



Do upstream mining activities alter fish communities beyond a reference condition defined for the South Nahanni River and Nahanni National Park?

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Objectives

Document a reference condition for algal, benthic invertebrate and fish communities in the South Nahanni River and compare to communities downstream of two mine exposure areas using a:

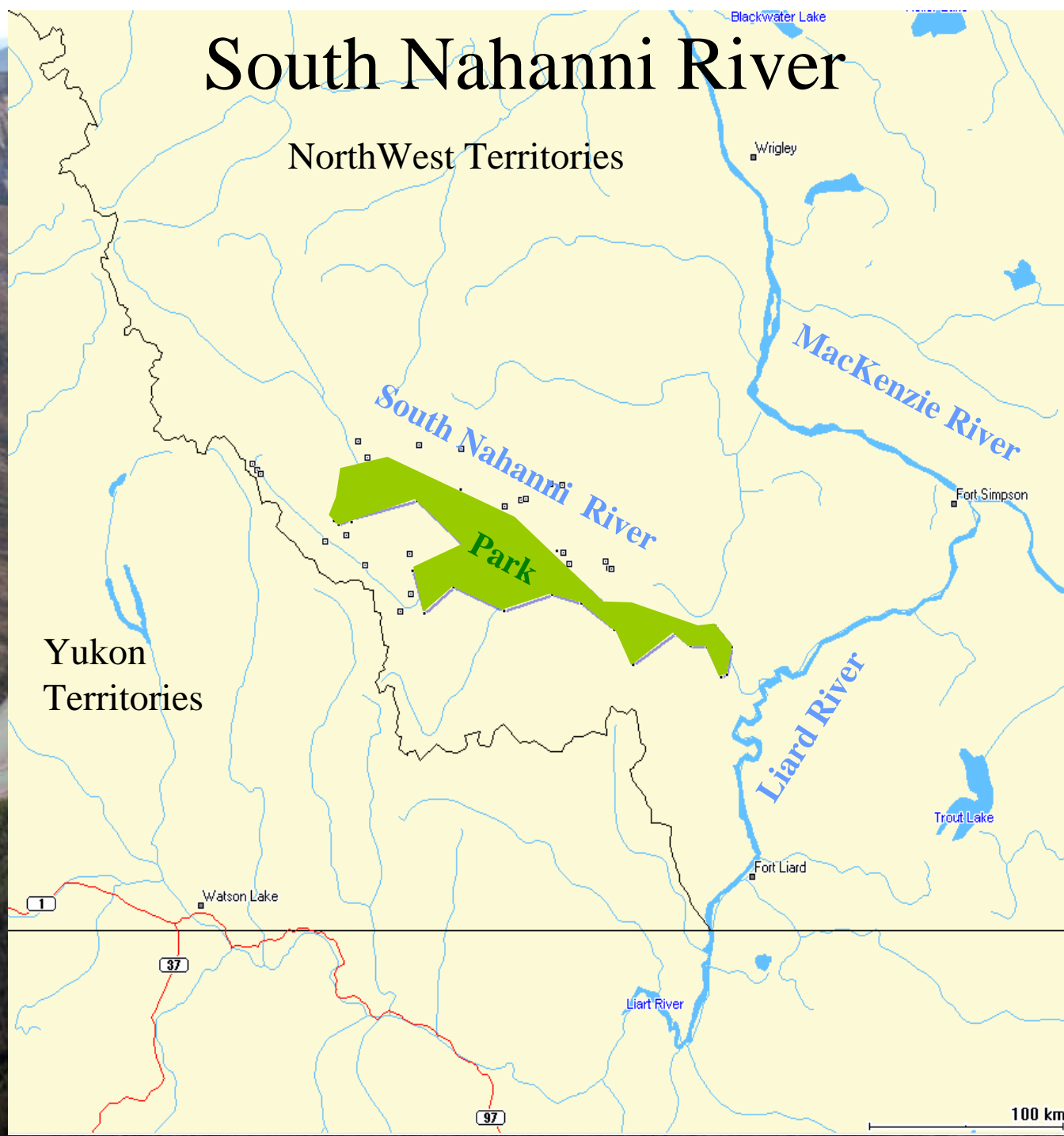
- Reference Condition Approach (RCA)
- Metal mining EEM methodology at reference, near field and far field
- Sentinel fish population, slimy sculpin

To establish through in situ artificial stream studies with a relevant northern test species dose response relationships for stressors of northern importance.

Study area



South Nahanni River



NorthWest Territories

Wrigley

MacKenzie River

Fort Simpson

Yukon Territories

South Nahanni River
Park

Liard River

Trout Lake

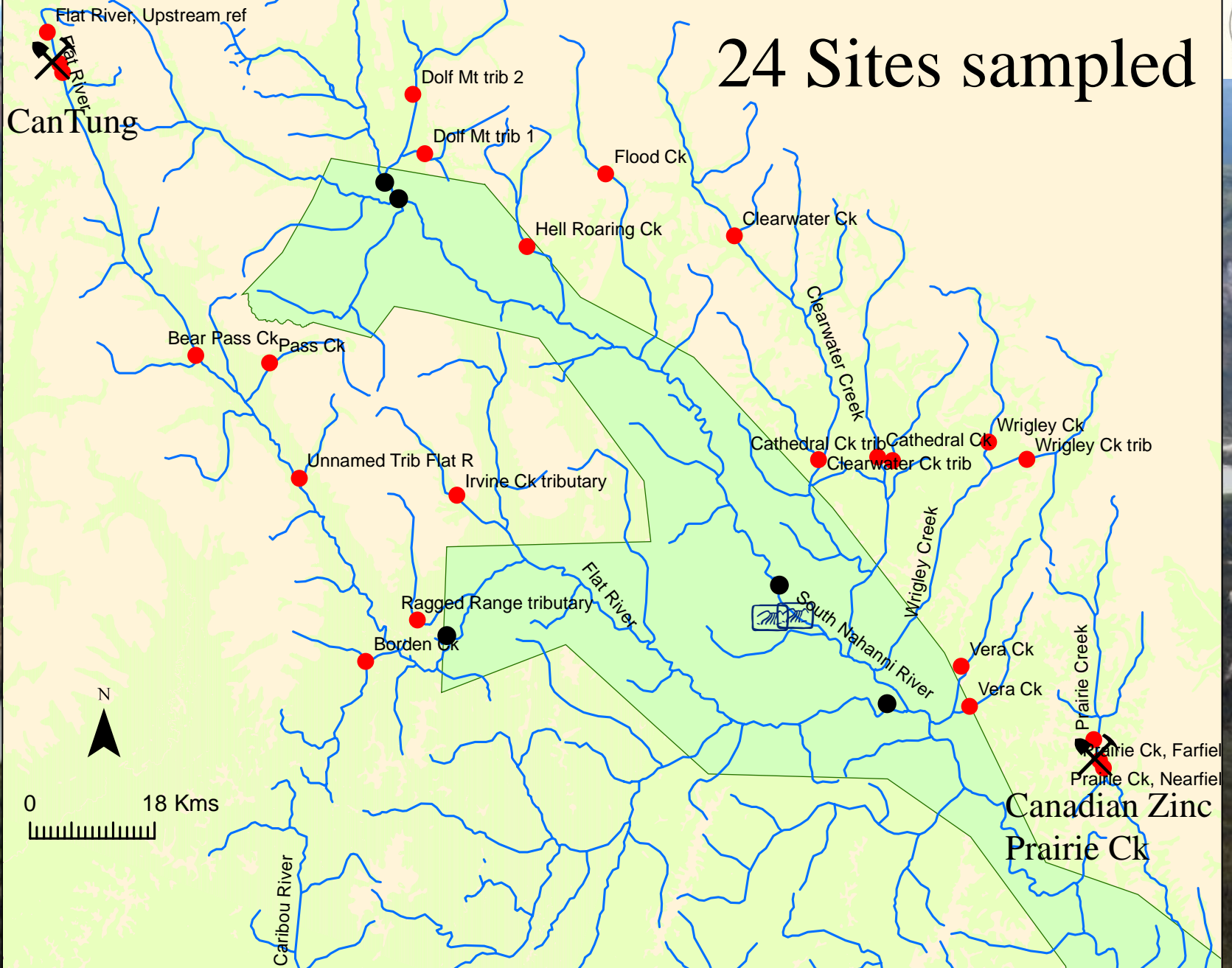
Fort Liard

Watson Lake

Liard River

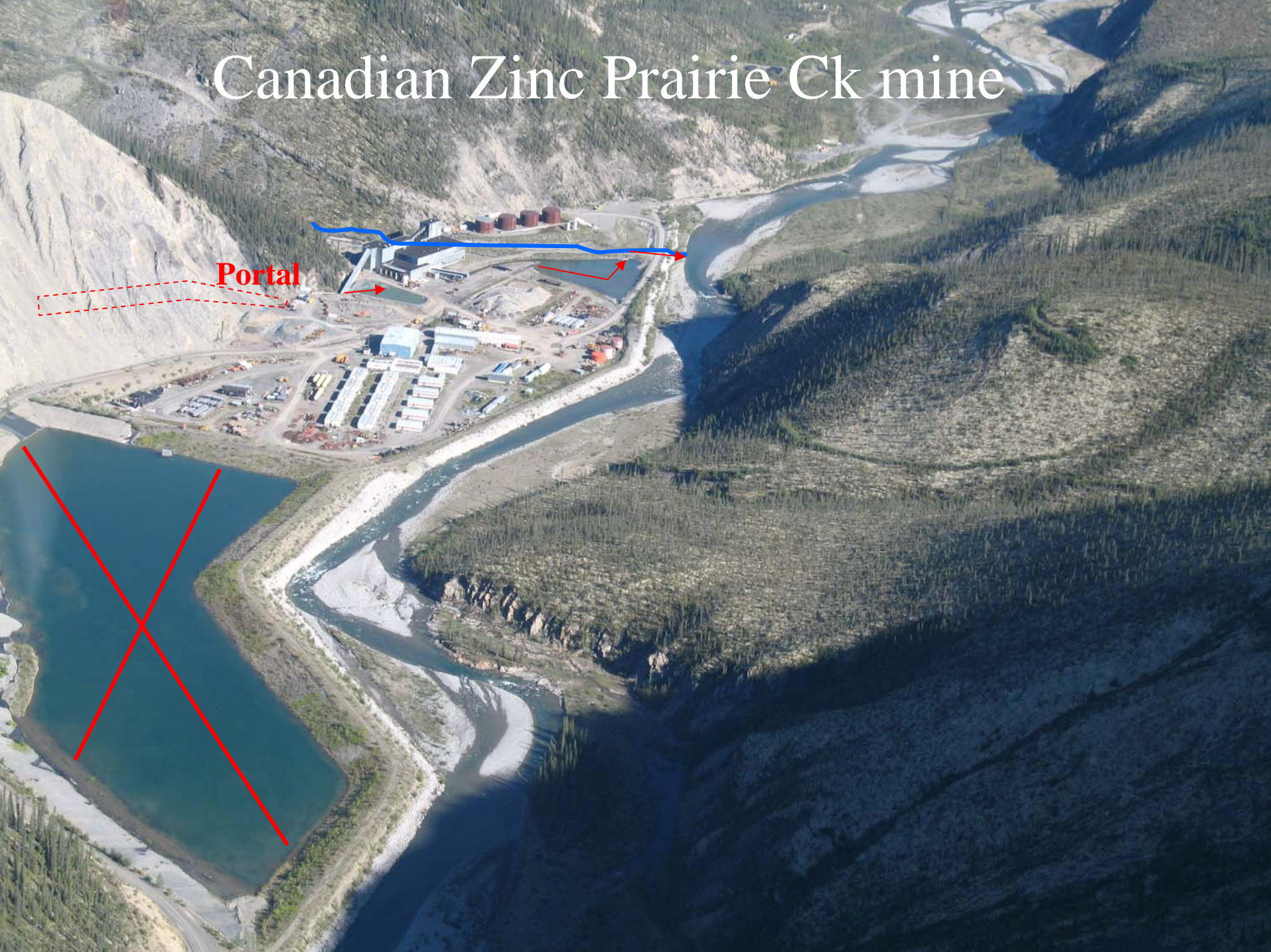
100 km

24 Sites sampled



Canadian Zinc
Prairie Ck

Canadian Zinc Prairie Ck mine



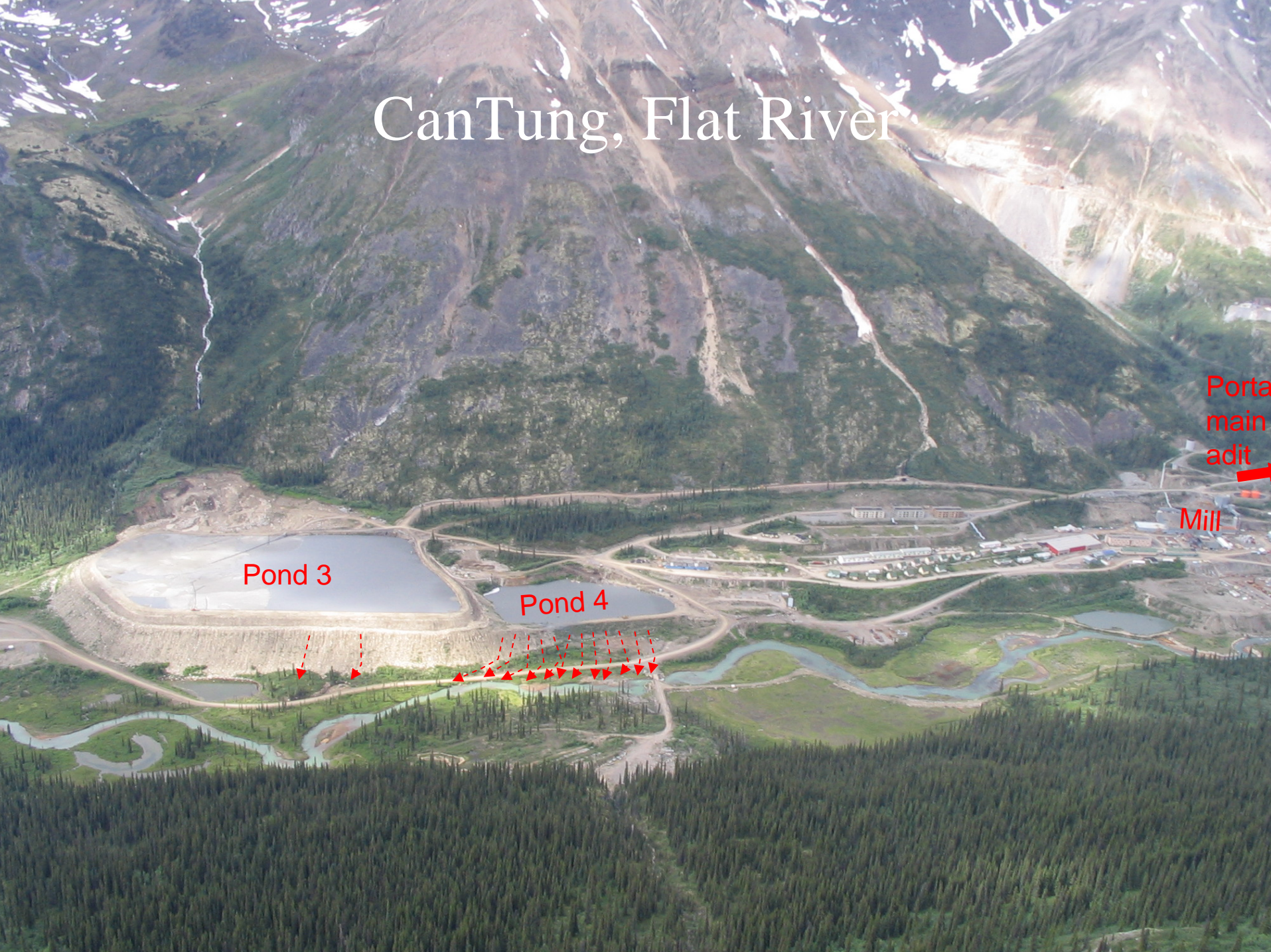
Portal

Canadian Zinc Prairie Ck mine

- Estimated > \$2.5 billion deposits of zinc, lead and copper with silver and gold credits
- 1000 t/day mill built in 1982 but never brought into production
- Currently being developed with a view to starting production
- July 2006 discharge into Harrison Ck averaged ~518 m³ per day

Canadian Zinc	
Parameter	Level (mg/L unless stated otherwise)
pH	8.4
Conductivity	1317 μ s/cm
Ammonia	0.2
TSS	12.3
As	0.0025
Cd	0.0257
Cu	0.012
Pb	0.024
Hg	0.0003
Ni	0.008
Zn	2.32

CanTung, Flat River



Pond 3

Pond 4

Porta
main
adit

Mill

CanTung, Flat River

- Active (since 2001) underground mine for Tungsten in the form of scheelite, tailings disposed of by infiltration
- In July 2006 there were 119,200 m³ of fluid discharged to tails.
- Tailings discharge contains, suspended sediments from mill, 140m³/day domestic sewage.

Parameter	Canadian Zinc	CanTung (pond 4)
	Level (mg/L unless stated otherwise)	Level (mg/L unless stated otherwise)
pH	8.4	8.2
Conductivity	1317 μ s/cm	755 μ s/cm
ammonia	0.2	2.43
TSS	12.3	1140
As	0.0025	0.0108
Cd	0.0257	0.0031
Cu	0.012	2.5
Pb	0.024	0.049
Hg	0.0003	nd
Ni	0.008	0.035
Zn	2.32	0.408

**EEM
sites**

Stream	Slimy sculpin	Arctic grayling	Bull trout	Round whitefish
Prairie Ck, Upstream	47	-	-	-
Prairie Ck, Nearfield	72	-	5	-
Prairie Ck, Farfield	32	-	2	-
Flat R, Upstream	205	6	1	-
Flat R, Nearfield	110	7	-	-
Flat R, Farfield	91	1	-	7
Total	557	14	8	7
Average	93	2.3	1.3	1.2

RCA
sites

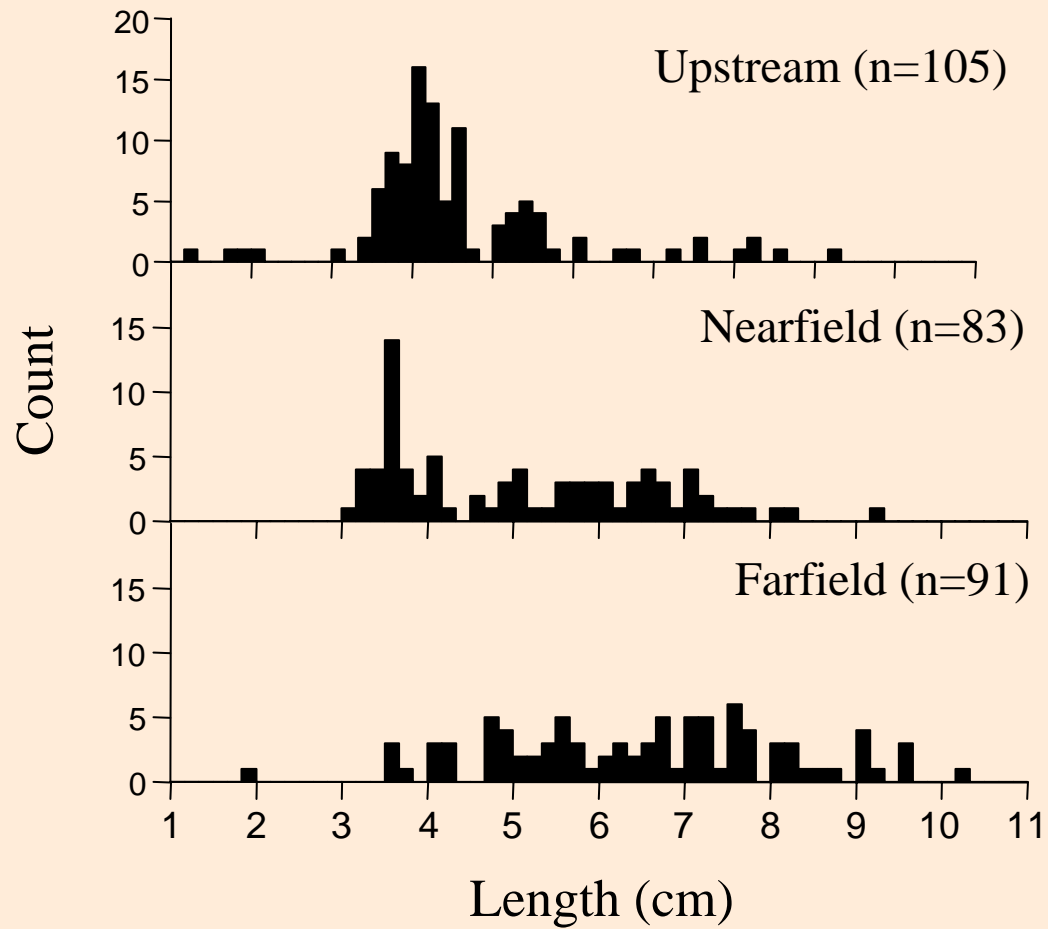
Stream	Slimy sculpin	Arctic grayling	Bull trout
Wrigley Ck	31	2	2
Cathedral Ck trib	9	-	-
Cathedral Ck	1	2	1
Flood Ck	31	5	-
Hell Roaring Ck	48	-	-
Dolf Mt trib 1	-	4	-
Vera Ck	-	3	-
Vera Ck	37	-	-
Wrigley Ck trib	43	-	-
Clearwater Ck trib	9	2	1
Clearwater Ck	20	-	2
Dolf Mt trib 2	75	-	2
Borden Ck	4	-	-
Unnamed Trib Flat R	6	-	-
Total	314	18	8
Average	22	1.3	0.6



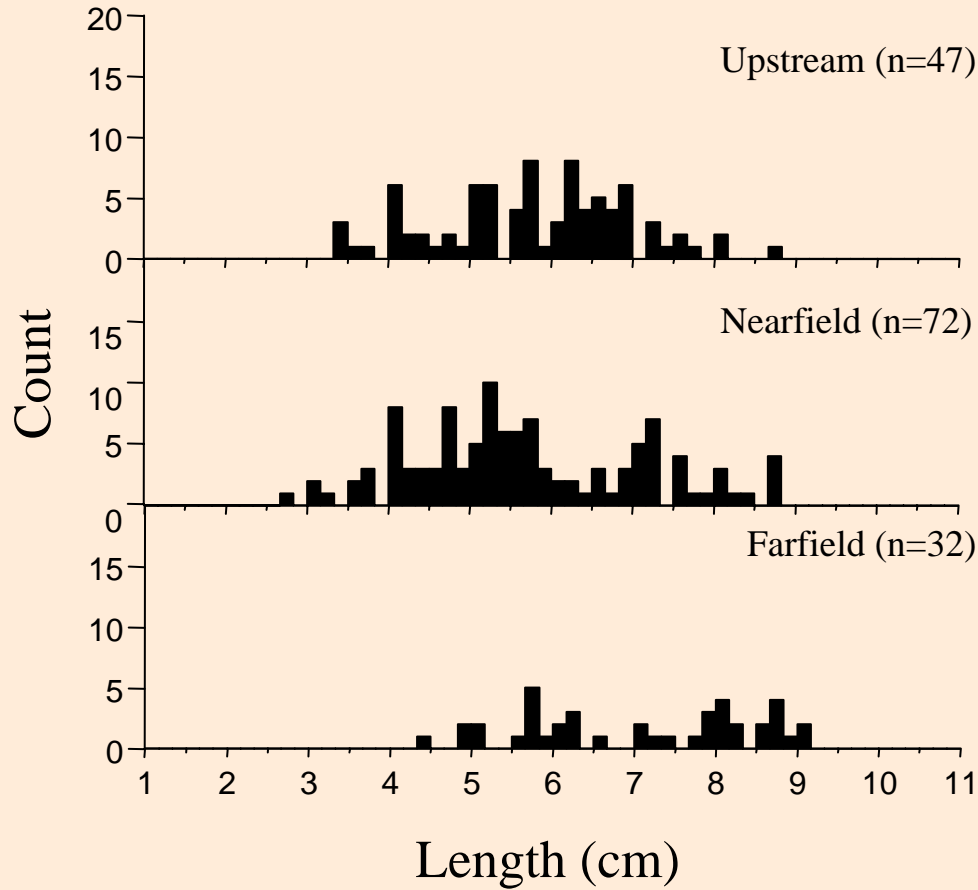
Fish communities

- Caught four species of ~20 reported as being present in the Liard River
- Low species abundance reflects inland headwater nature of catchments
- 94% of all fish caught were slimy sculpin
- Slimy sculpin only real option for effects assessment using fish

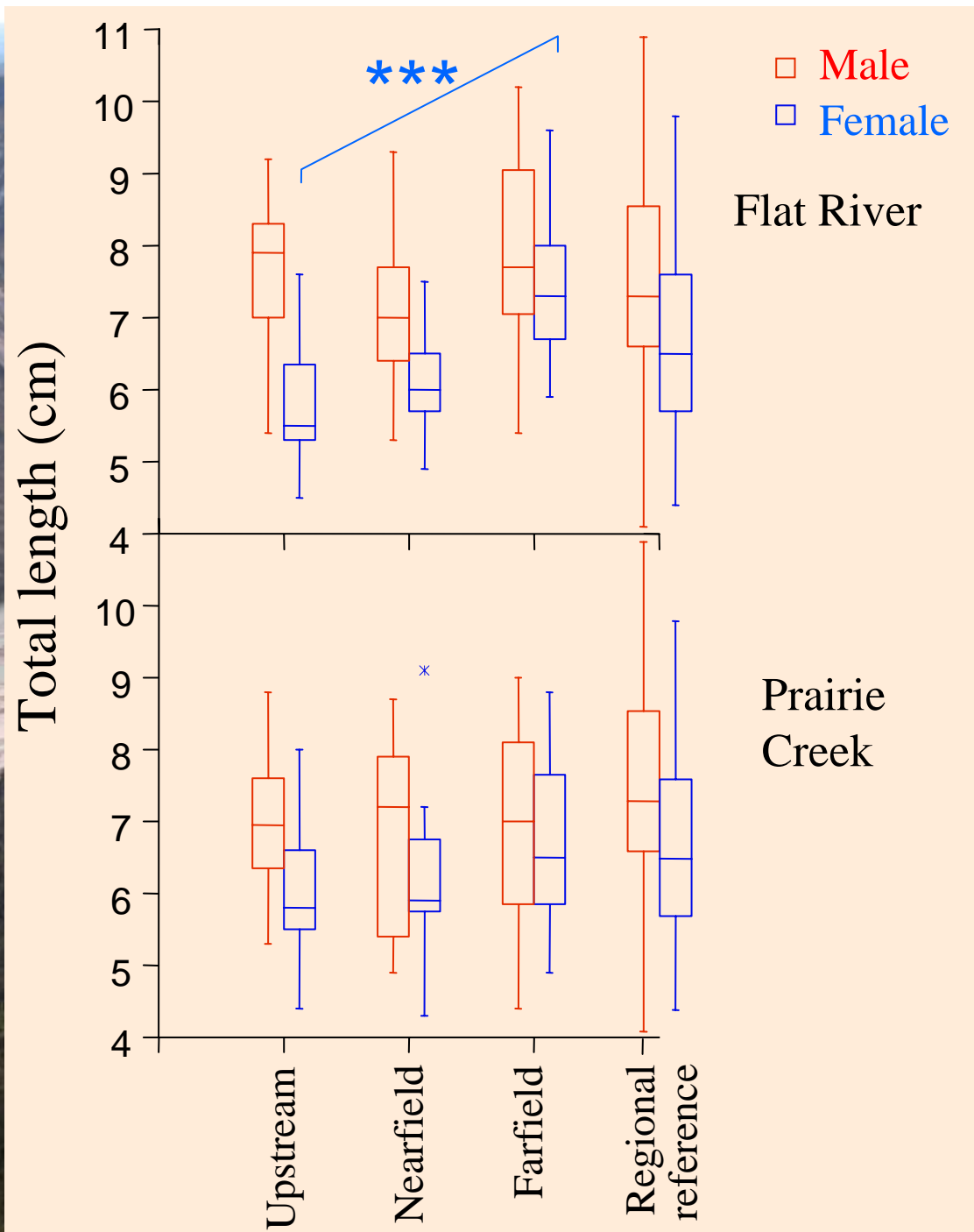
Flat River slimy sculpin populations



Prairie Creek slimy sculpin populations



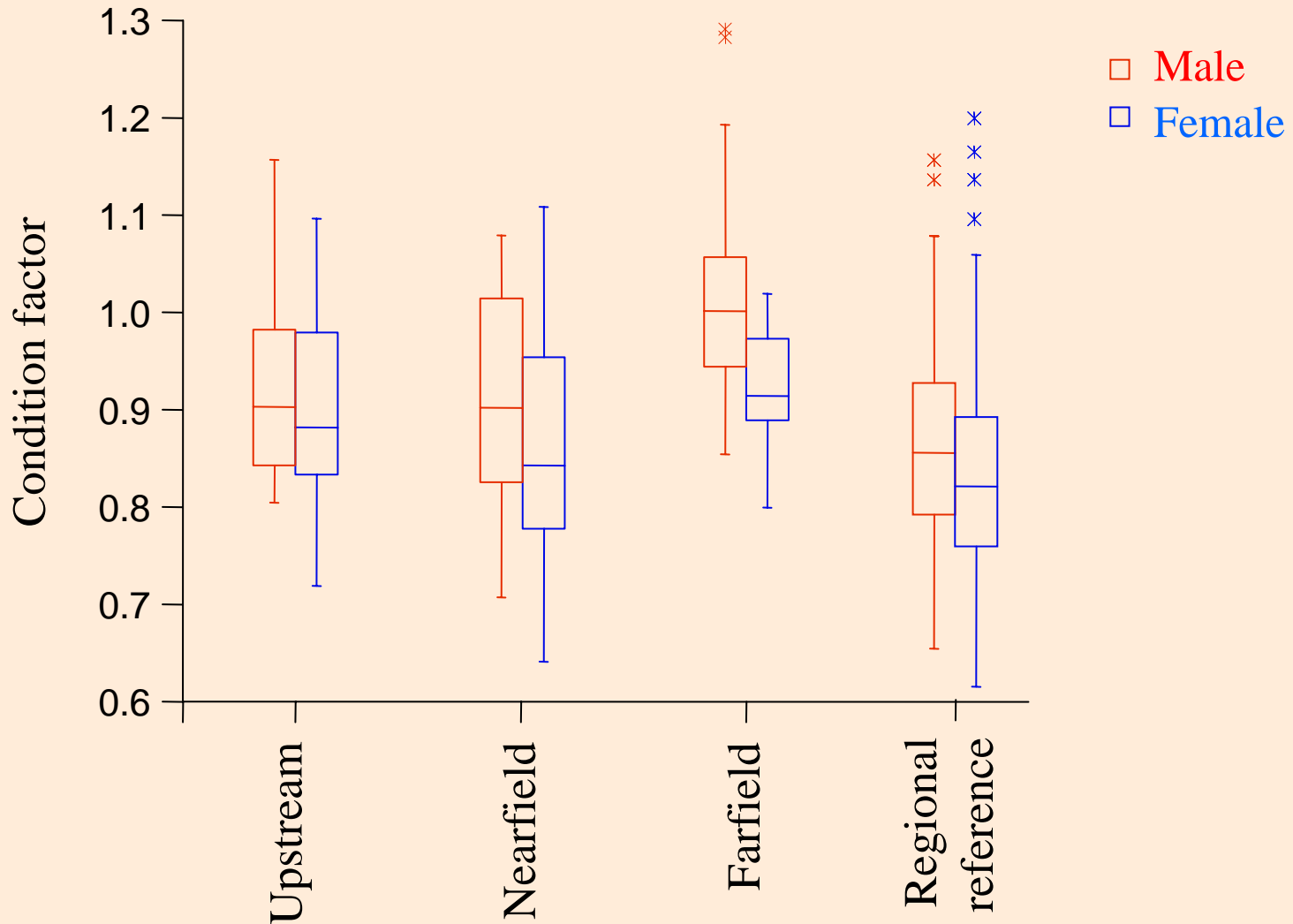
EEM sites
adult
slimy sculpin
length



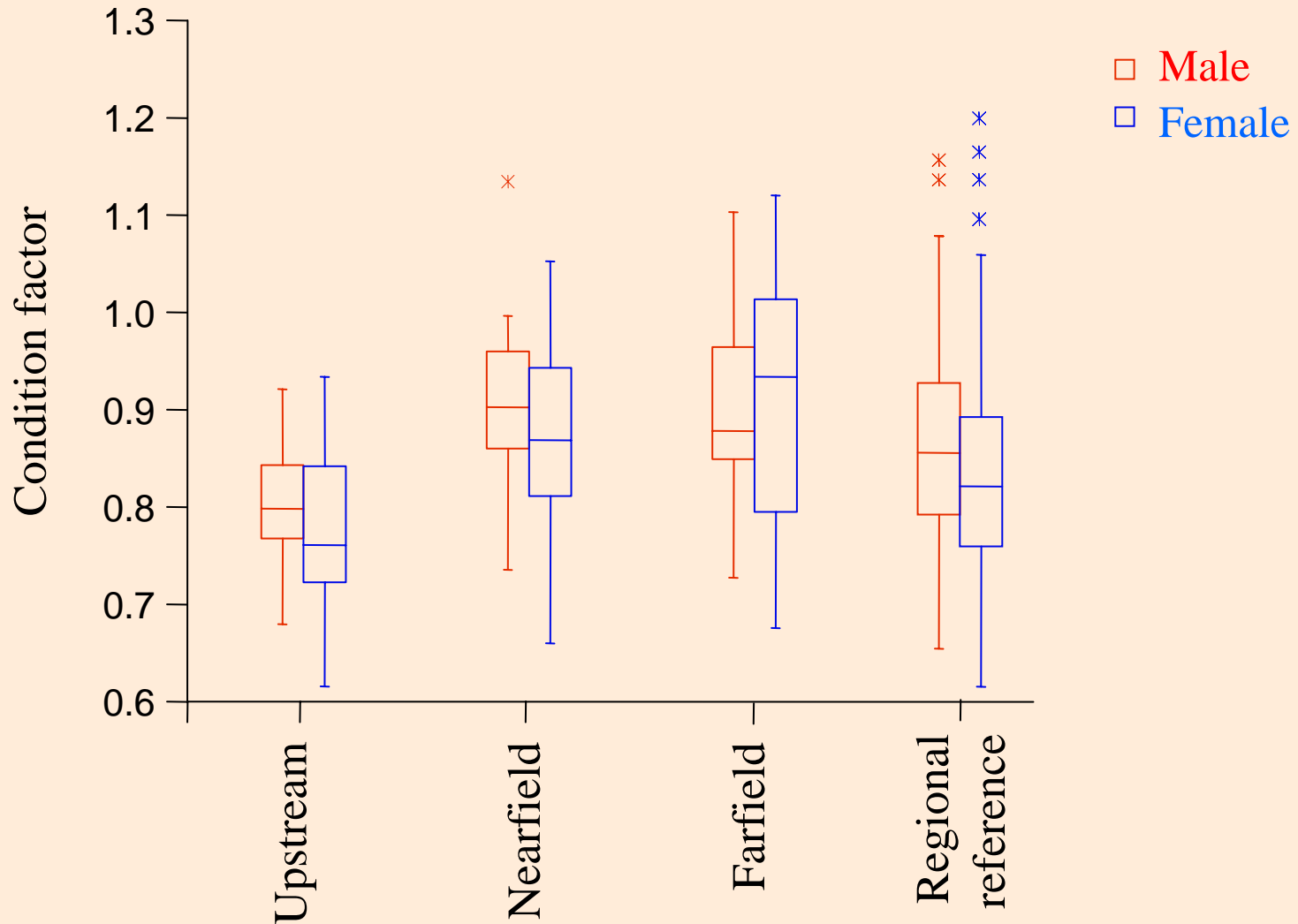
Slimy sculpin populations

- Wide size range of sculpin caught
- Adult males are longer than females
- Strong habitat preferences of adults for slower margins or side channels and smaller fish for main channels may drive size range of sculpin caught. i.e. >side channels>adult sculpin
- Can't rule out a natural downstream trend of increasing fish size

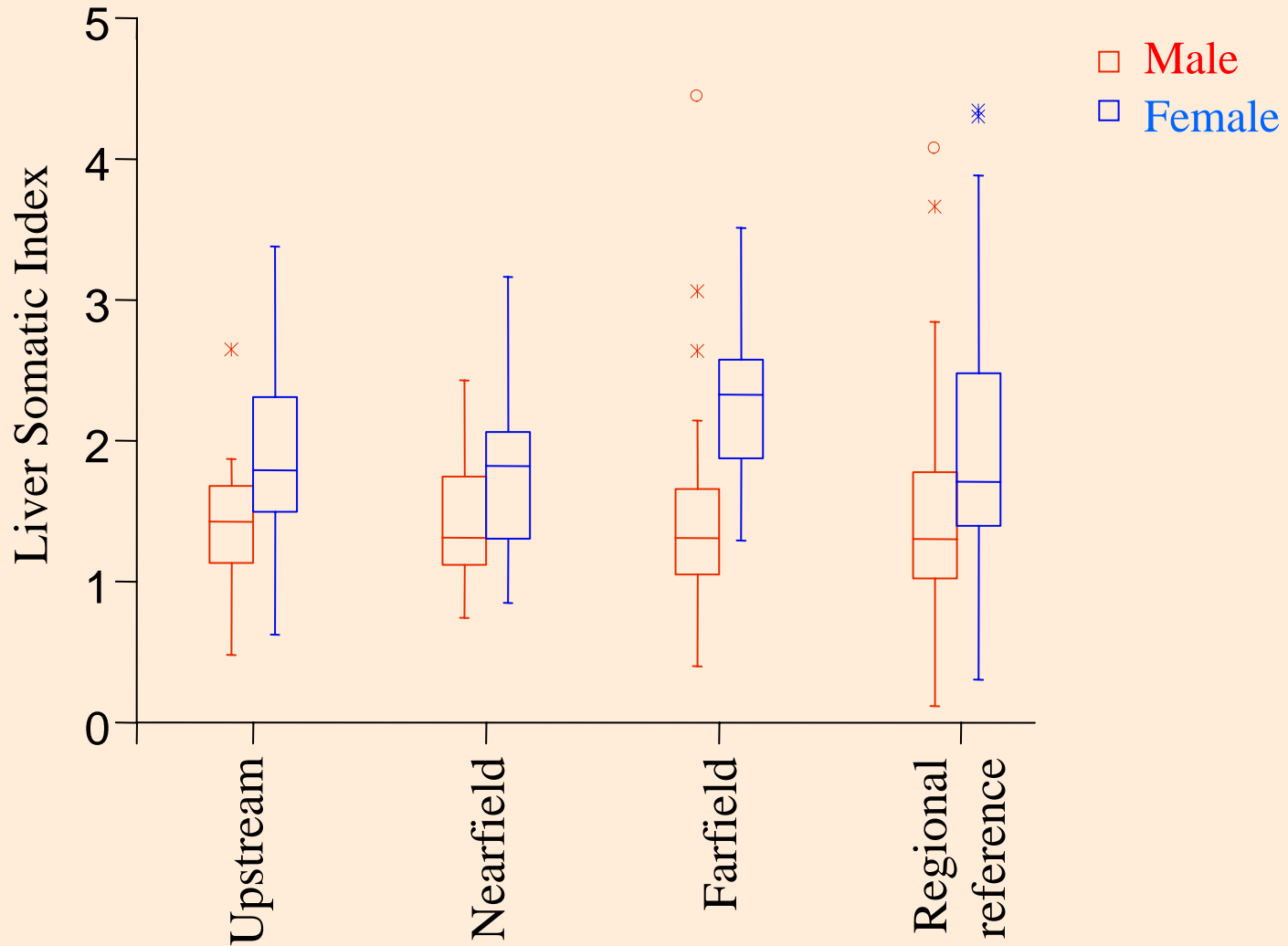
Flat River EEM site adult sculpin condition factor



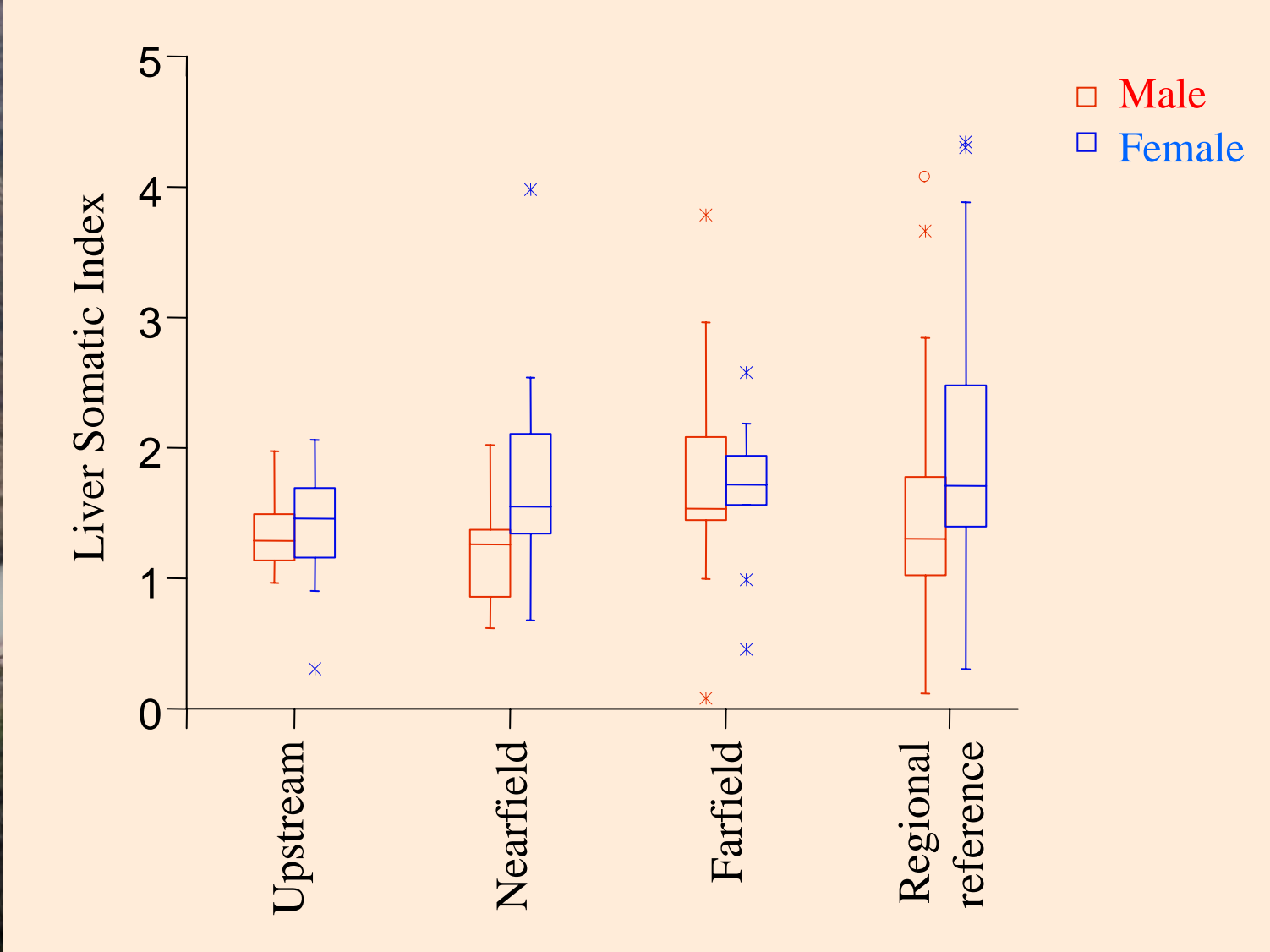
Prairie Ck EEM site adult sculpin condition factor



Flat River EEM site adult sculpin liver size



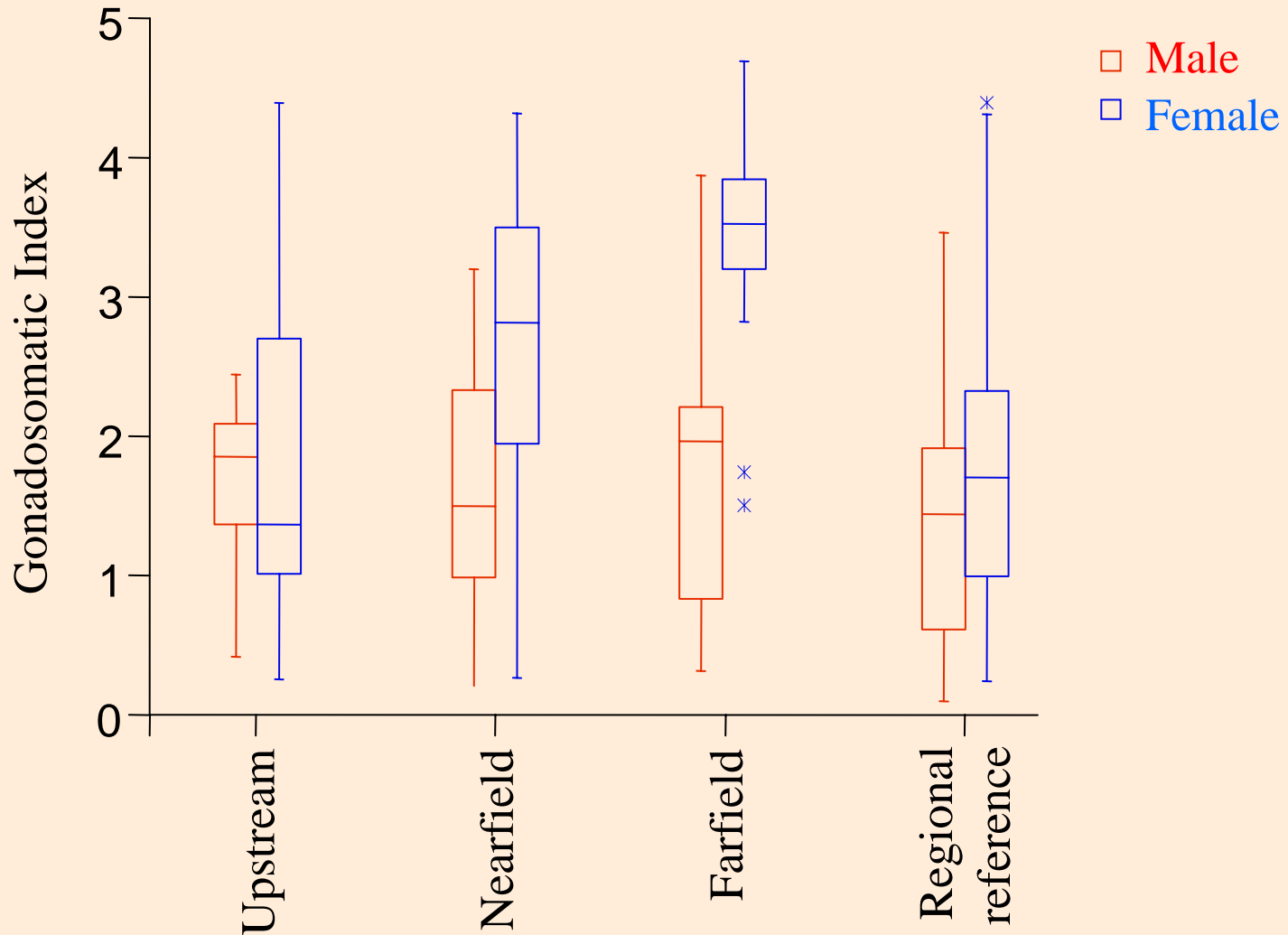
Prairie Ck EEM site adult sculpin liver size



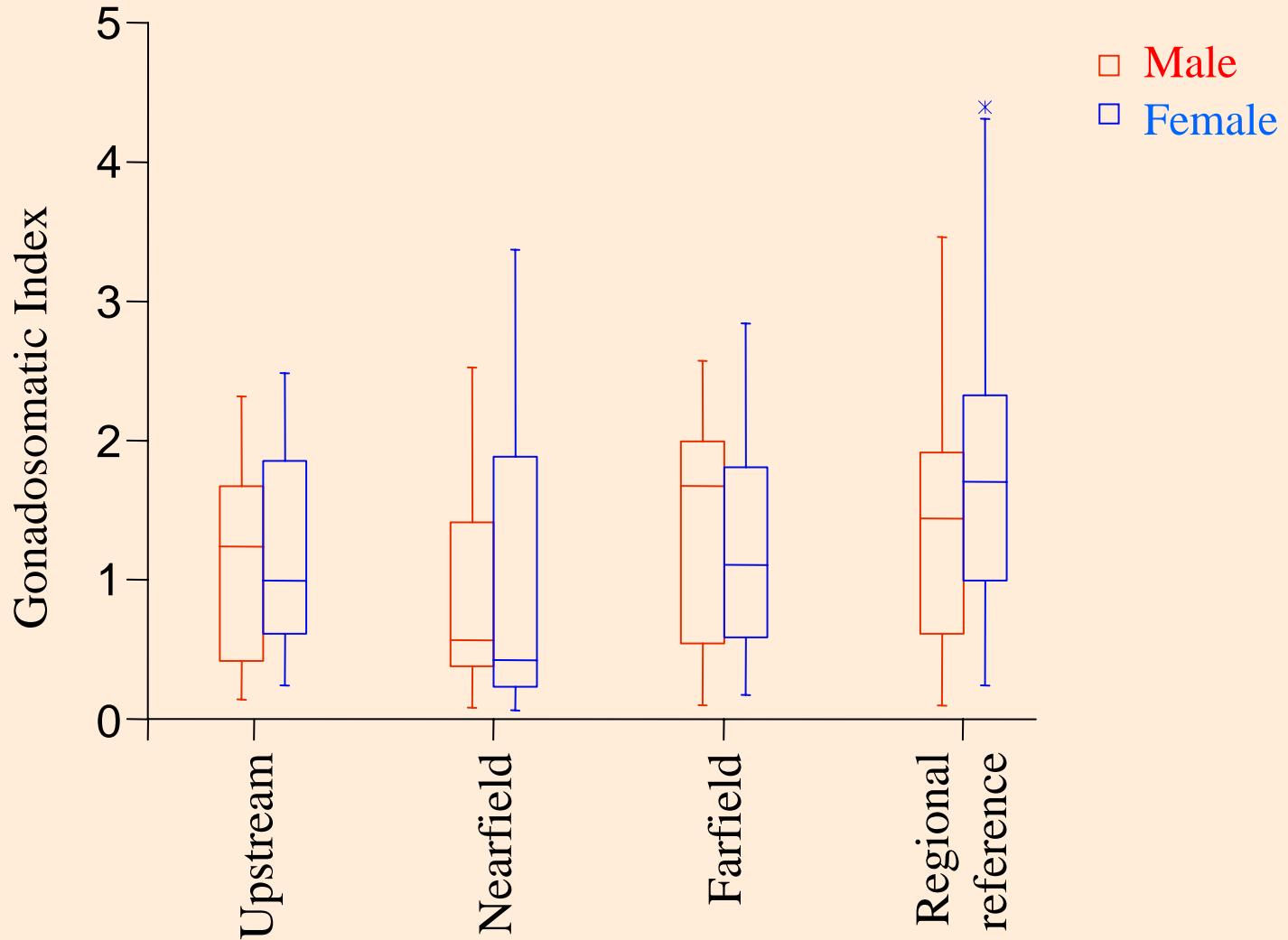
Slimy sculpin condition

- Almost all fish were in good condition
- Flat River fish were in better condition than Prairie Creek
- Slight downstream trend of increasing condition at EEM sites but no significant differences found in preliminary analysis

Flat R EEM site adult sculpin gonad size



Prairie Ck EEM site adult sculpin gonad size



Slimy sculpin gonad size

- Few fecund females found and gonadosomatic index (GSI) were $\frac{1}{4}$ of those reported for spring spawning sculpin in more southern rivers¹
- Male GSIs were in range found previously
- Although larger than regional reference size, female sculpin gonads from nearfield and farfield Flat River sites were not significantly larger than upstream reference site

¹ Gray, M. A., and K. R. Munkittrick. 2005. An effects-based assessment of slimy sculpin (*Cottus cognatus*) populations in agricultural regions of northwestern New Brunswick. *Water Quality Research Journal of Canada* 40(1):16-27.

Conclusions

- Slimy sculpin again prove their utility as monitoring species
- Little evidence of mine effects in preliminary analysis of individual sculpin variables
- Metal analysis of water, sediment and sculpin is being carried out to determine exposure to mine effluents
- Sculpin population dynamics around mines requires further analysis, i.e. aging and modeling of length at age relationships
- Examination of the complete dataset using a Reference Condition Approach with all habitat, physiochemical and landscape variables will help determine natural habitat or longitudinal trends in aquatic communities

The crew

