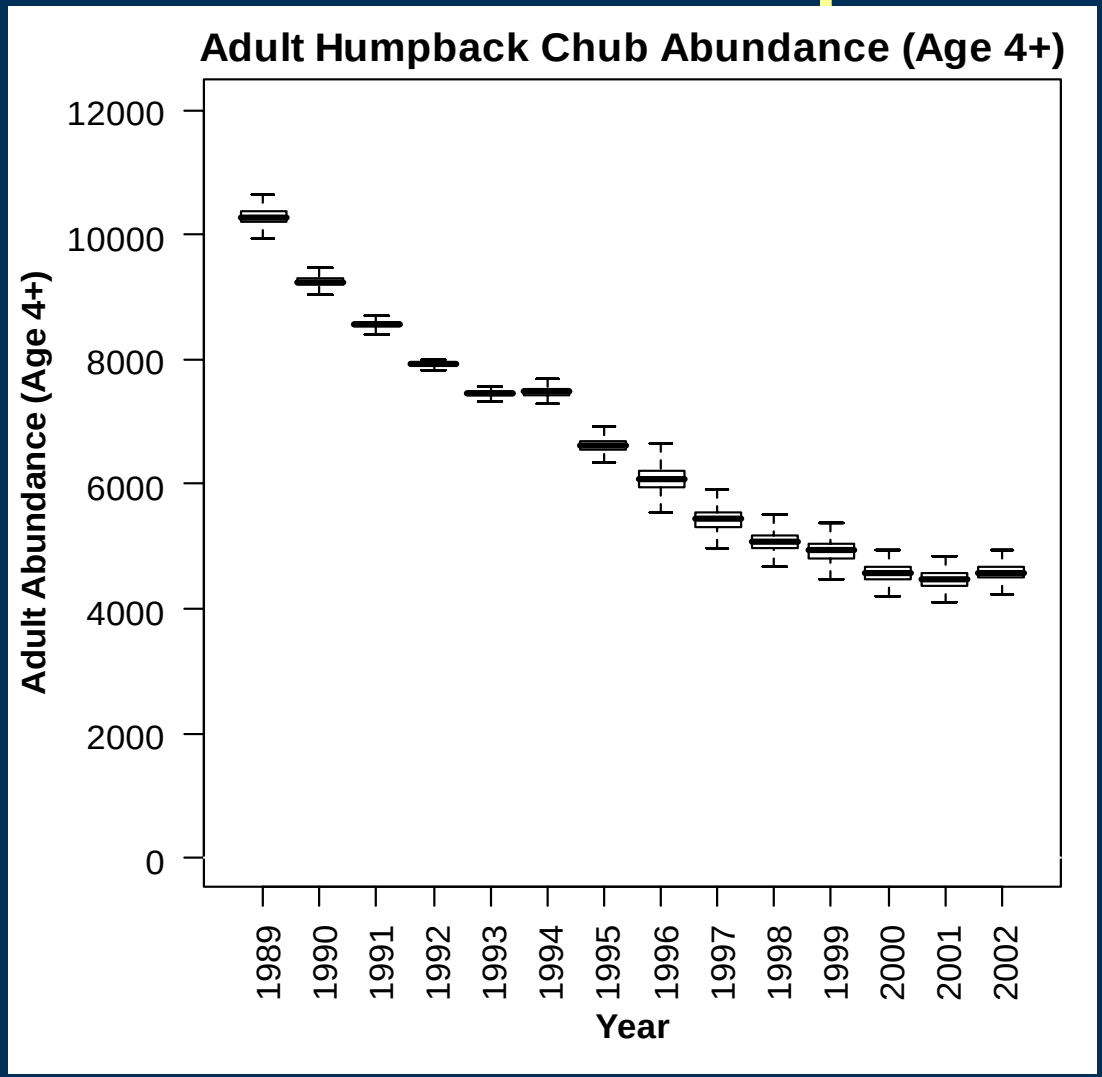
USGS
science for a changing world

FORAGING ECOLOGY OF NONNATIVE TROUT IN THE COLORADO RIVER, GRAND CANYON: PREDATION ON NATIVE FISHES AND THE EFFECTS OF TURBIDITY

M.D. Yard[1], L.G. Coggins[1], Jr., C.V. Baxter[2]
Presented by: M.E. Andersen[1]
[1]Southwest Biological Science Center
Grand Canyon Monitoring and Research Center
And [2]Idaho State University

U.S. Department of the Interior
U.S. Geological Survey

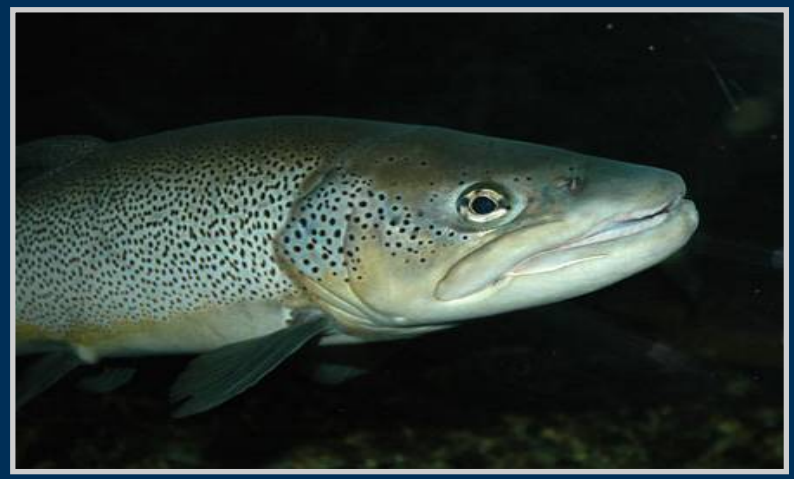
Status of Adult Humpback chub, 2002



AZGFD

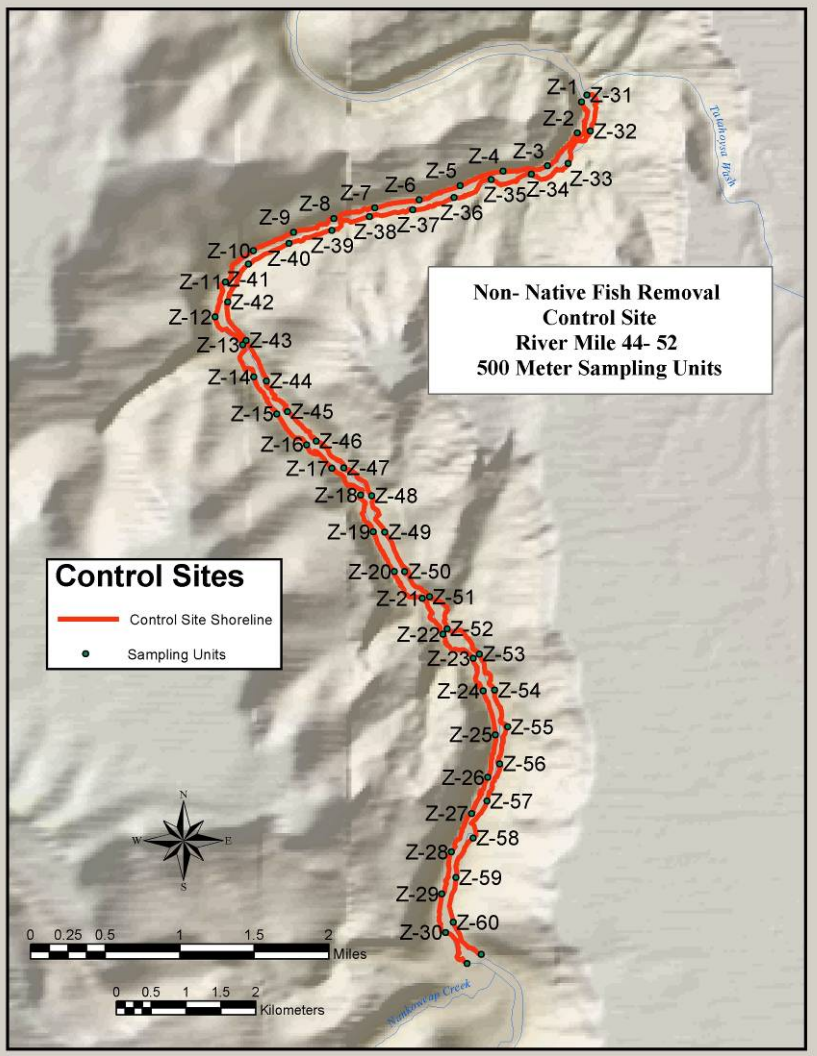
One Threat: Nonnative predation

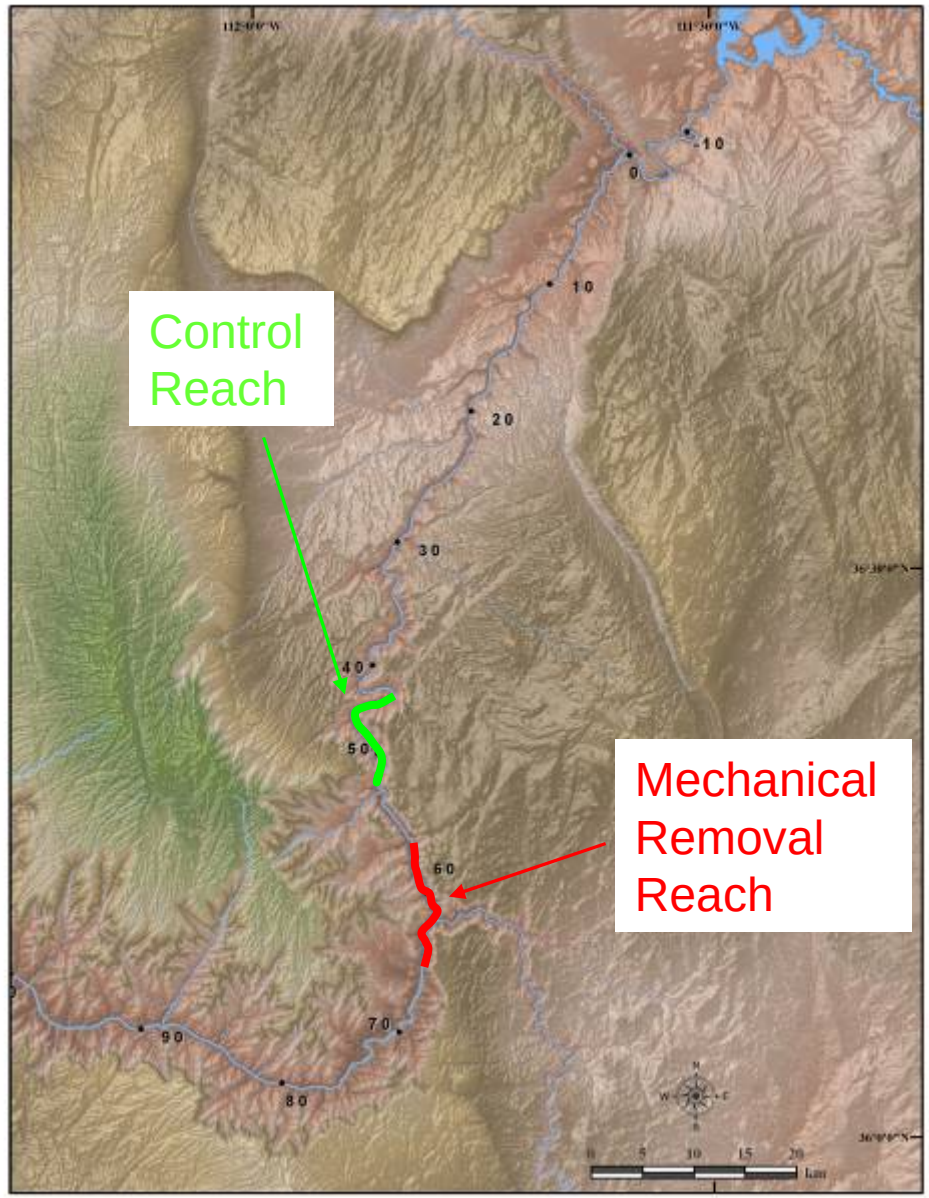
- Rainbow trout
- Brown trout
- Other nonnative piscivores



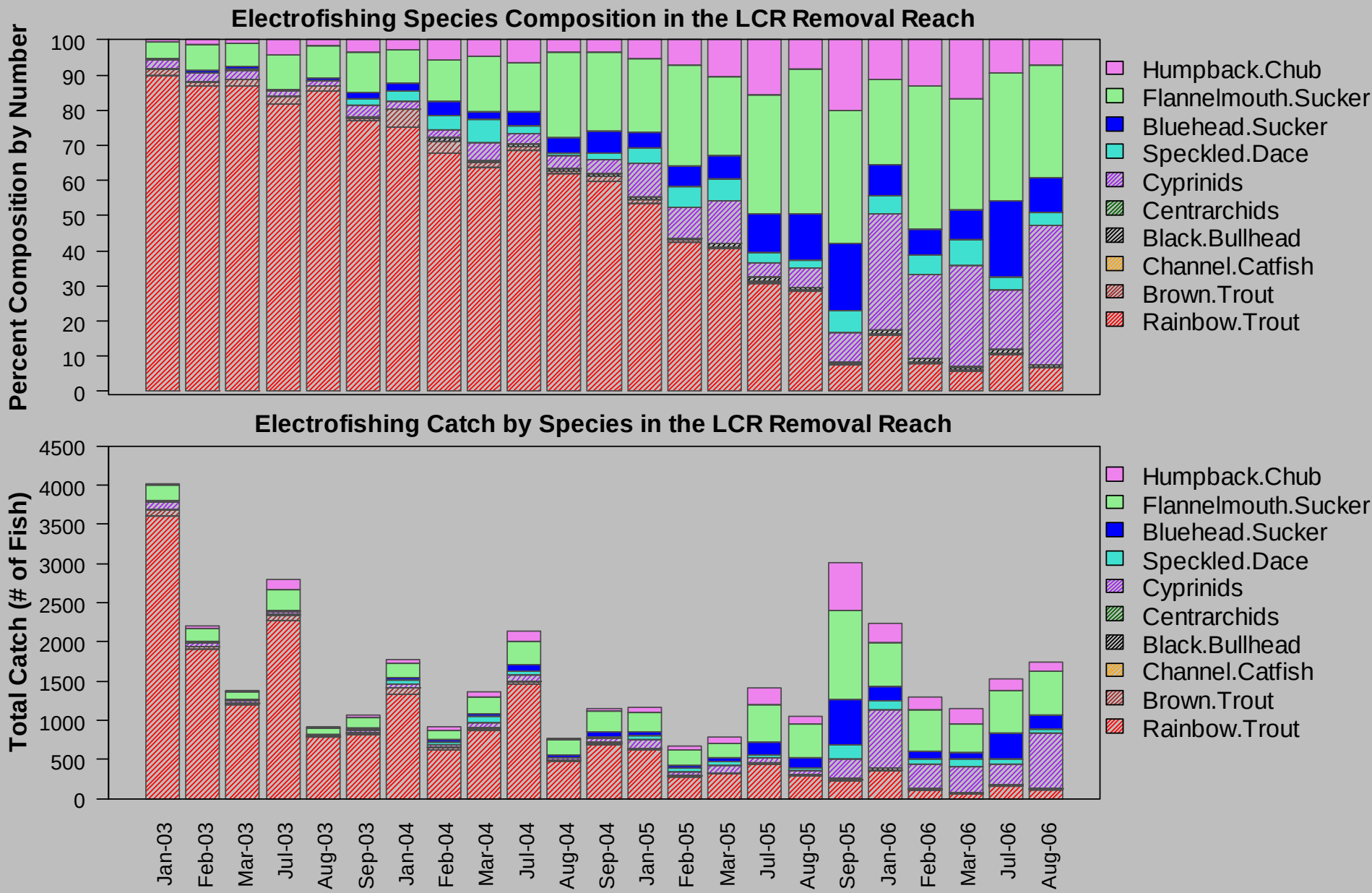
USGS

Mechanical Removal Locations





Results - Mechanical Removal Reach



OBJECTIVES – Foraging Ecology

1. Determine the incidence of piscivory by rainbow trout and brown trout on native fishes

2. Compare the use vs. availability of different invertebrate and fish prey by these trout

3. Evaluate how turbidity affects prey availability and utilization, including the degree of piscivory.

    a. Model the effects of turbidity on drift foraging.

    b. Estimate the quantity of native fish consumed by nonnative trout under management scenarios with and without fish suppression

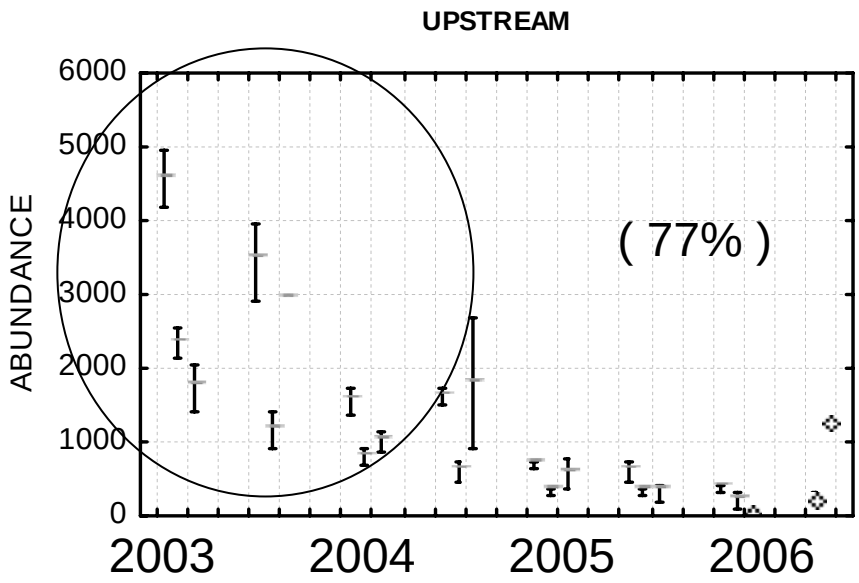
USGS

Methods

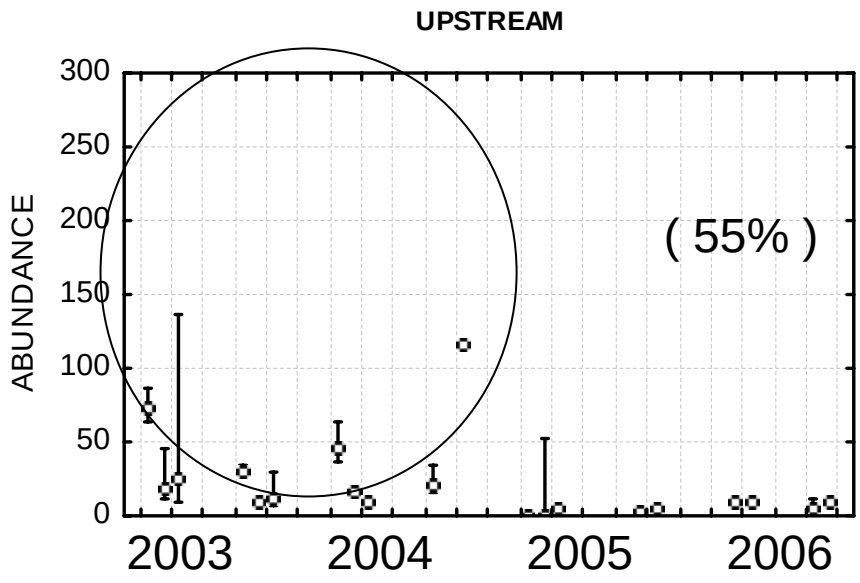
- Fish Sampling
  - Electrofishing (nRBT = 17,258; nBRT = 479)
- Prey Availability
  - Electrofishing, Drift Sampling, Benthic Sampling
- Diet Analysis
  - Fish Metrics, Frequency of Piscivory, Diet Composition, Diet Indices, Modeling

USGS

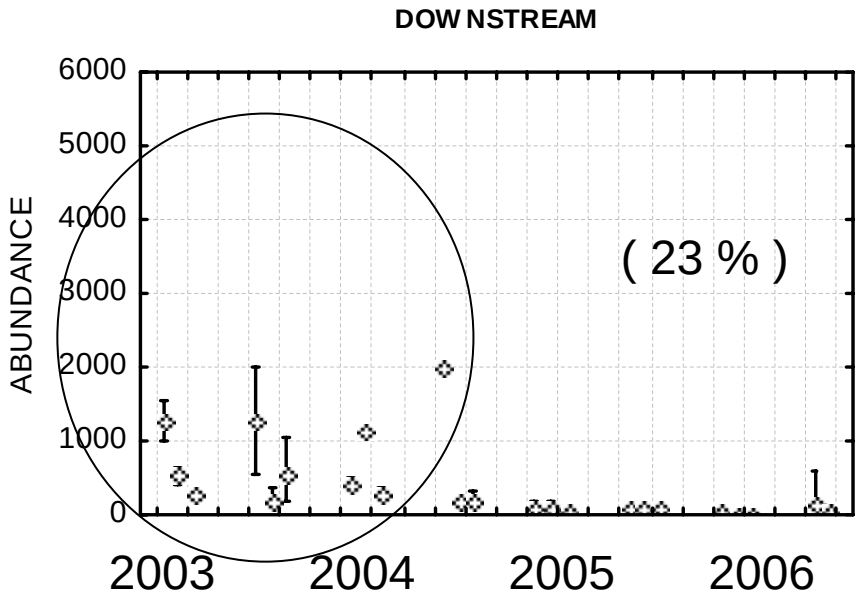
RAINBOW TROUT

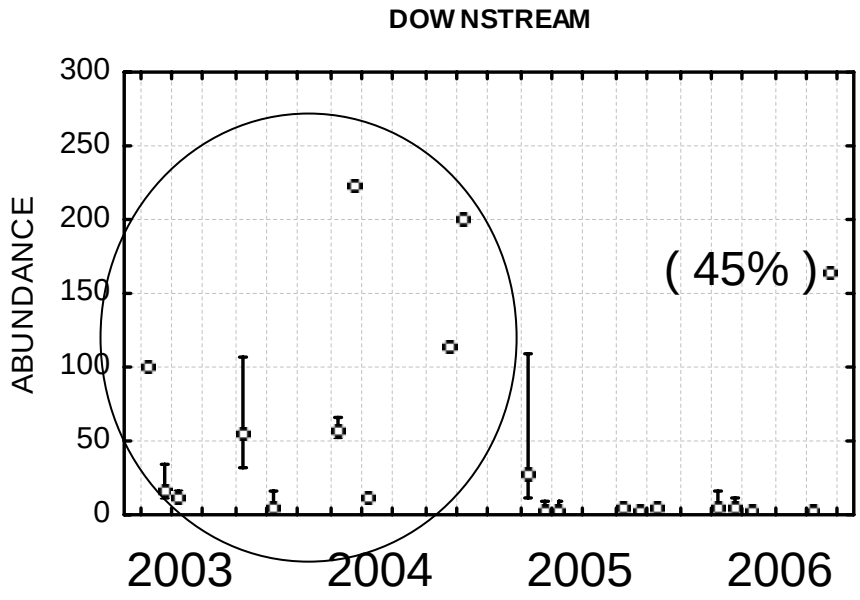


BROWN TROUT



Preliminary Data, Subject to Review and Revision





INCIDENCE OF PREDATION

(Rainbow and Brown Trout)

VERTEBRATE PREY

ORIGIN	TYPE	PREY PROPORTIONS
AQUATIC	FISH	90.3%
TERRESTRIAL	OTHER	2.5%
	LIZARDS	1.2%
	BIRDS	0.8%
	BATS	0.2%
UNKNOWN	VERTEBRATE	5.0%

USGS

Preliminary Data, Subject to Review and Revision

INCIDENCE OF PISCIVORY

(Rainbow and Brown Trout)

IDENTIFIABLE FISH PREY

TYPE	COMMON NAME	SPECIES	PREY PROPORTIONS
NATIVE FISH	FLANNELMOUTH SUCKER	*(Catostomus latipinnus)*	10.6%
	BLUEHEAD SUCKER	*(Catostomus discobolus)*	3.0%
	UNIDENTIFIABLE SUCKER	*(Catostomus sp.)*	28.8%
	HUMPBACK CHUB	*(Gila cypha)*	27.3%
	SPECKLED DACE	*(Rhinichthys osculus)*	15.2%
NON-NATIVE FISH	FATHEAD MINNOW	*(Pimephales promelas)*	7.8%
	RAINBOW TROUT	*(Oncorhynchus mykiss)*	7.3%

IDENTIFIABLE FISH PREY

TYPE	PREY PROPORTIONS	COMMUNITY COMPOSITION
NATIVE FISH	85.0%	30.0%
NON-NATIVE FISH	15.0%	70.0%

USGS

Preliminary Data, Subject to Review and Revision

INCIDENCE OF PISCIVORY

Rainbow Trout

- MIP was low and varied with location and season
  - Seasons ($p < 0.01$, summer 1.7%, and winter 1.05%)
  - Locations ($p < 0.01$, upstream 0.61%, downstream 2.1%)
  - Years ($p = 0.59$)

Brown Trout

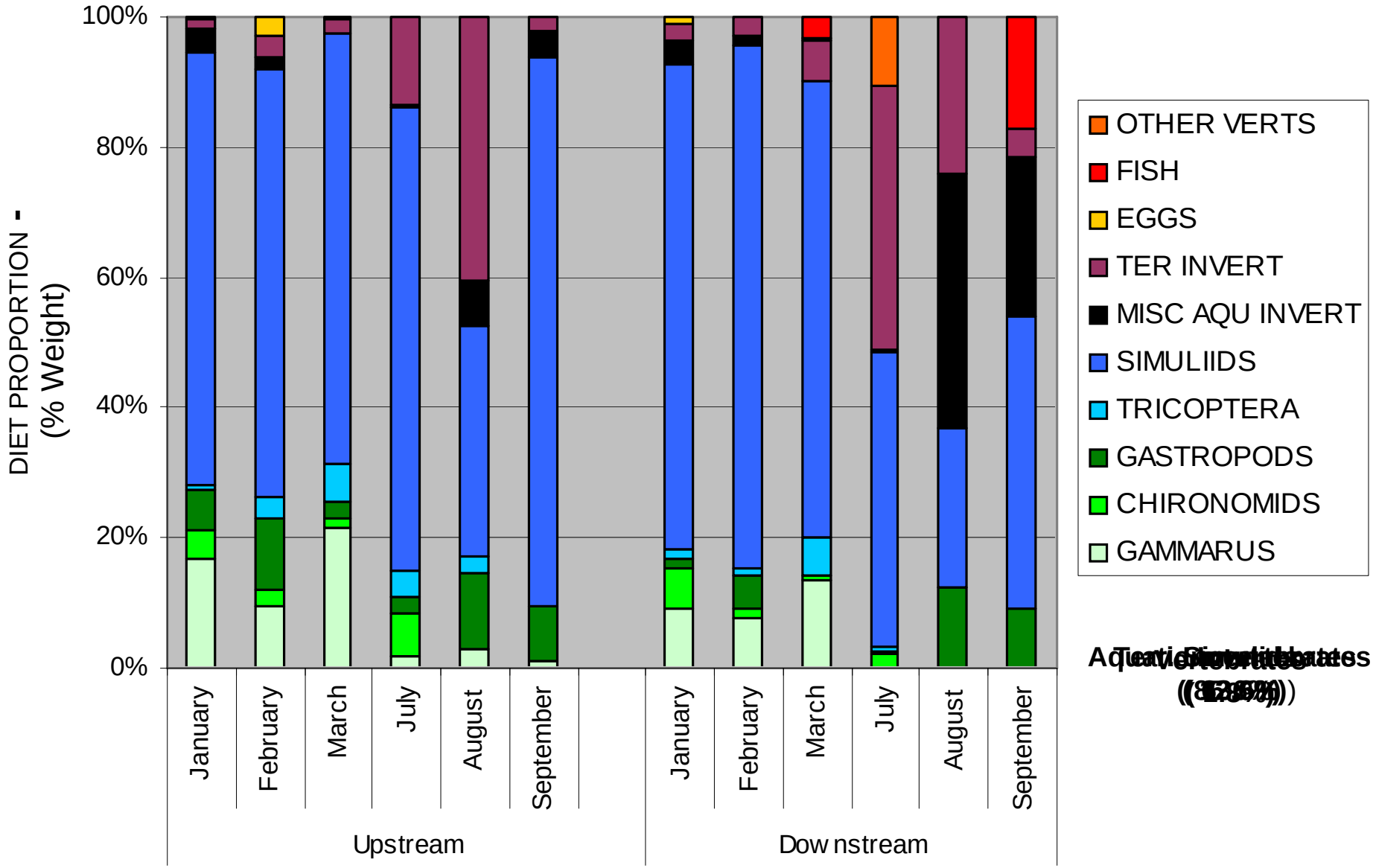
- MIP was high and varied with location
  - Seasons ($p = 0.09$)
  - Locations ($p < 0.01$, upstream 11.6%, downstream 36%)
  - Years ($p = 0.6$)

USGS

Preliminary Data, Subject to Review and Revision

RAINBOW TROUT
2003-2004

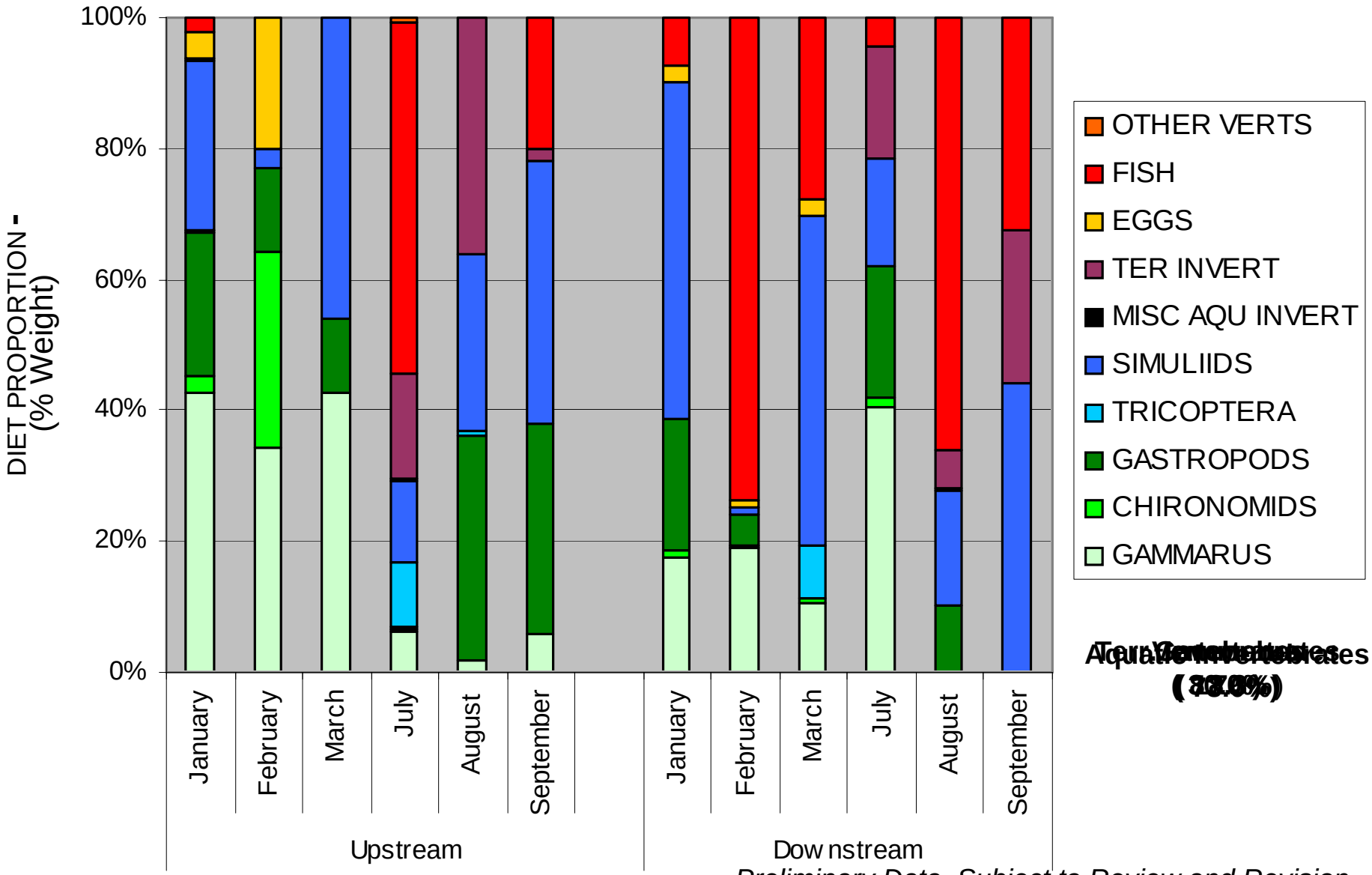
N = 956



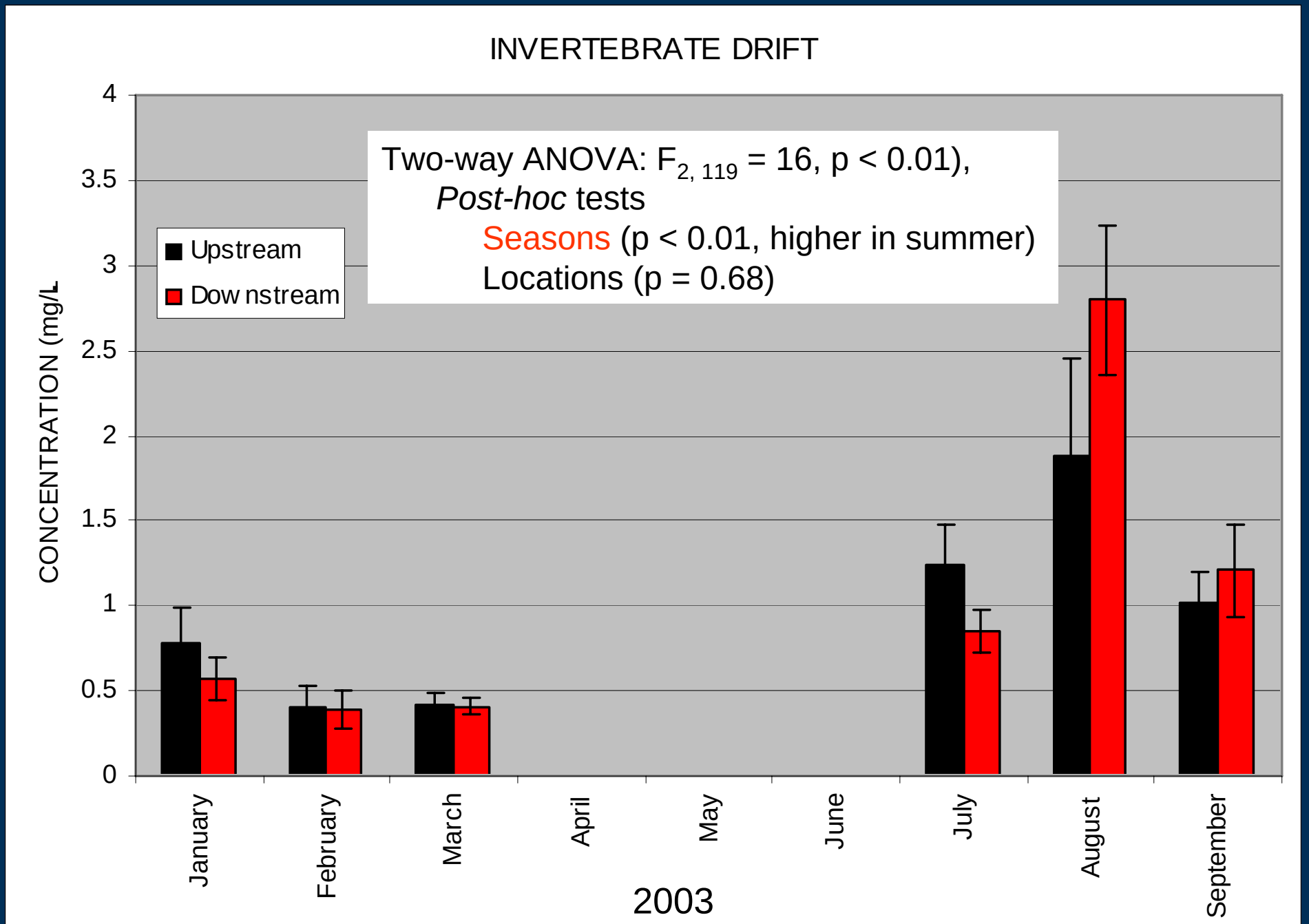
Preliminary Data, Subject to Review and Revision

BROWN TROUT
2003-2004

N = 372



Preliminary Data, Subject to Review and Revision


INVERTEBRATE DRIFT
Two-way ANOVA: $F_{2, 119} = 16$, $p < 0.01$),
Post-hoc tests
Seasons ($p < 0.01$, higher in summer)
Locations ($p = 0.68$)
Upstream
Downstream
CONCENTRATION (mg/L)
4
3.5
3
2.5
2
1.5
1
0.5
0
January
February
March
April
May
June
July
August
September
2003

Rainbow Trout Diet Analysis

SUMMARY

- **Abundance is less downstream (23%)**
- **Condition factor is less downstream**
- **Stomachs are frequently empty downstream**
- **Stomachs are frequently empty in summer**

CONTRADICTIONS

- **Diet composition remains the same upstream and downstream**
- **Drift prey availability is higher in summer**
- **Drift prey availability remains the same upstream and downstream**
- **Benthic prey availability is higher in winter**
- **Benthic prey availability is higher downstream**

USGS

Preliminary Data, Subject to Review and Revision

LCR Inflow

USGS

FISH CONSUMPTION ESTIMATES

		FISH SUPPRESSION			WITHOUT FISH SUPPRESSION[a]		
Year	Species	Upstream	Downstream	Total	Upstream	Downstream	Total
RAINBOW	2003	4,334	5,751	10,086	9,701	16,061	25,762
	2004	1,389	4,682	6,071	6,830	8,545	15,375
	Total	5,724	10,433	16,157	16,530	24,606	41,137
BROWN	2003	626	7,088	7,713	1,948	17,644	19,593
	2004	311	5,181	5,491	2,017	11,189	13,206
	Total	936	12,269	13,205	3,965	28,834	32,799
COMBINED	2003	4,960	12,839	17,799	11,649	33,706	45,355
	2004	1,700	9,863	11,563	8,847	19,734	28,581
	Total	6,660	22,702	29,362	20,496	53,440	73,936

[a] Rainbow trout picivory rates expanded by largest abundance estimate (upstream = 4,977; downstream = 1,727)

Brown trout picivory rates expanded by largest abundance estimate (upstream = 109; downstream = 136)

USGS

Preliminary Data, Subject to Review and Revision

Conclusions

RAINBOW TROUT

- **Detection ability, rather than food availability, appears to explain differences in rainbow spatial distribution and condition factors**
- **Drift feeding appears to be an inadequate strategy for providing daily rations**
- **Higher electivity for larger invertebrate prey items**
- **Foraging strategy may shift from visual sight feeding to a more mobile, searching strategy under increased turbidity**
- **At high densities cumulative affects from piscivory may exceed brown trout**

USGS

Preliminary Data, Subject to Review and Revision

Conclusions

BROWN TROUT

- **Highly piscivorous, but the least abundant trout**
- **Brown trout distribution and condition are not correlated to increased turbidity**
- **Diet is not correlated with invertebrate drift availability**
- **Incidence of piscivory is correlated with prey availability of native fish**
- **Incidence of piscivory is not influenced by turbidity**
- **Brown trout use a mobile foraging strategy that includes epibenthic feeding and piscivory**

USGS

Preliminary Data, Subject to Review and Revision