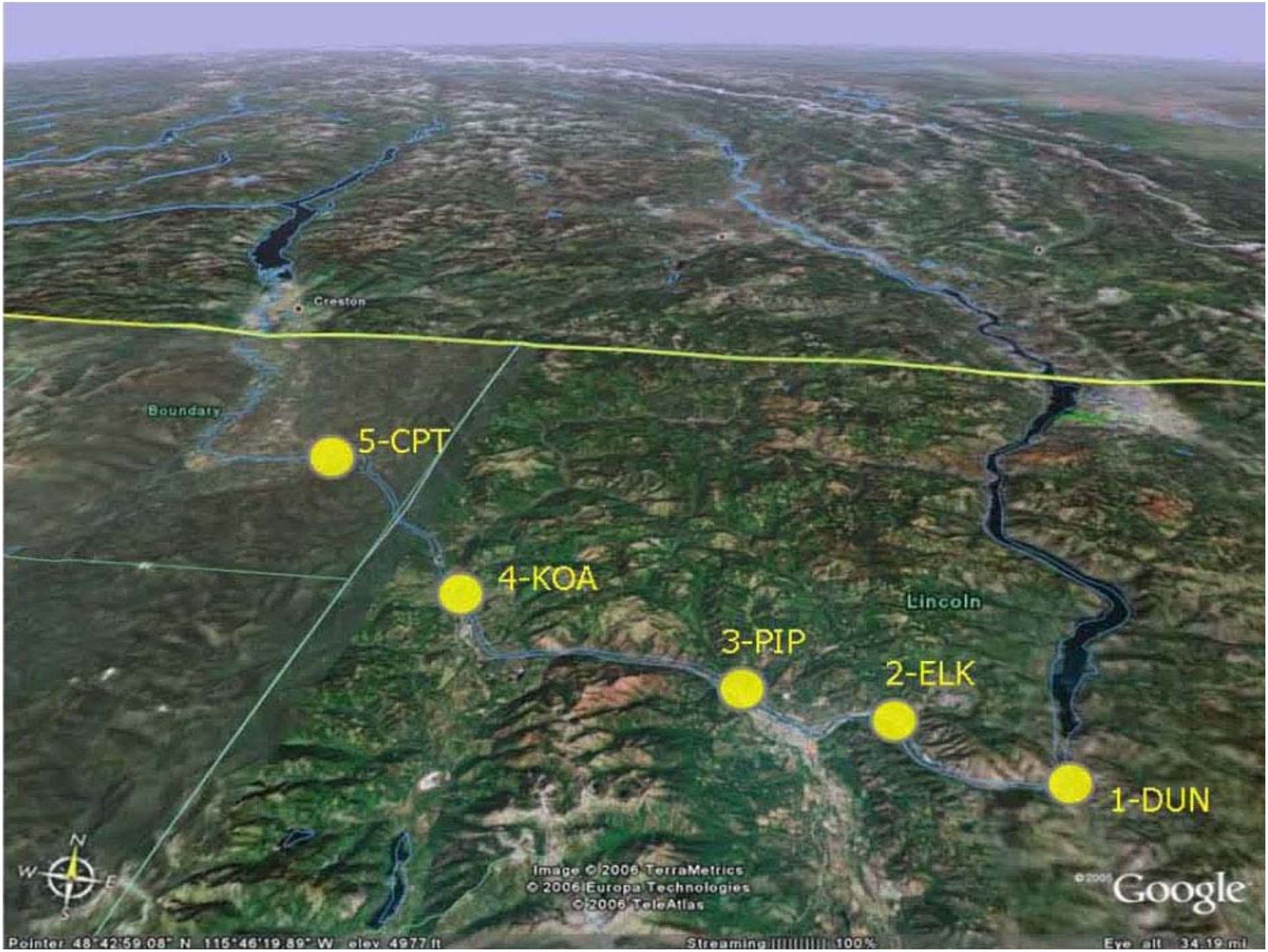
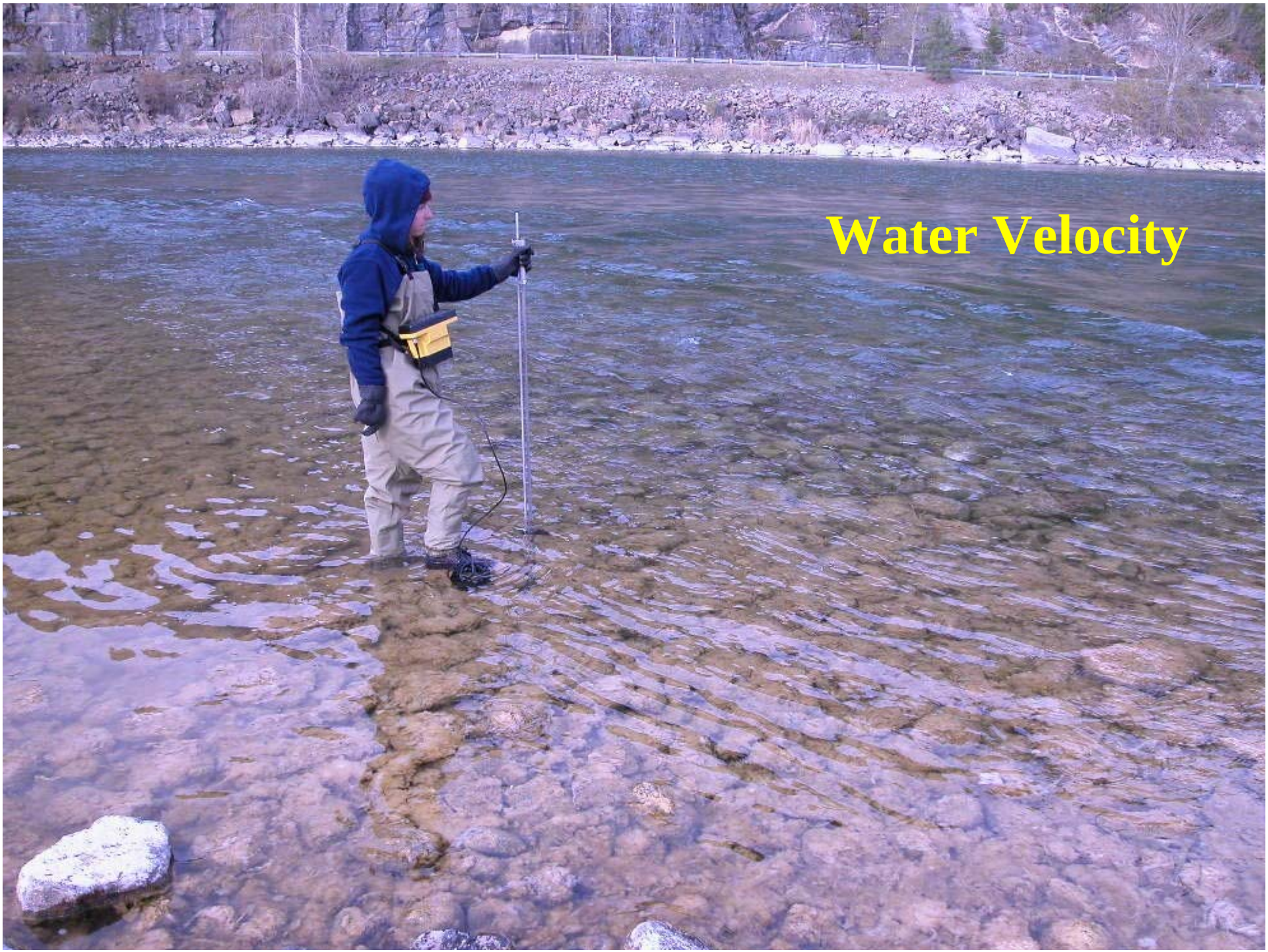
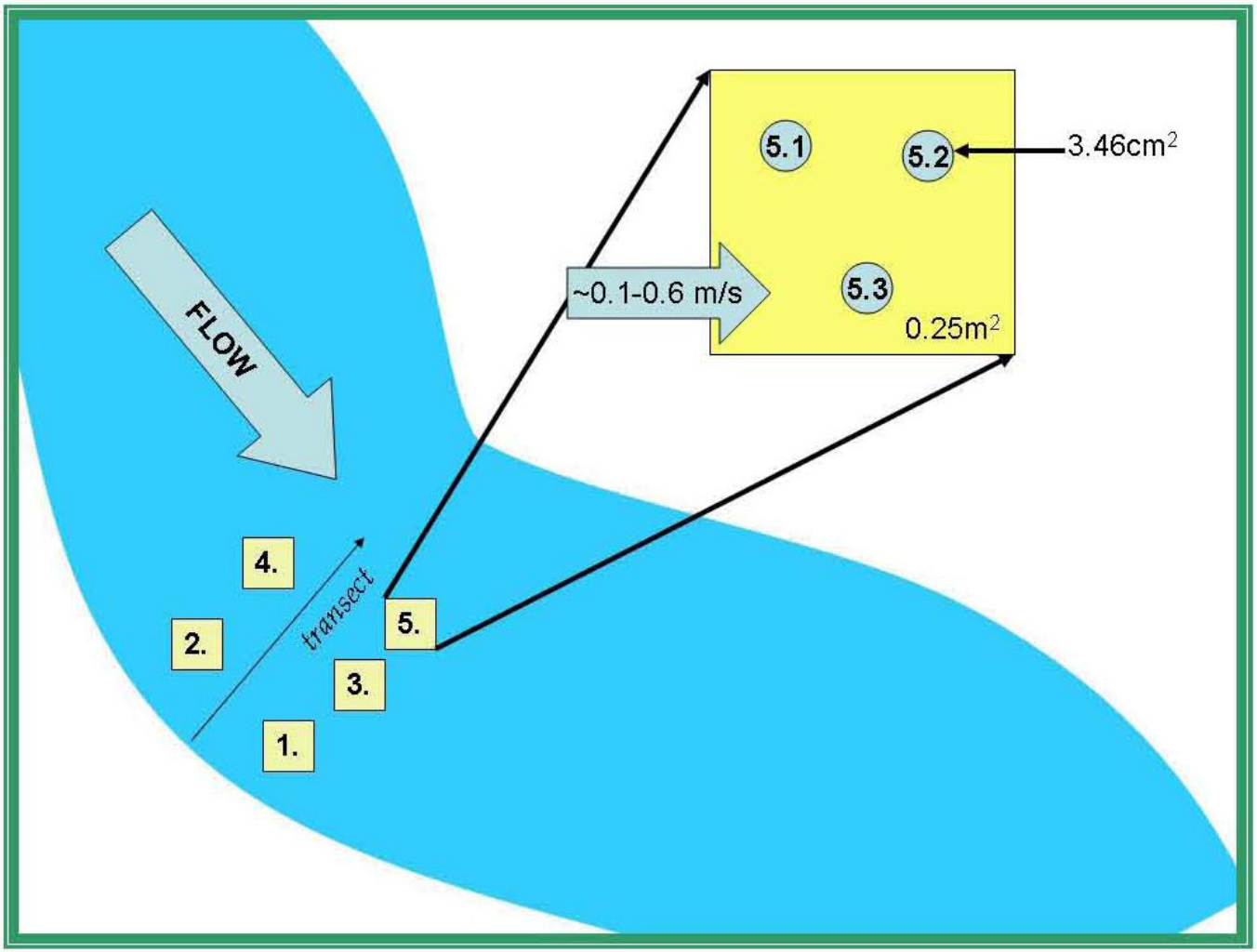

Creston
Boundary
5-CPT
4-KOA
Lincoln
3-PIP
2-ELK
1-DUN
Image © 2006 TerraMetrics
© 2006 Europa Technologies
© 2006 TeleAtlas
©2006 Google
Pointer 48°42'59.08" N 115°46'19.89" W elev 4977 ft
Streaming 100%
Eye alt 34.19 mi


Water Velocity

PERIPHYTON SAMPLING



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BENTHIC SAMPLING

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Substrate Classification

Periphyton Sampling

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Lab Methods

- Fixed count/known area subsample technique (500 organism subsample) – 90%+ sorting efficiency maintained through QA
- ID to genus/species, midges to family, worms to class – taxonomy QA 90%+ agreement
- Algae biomass using AFDM (mean of 3 per benthic sample)

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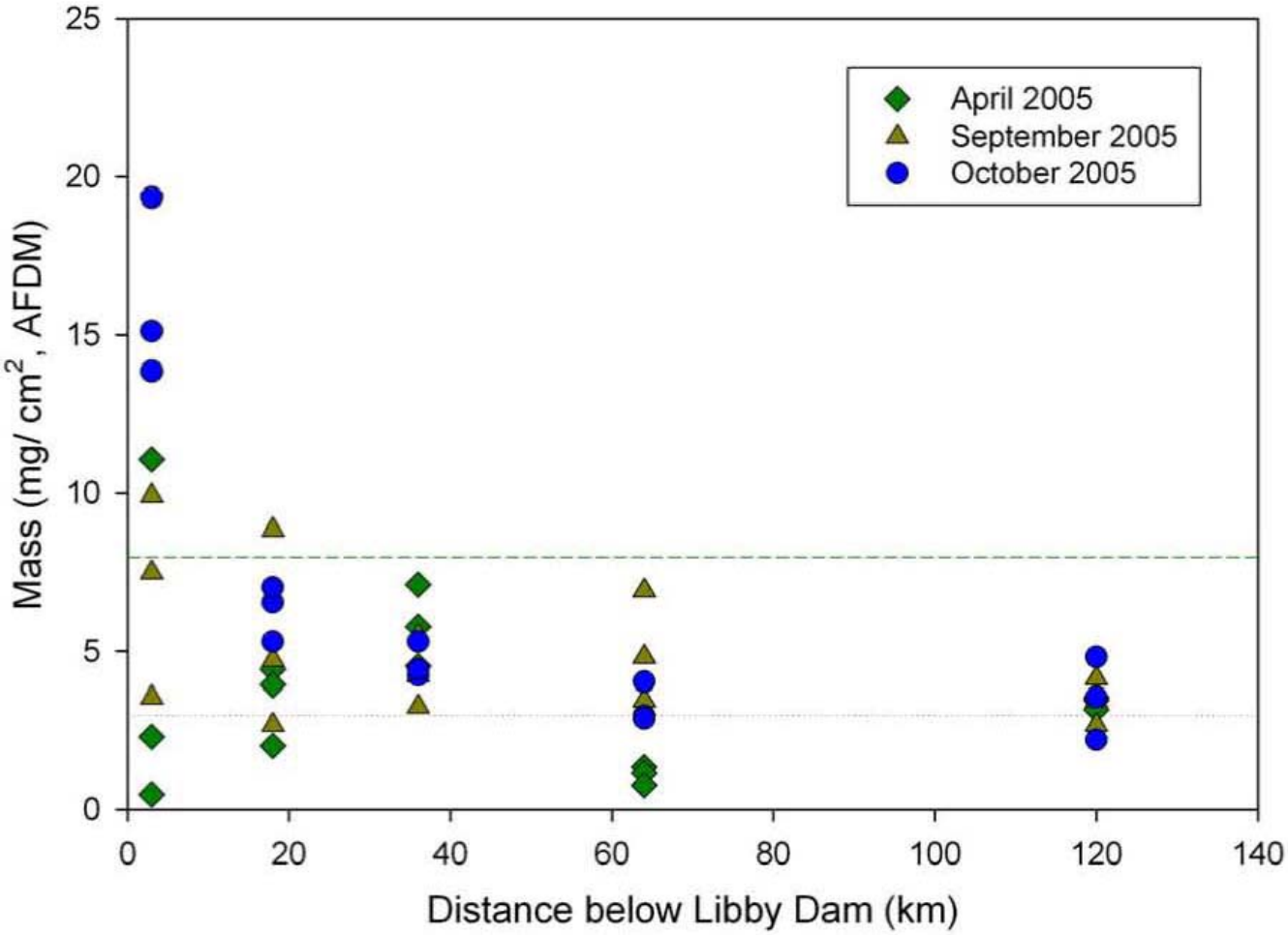
RESULTS

Periphyton Biomass below Libby Dam



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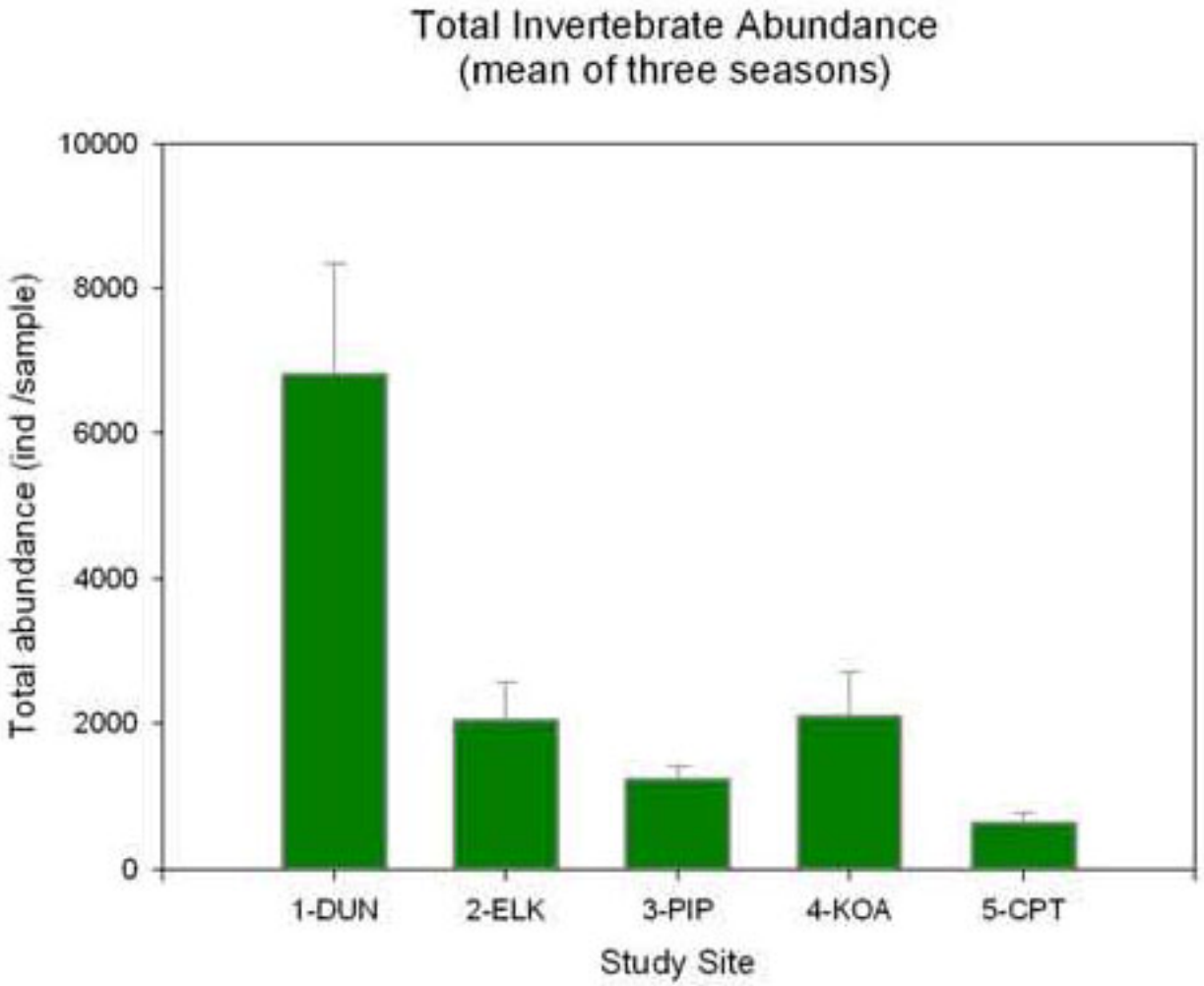

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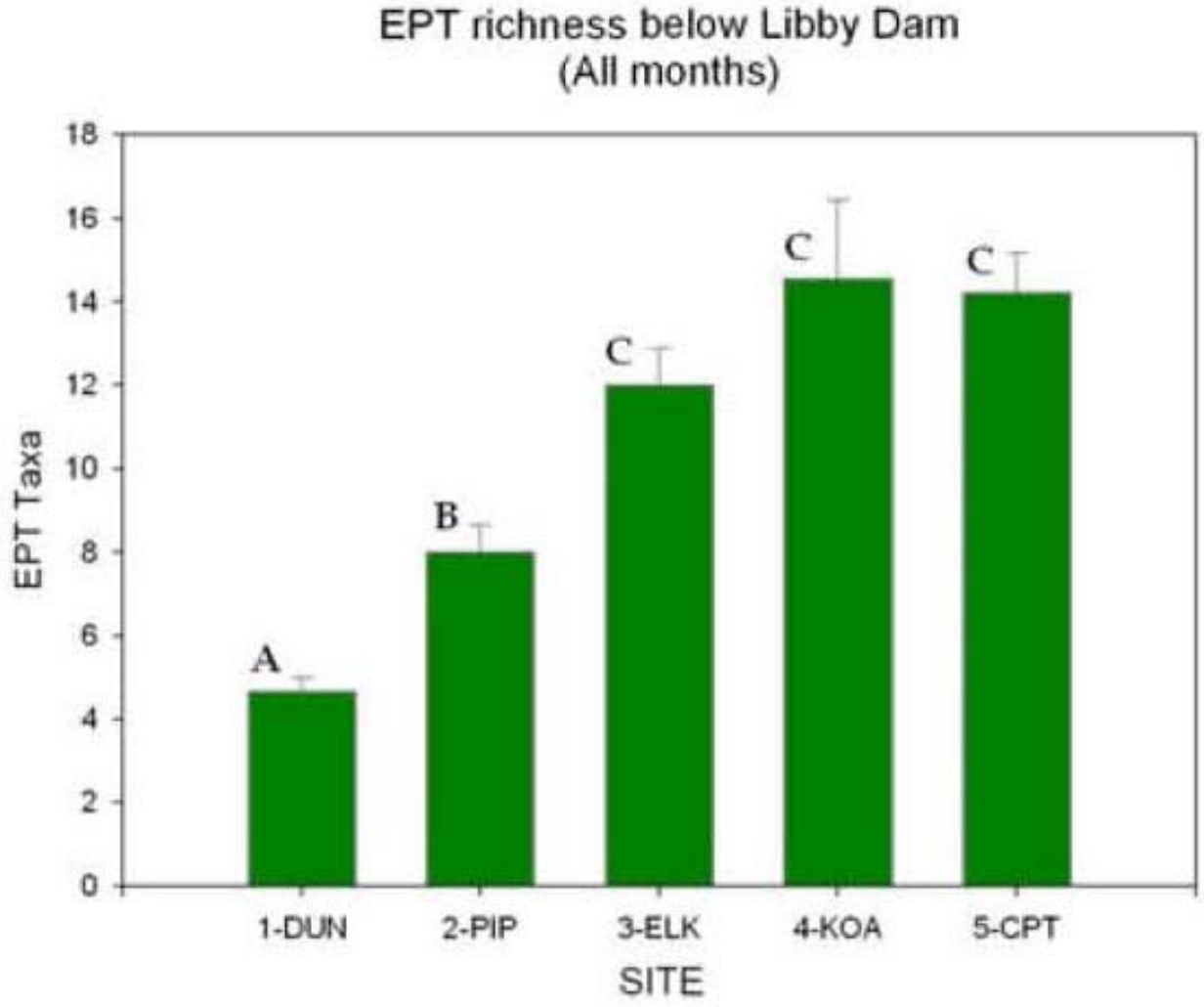

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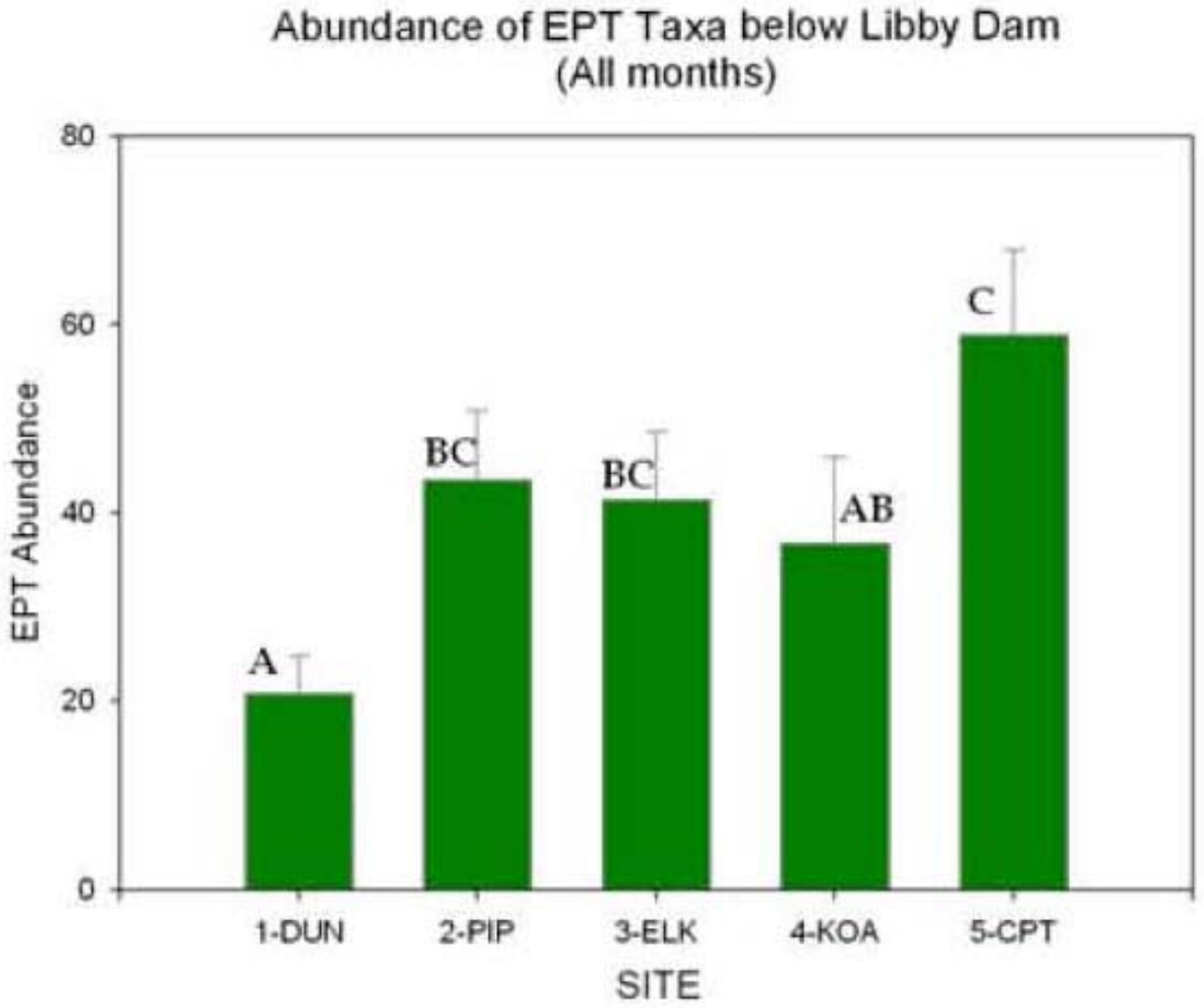

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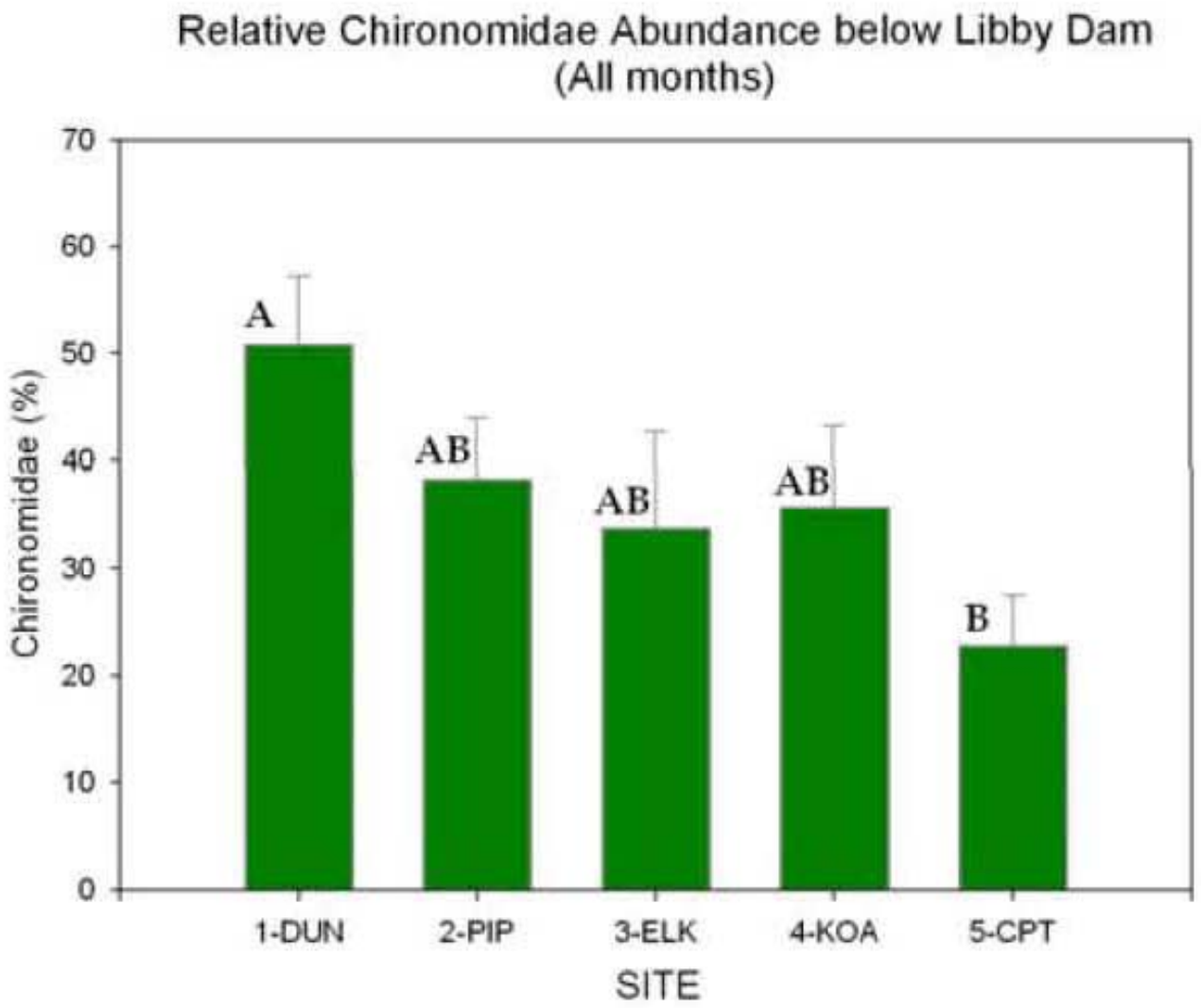

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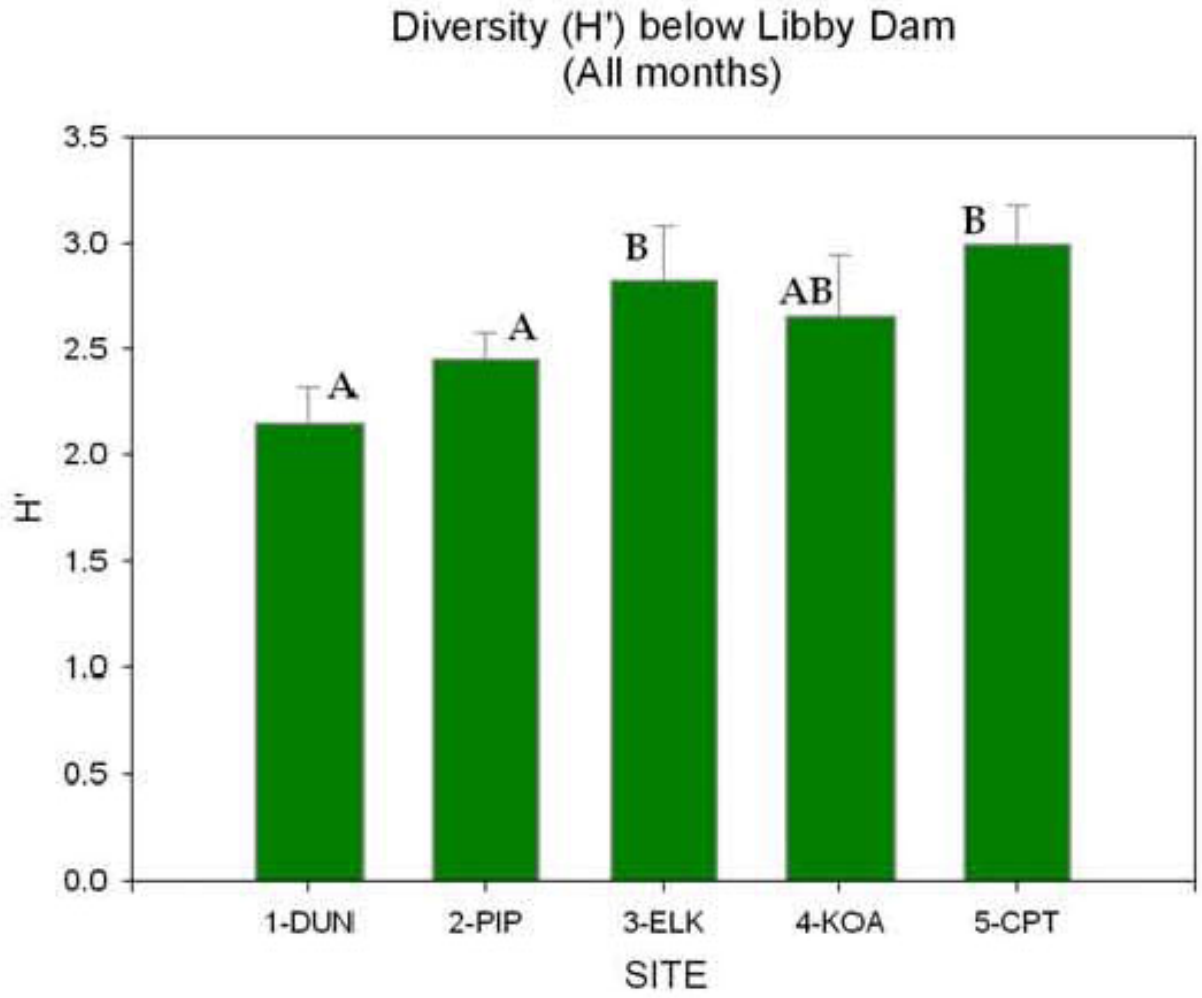

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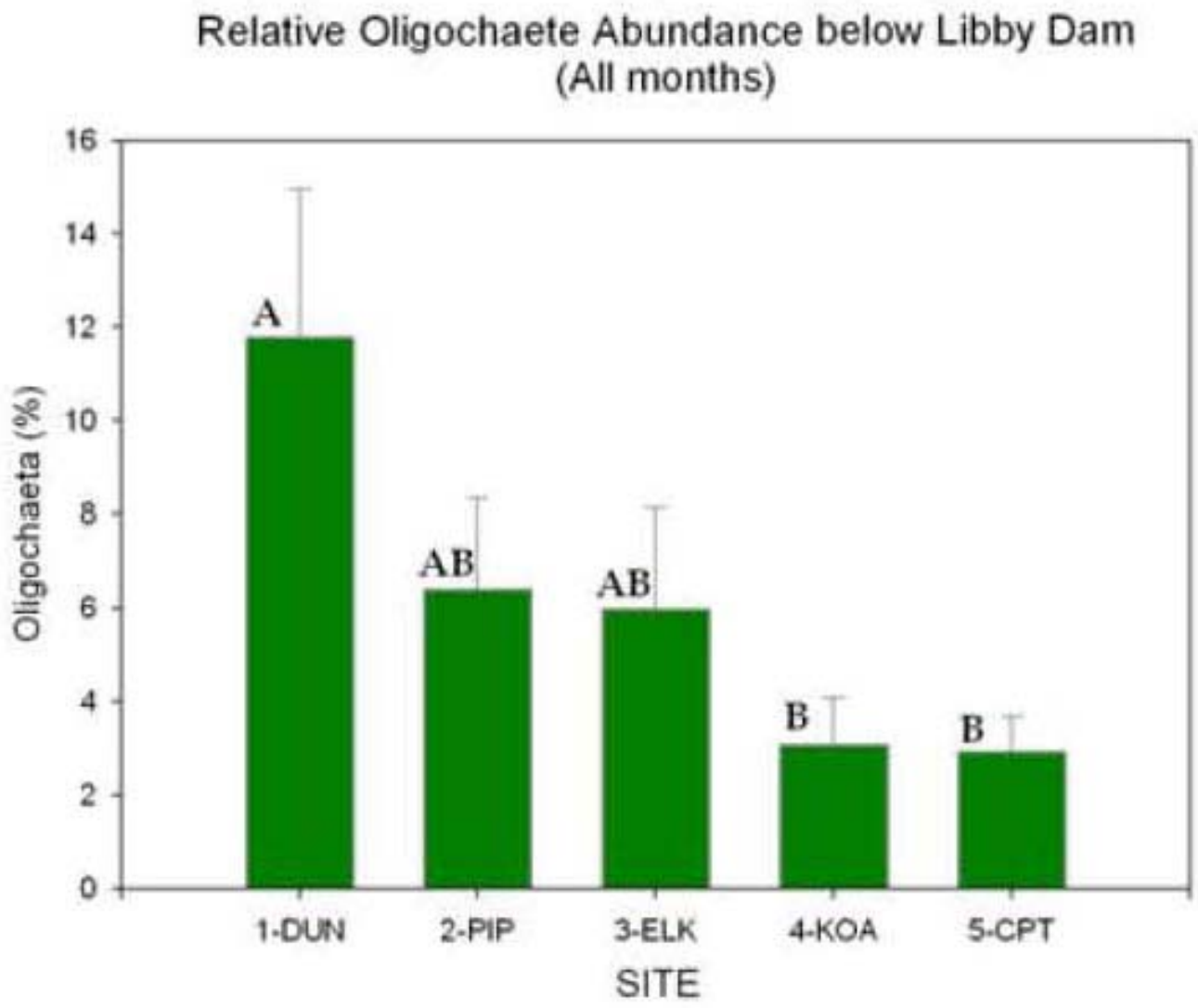

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Isolating Effects of Didymo From Covariates

- Initial ANOVA showed SITE and MONTH had a significant effect on all metrics
- When we replaced ANOVA with GLM, using forward stepwise variable selection algorithm, effect of SITE on most metrics was obscured
- When we added algal biomass to the procedure, ALGAE contributed significantly to every model.
- Generally, ALGAE was the single largest predictor of benthic community structure!

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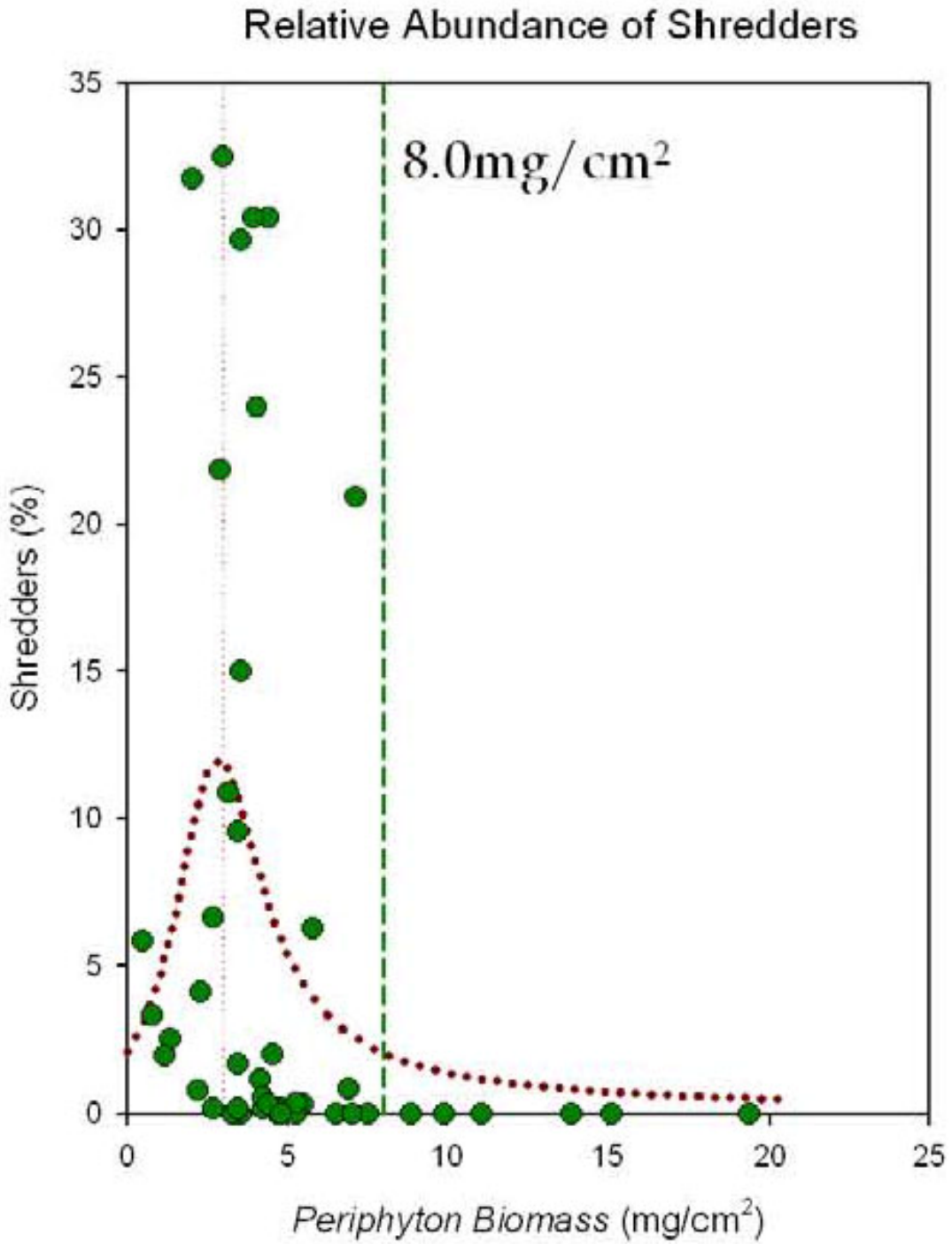

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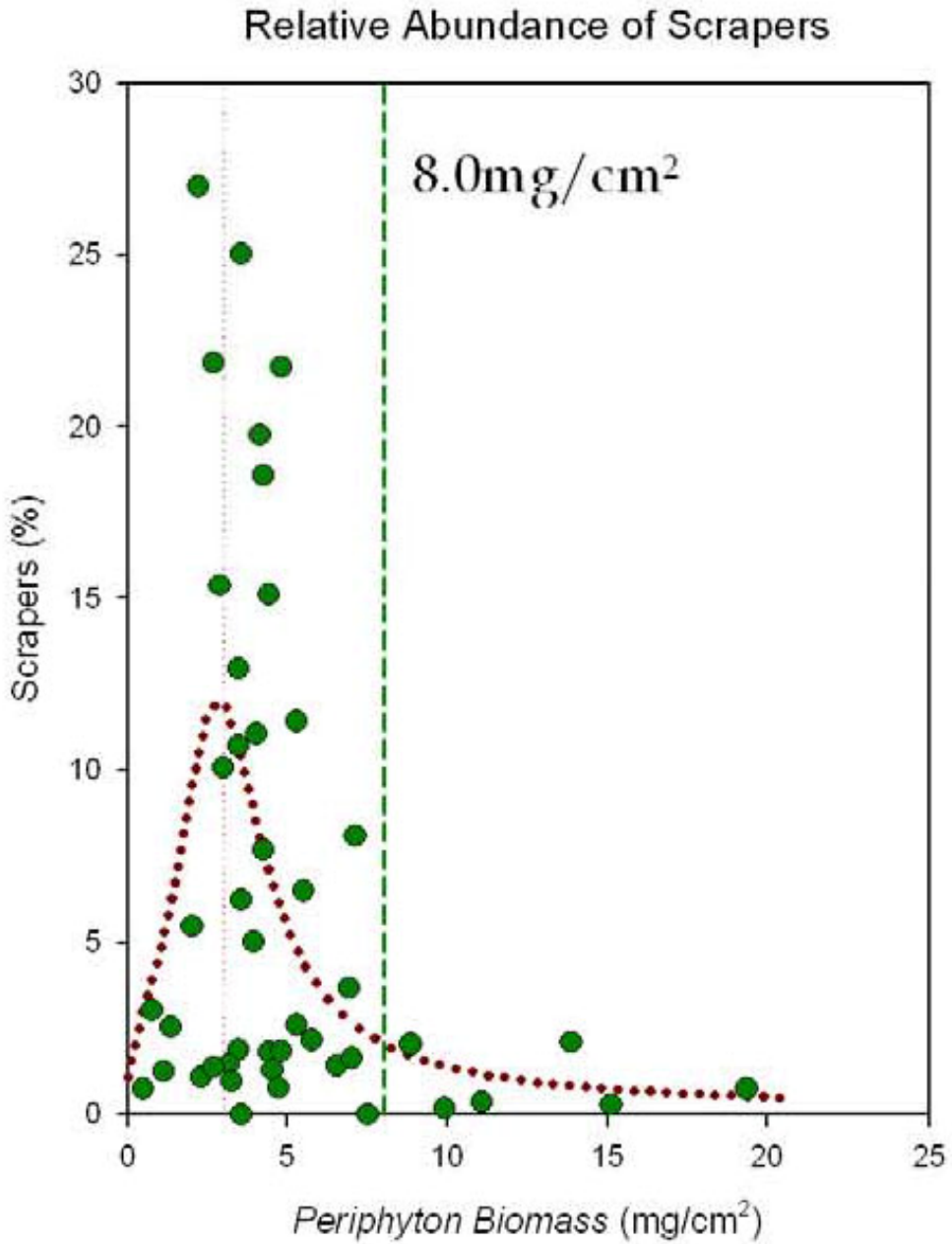

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			P-value	R^2
ECM				
	Total Abundance	= 6.17 + Particle*(0.004)	0.075	0.072
	Taxa Richness	= 15.1 + Embed*0.137 + Month*(4.73)	0.031	0.192
	Diversity (H′)	=1.89 + Month*(0.75)+Particle*Month(0.001)	<0.001	0.333
CSM				
	EPT Richness	*No terms met tolerance criteria*	N.S.	n/a
	% EPT (abund)	= 6.49 + Month*(16.9)	<0.001	0.314
	% Chironomidae	= 60.2 -21.5*(Month) + 0.037(Particle*Month)	0.001	0.299
	% Oligochaete	*No terms met tolerance criteria*	N.S.	n/a
	% Non-Insect	= 17.9 -11.5*(Flow)	0.103	0.061
CFM				
	Gatherers	= 40.4 +0.103(Particle)-9.24(Flow*Month)	0.004	0.229
	Filterers	= 2-.4 + 32.5 (Flow) -0.059(Particle)	<0.001	0.307
	Collectors	*No terms met tolerance criteria*	N.S.	n/a
	Shredders	*No terms met tolerance criteria*	N.S.	n/a
	Scrapers	= (-1.52) + 4.06 (Month)	0.002	0.198

			P-value	Algae P	R^2
ECM					
	Total Abundance	= 6.50 + 0.154 (Algae)	<0.001	<0.001	0.288
	Taxa Richness	= 24.1 – 0.241 (Algae)	0.034	0.034	0.317
	Diversity (H′)	= 2.01 + Month*(0.733) + Particle*Month(0.001) + Algae(0.066)	<0.001	0.008	0.439
CSM					
	EPT Richness	= 11.5 + 4.84 (Flow) – 0.51 (Algae)	0.011	0.008	0.198
	% EPT (abund)	= 48.9 -1.68 (Algae)	0.093	0.093	0.064
	% Chironomidae	= 48.7 + 0.355(Embed) -16.8(Month) + 3.28(Algae)	<0.001	<0.001	0.549
	% Oligochaeta	= 1.57 + 0.863 (Algae)	0.001	0.001	0.241
	% Non-Insect	= 24.8 -14.6(Flow) + 1.12(Algae) -0.044(Particle)	0.007	0.005	0.253
CFM					
	Gatherers	= 37.7 -24.5(Flow) + 2.05(Algae)+ 0.081 (Particle)	<0.001	0.007	0.348
	Filterers	= 9.98 +36.4(Flow) – 1.17(Algae)	<0.001	0.033	0.325
	Collectors	= 80.8 - 5.76 (Month) +1.68(Algae)	0.013	0.007	0.187
	Shredders	= 10.5 – 7.58(Algae)	0.075	0.075	0.072
	Scrapers	= 11.7 – 0.164 (Embed) – 0.614(Algae)	0.039	0.040	0.143

SUMMARY

- High density of Didymo knocks out most larger taxa, including EPT
- Didymo mats are a haven for small midges and worms
- Scrapers and shredders respond positively to smaller amounts of Didymo and then decline/disappear with increasing amounts.

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Acknowledgements

- Jim Dunnigan, MTWFP (funding)
- Brett Marshall, RCC (data analysis/report)
- Aimee Genung, Katie Marske, Lisa Anderson (EcoAnalysts Field crew)
- John Pfeiffer, EcoAnalysts (taxonomy)