

Interactions between environment and biota that influence predation of small bodied fish near the Little Colorado River, Grand Canyon, AZ.



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Grand Canyon Monitoring and Research Center  
&  
EcoNatura

# STUDY OBJECTIVES

## BIOTIC FACTORS

- Predator species
- Predator density
- Prey density

## ENVIRONMENTAL FACTORS

- Seasonal / Spatial differences
  - Sediment discharge
  - Reactive distance
  - Aquatic Foodbase
    - Alternative food resources
    - Food Availability



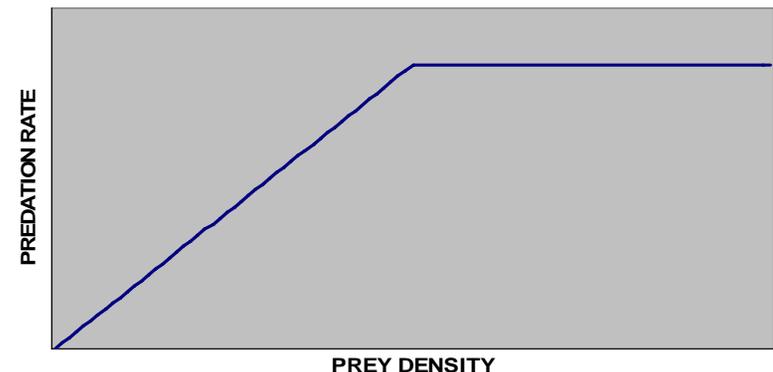
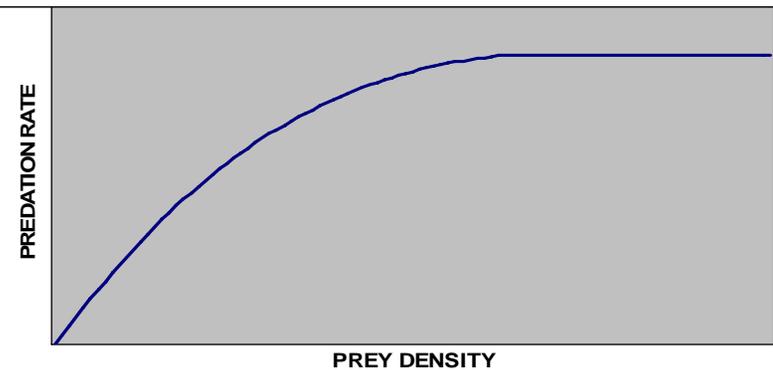
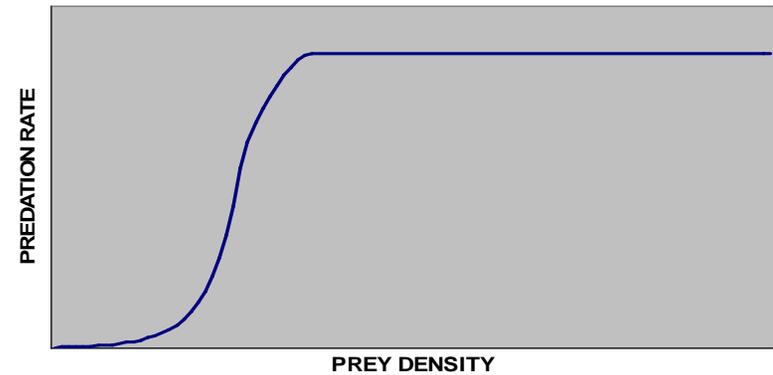
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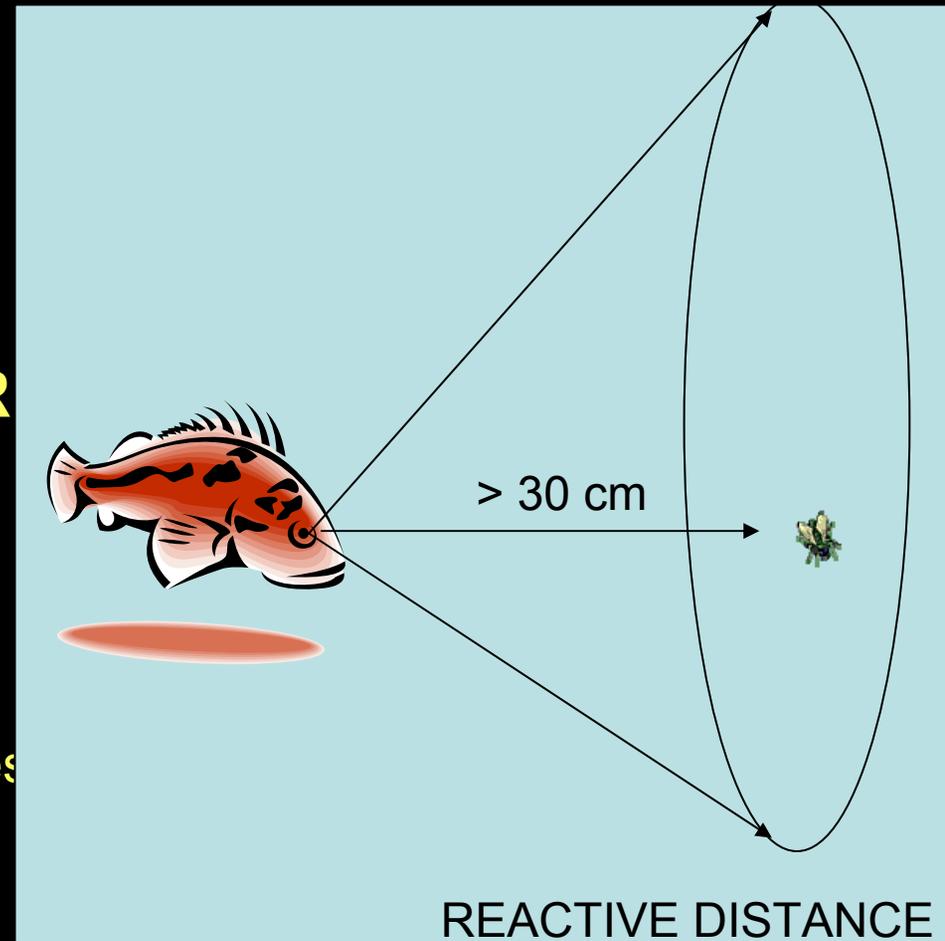
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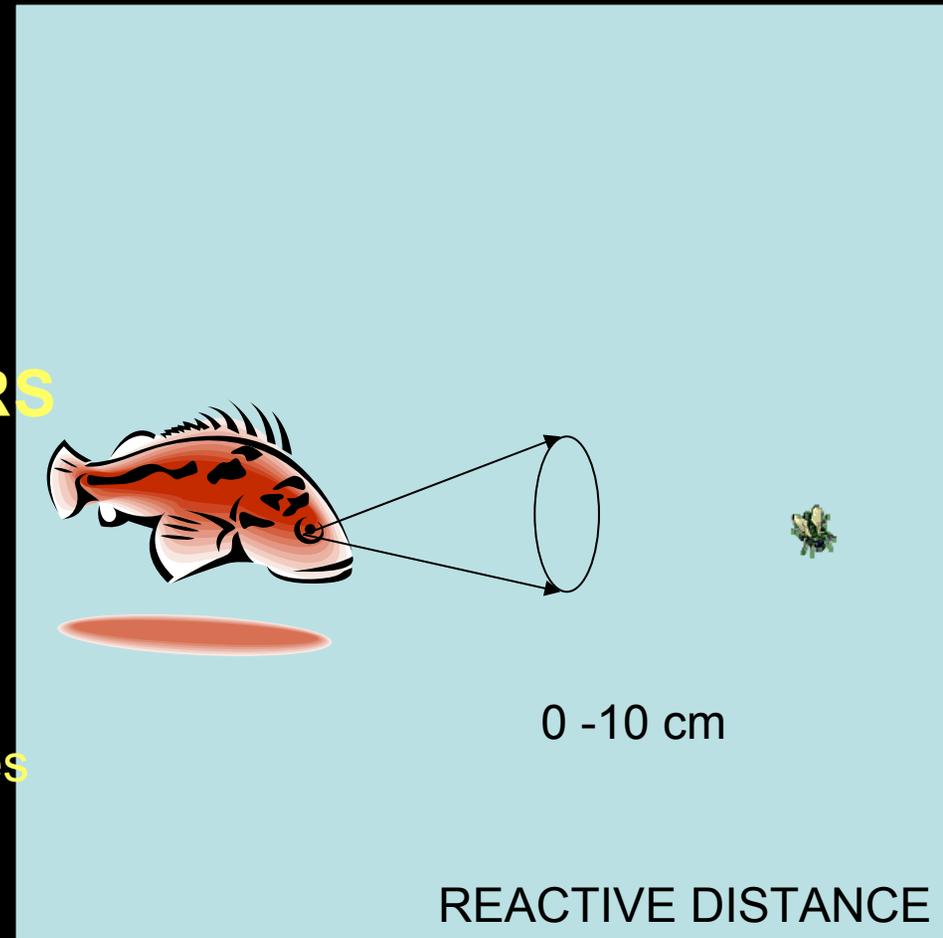
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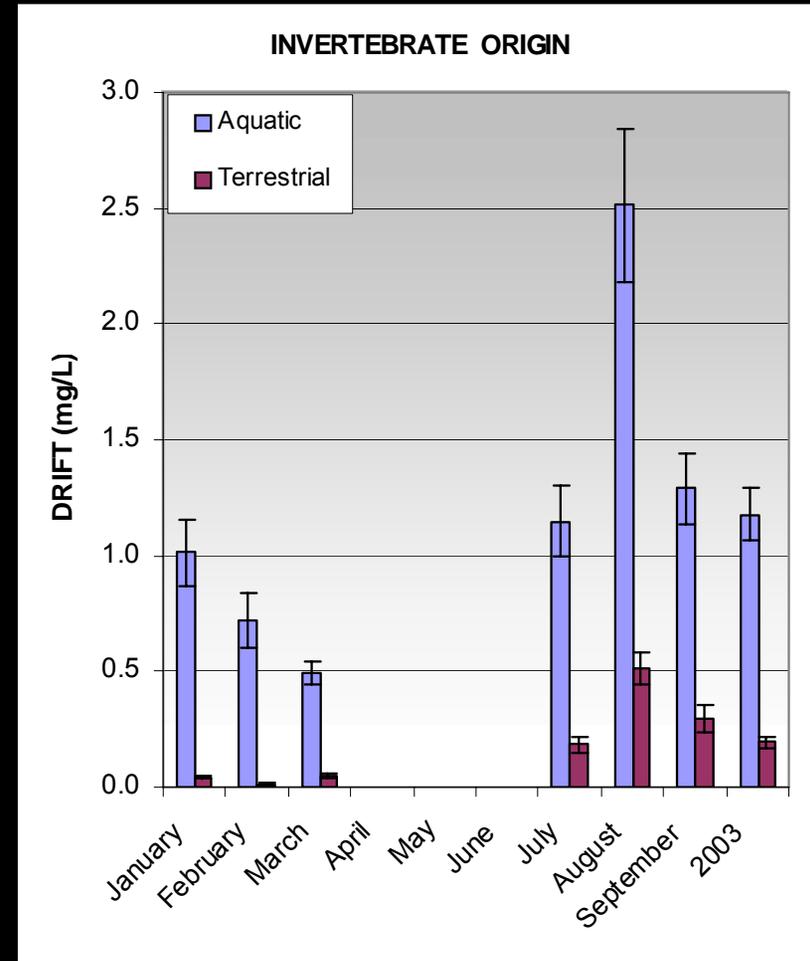
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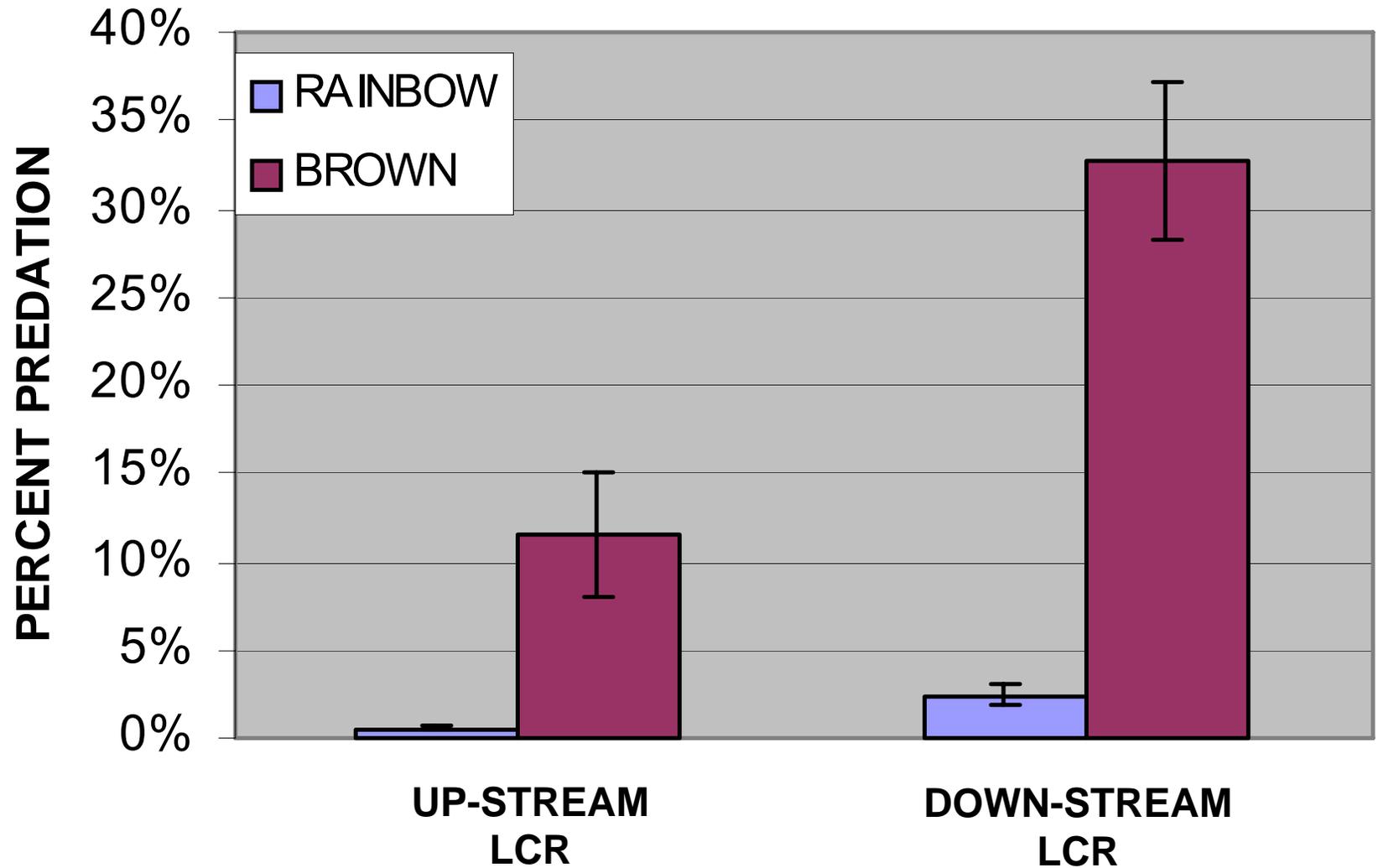
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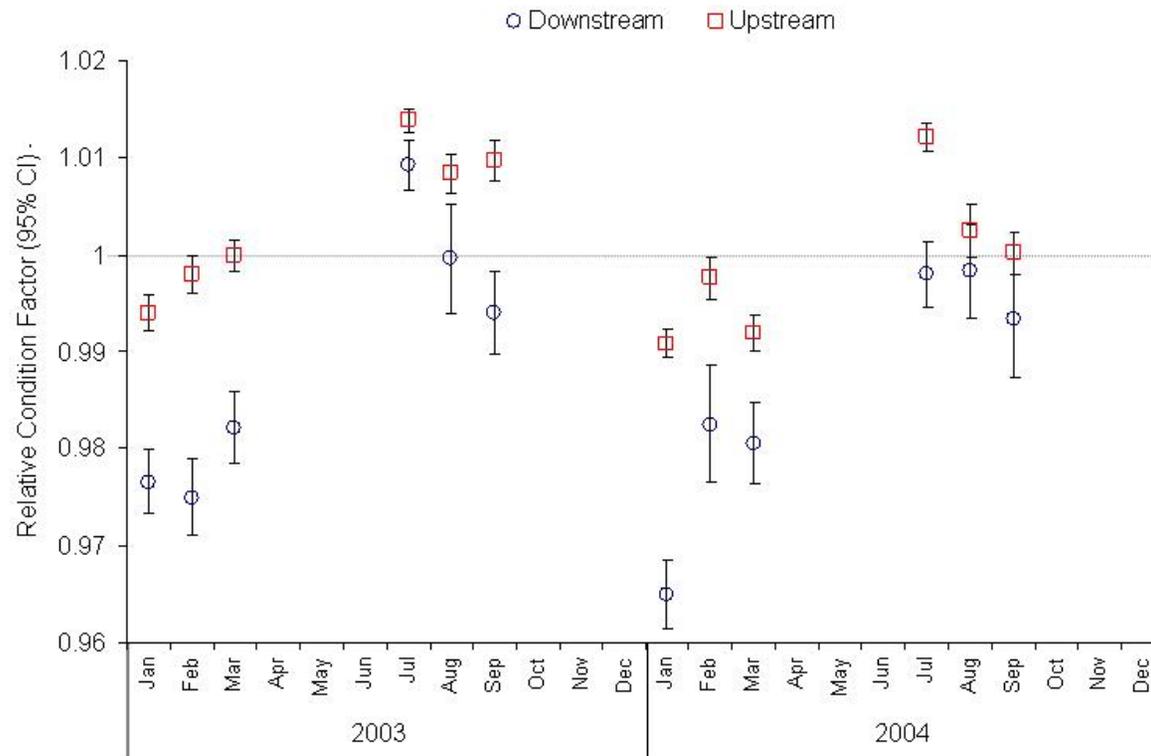
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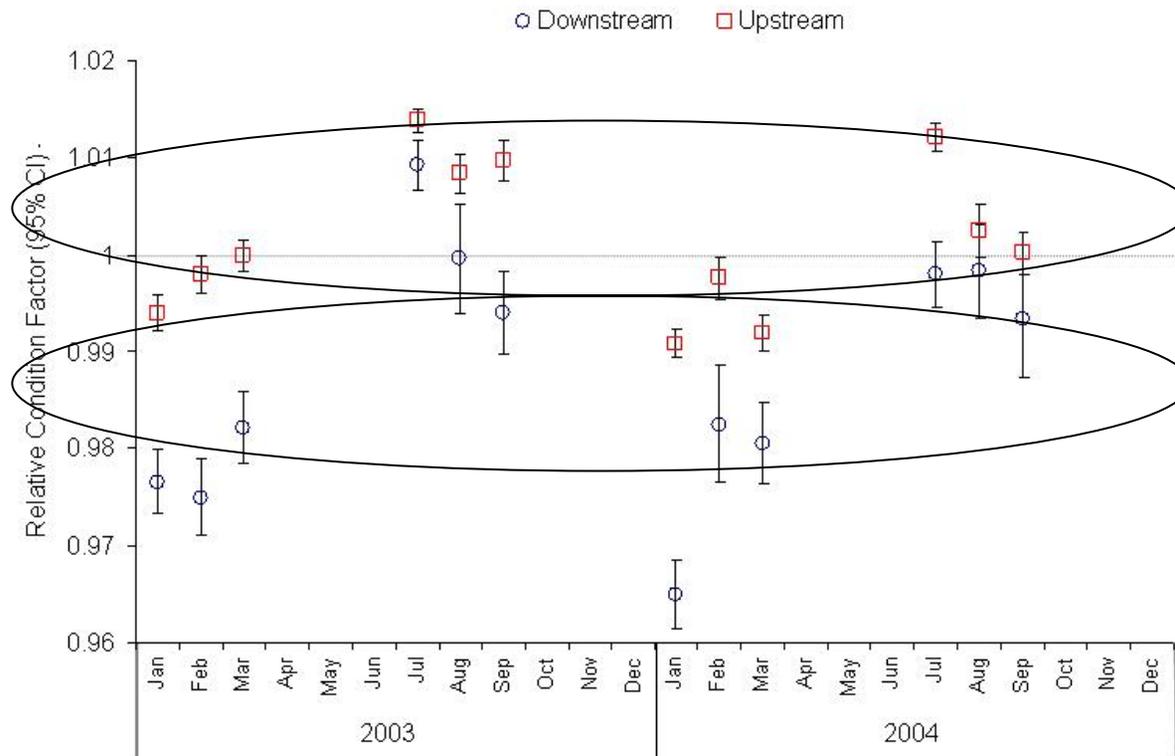
# PERCENT PREDATION SPATIAL STRATA



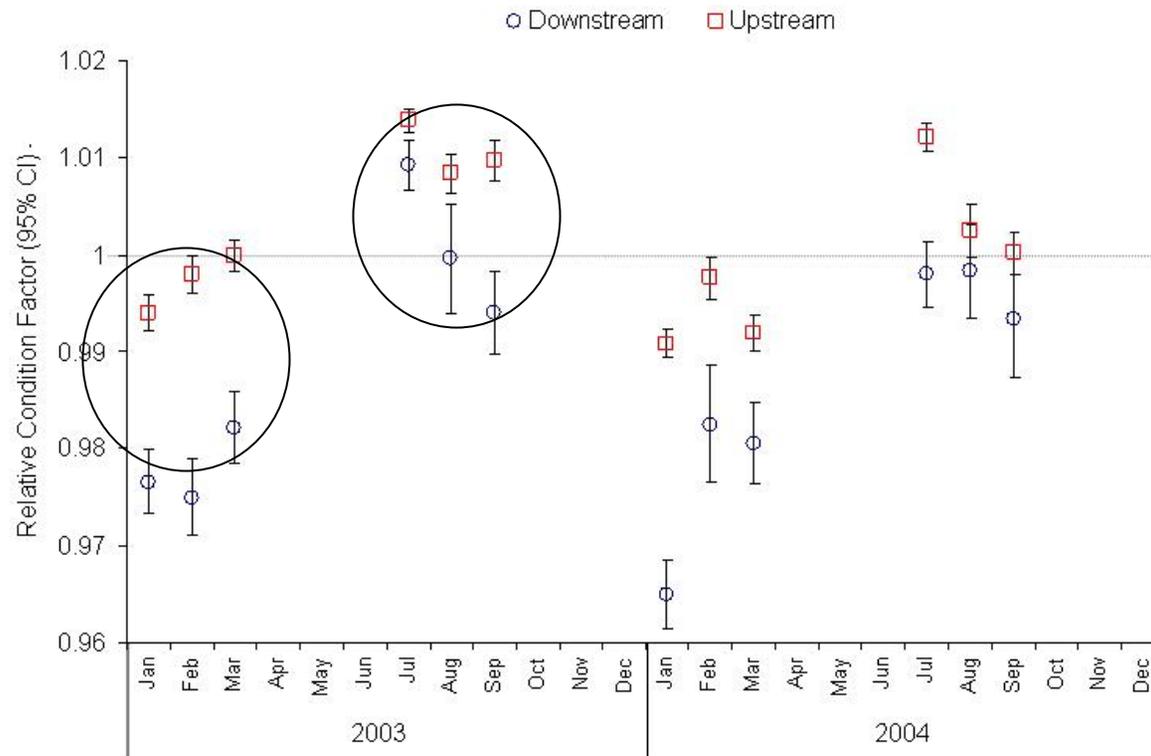
# RELATIVE CONDITION RAINBOW TROUT



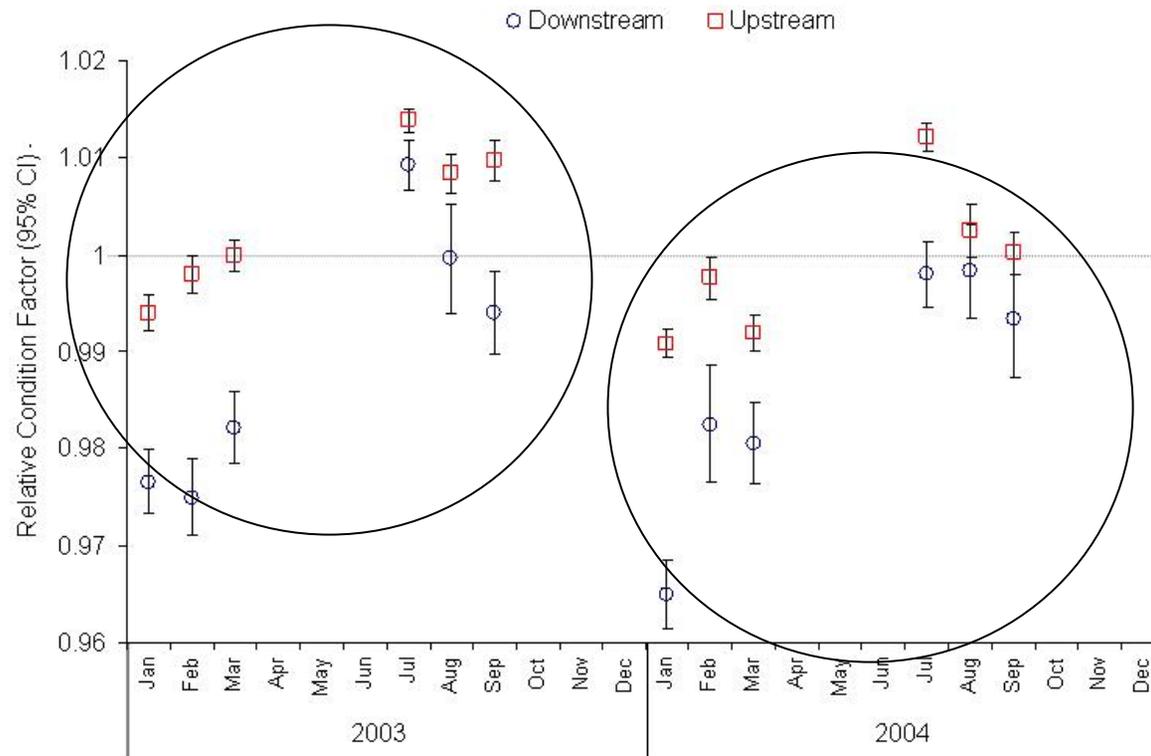
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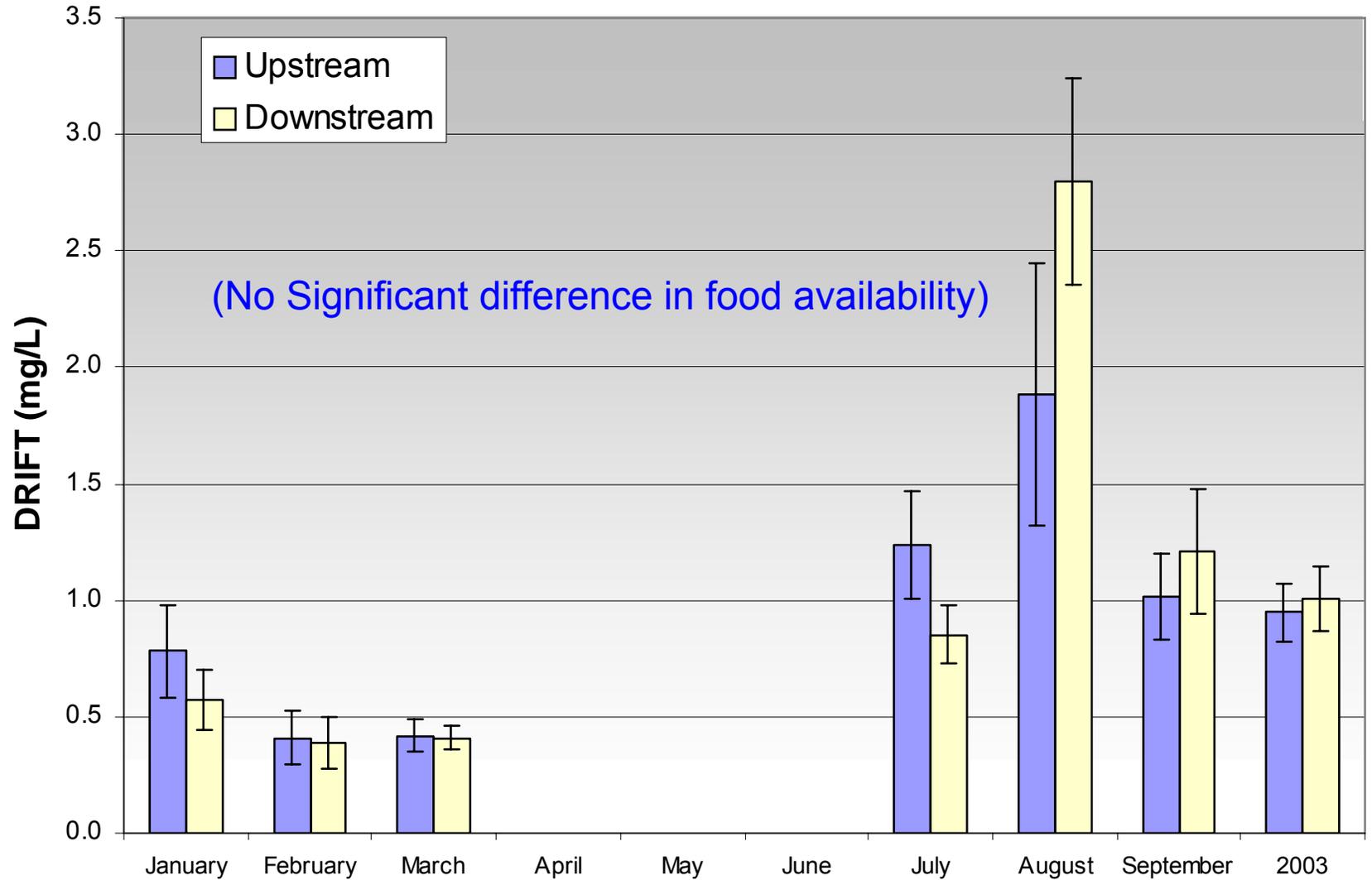


# RELATIVE CONDITION RAINBOW TROUT



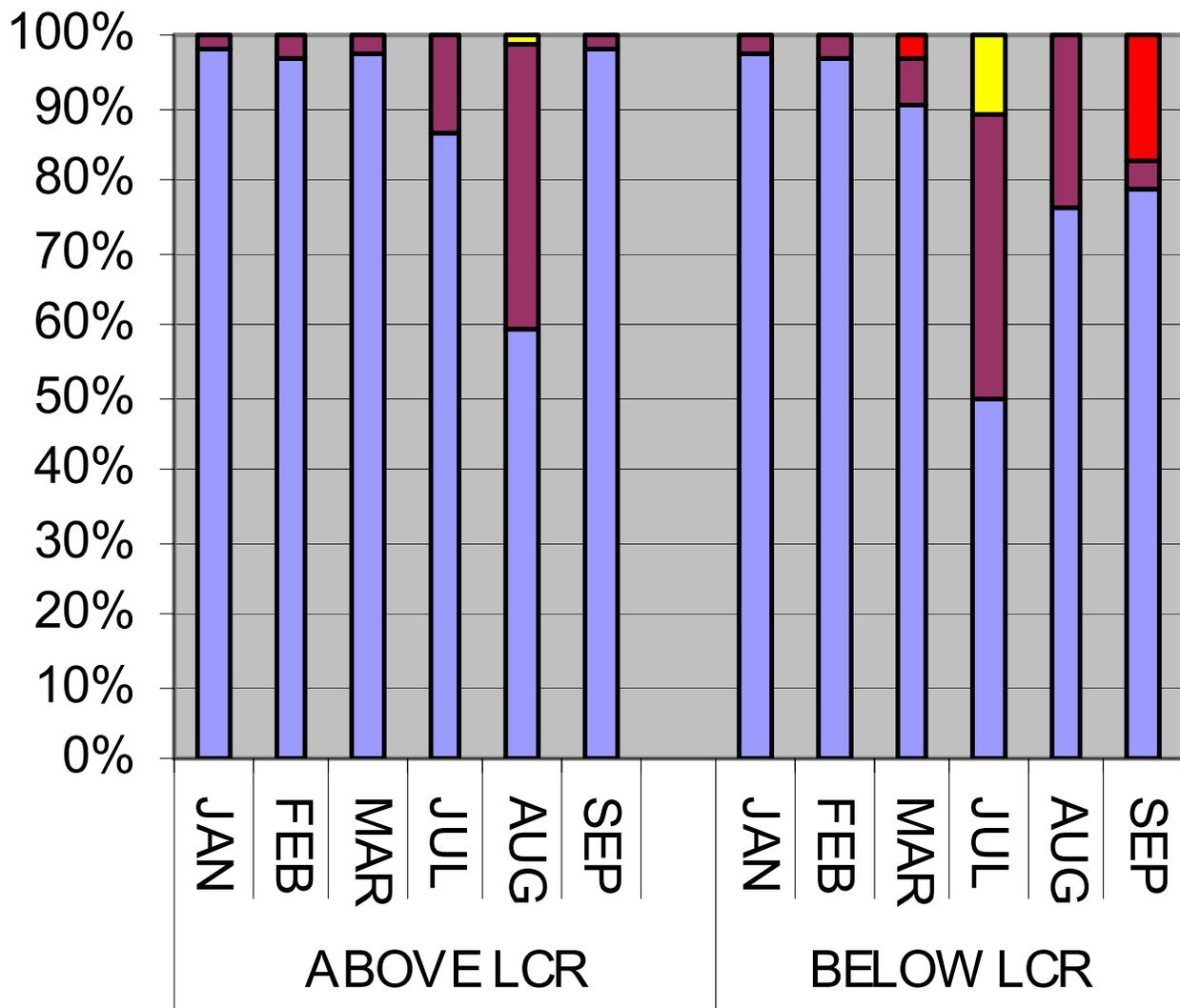
# MACROINVERTEBRATE DRIFT IN THE LCR REGION

## SPATIAL DISTRIBUTION



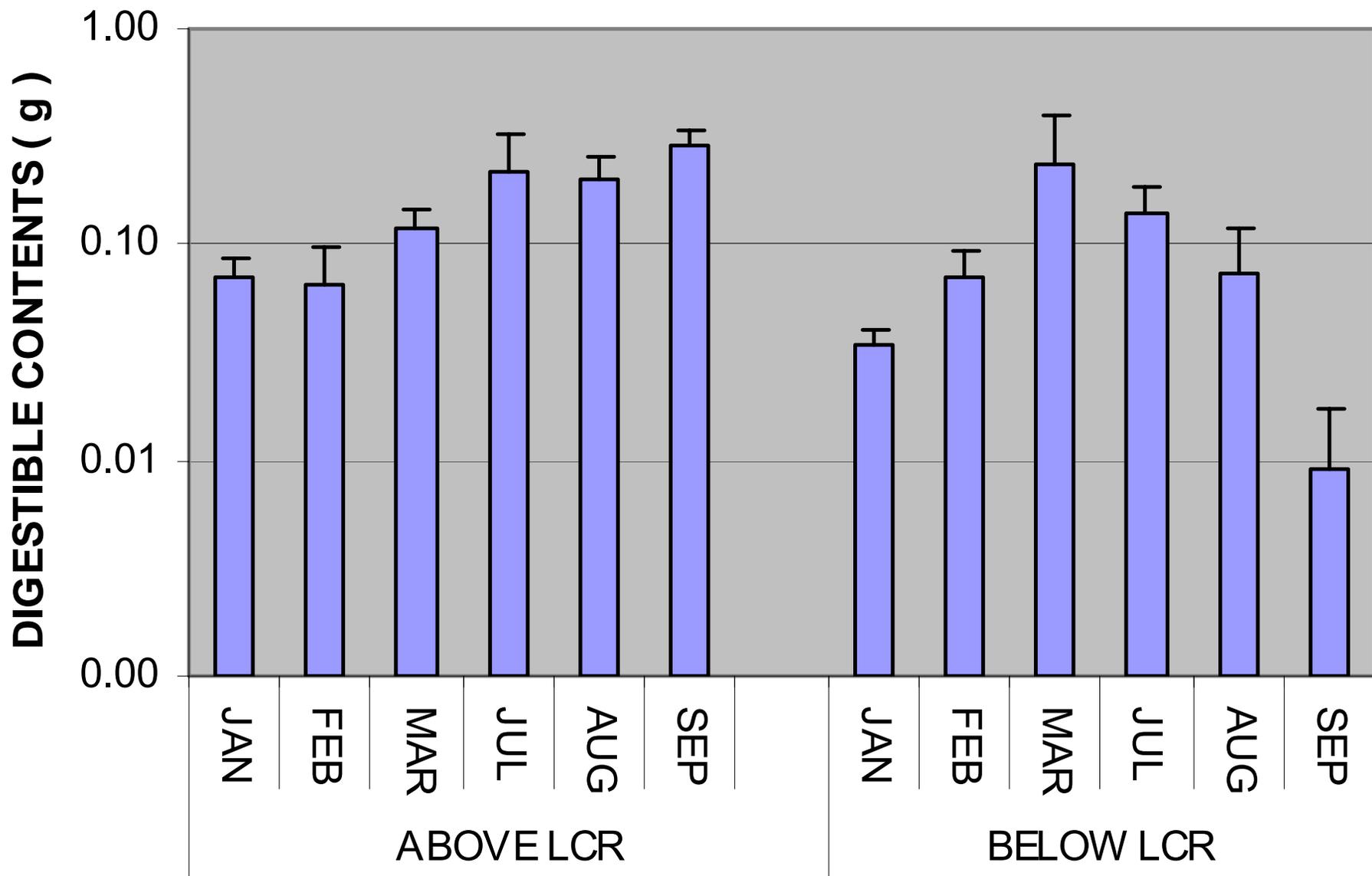
# RAINBOW TROUT - 2003

DIET PROPORTION



- OTHER VERT
- FISH
- TER INVERT
- AQU INVERT

# RAINBOW TROUT : 2003



# SEDIMENT DISCHARGE FROM TRIBUTARIES

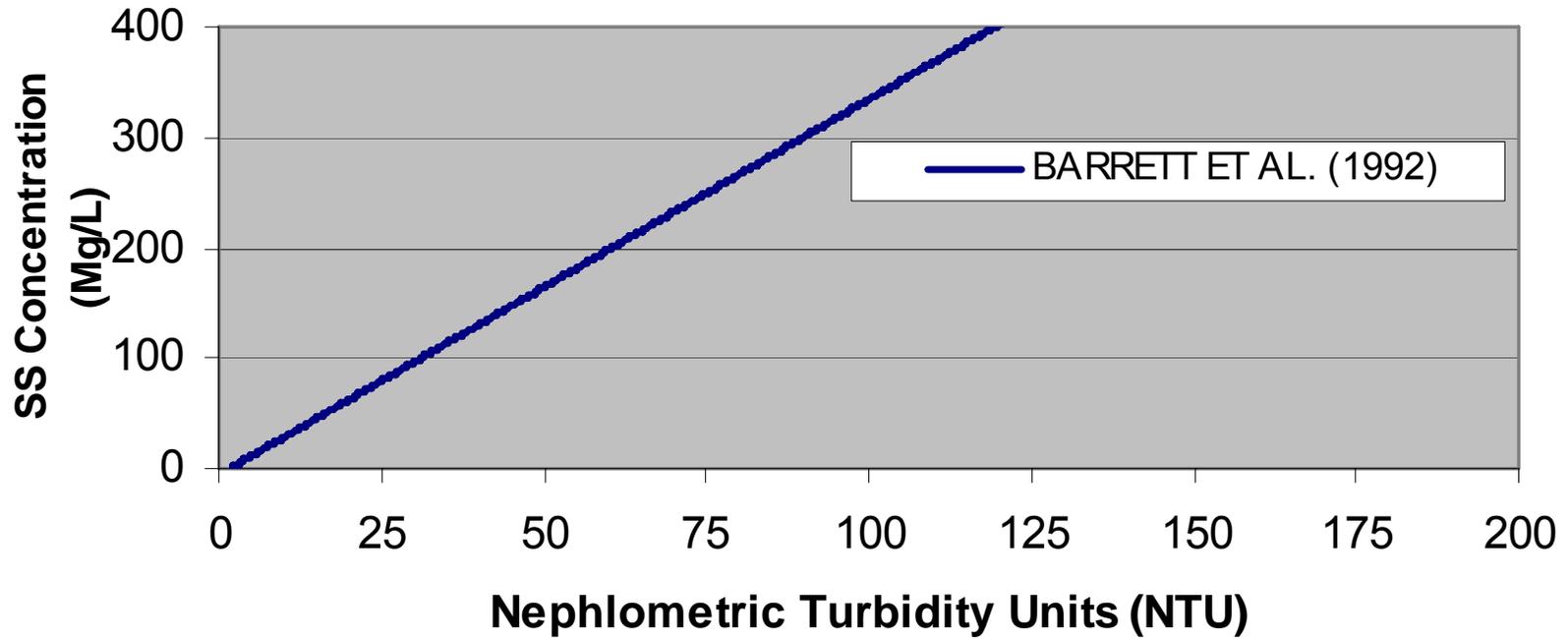
PARIA RIVER



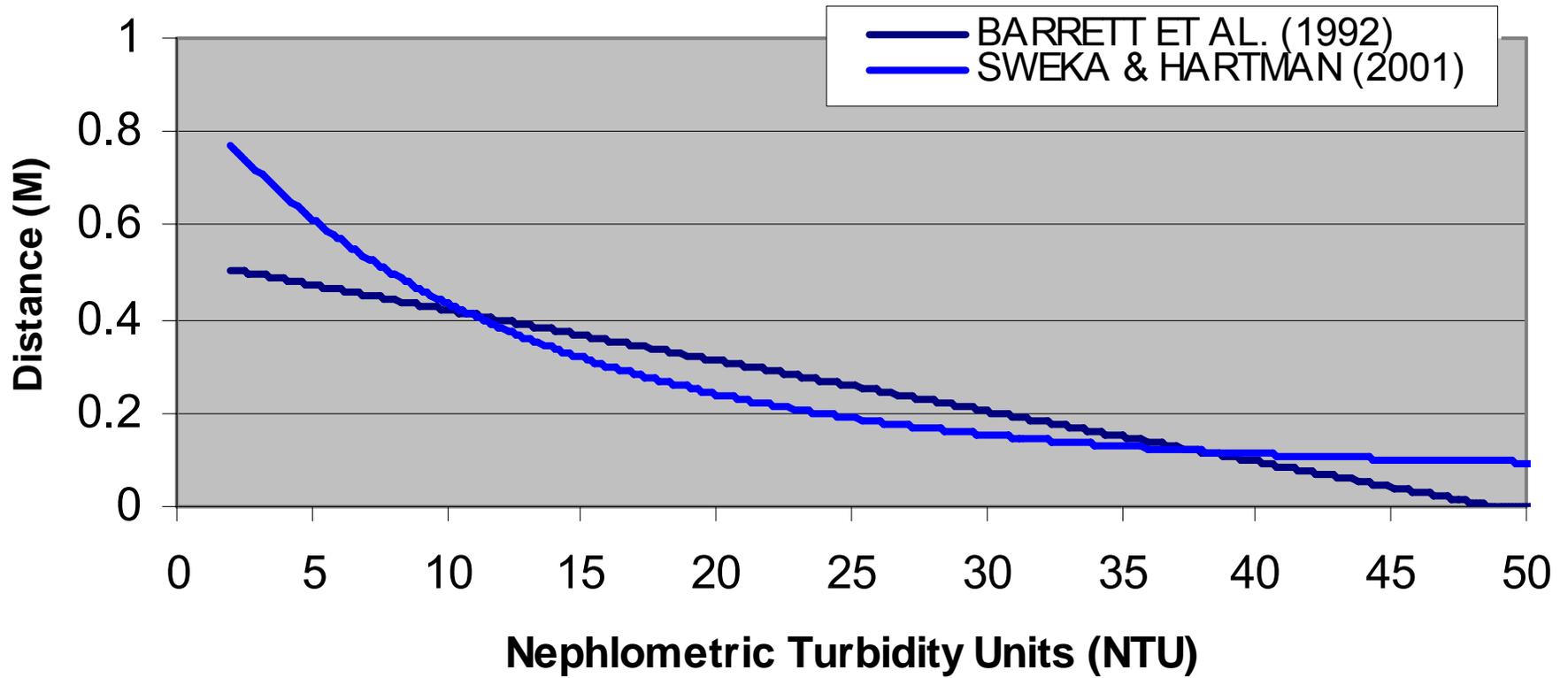
LITTLE COLORADO RIVER



# SUSPENDED SEDIMENT CONCENTRATION RELATIONSHIP

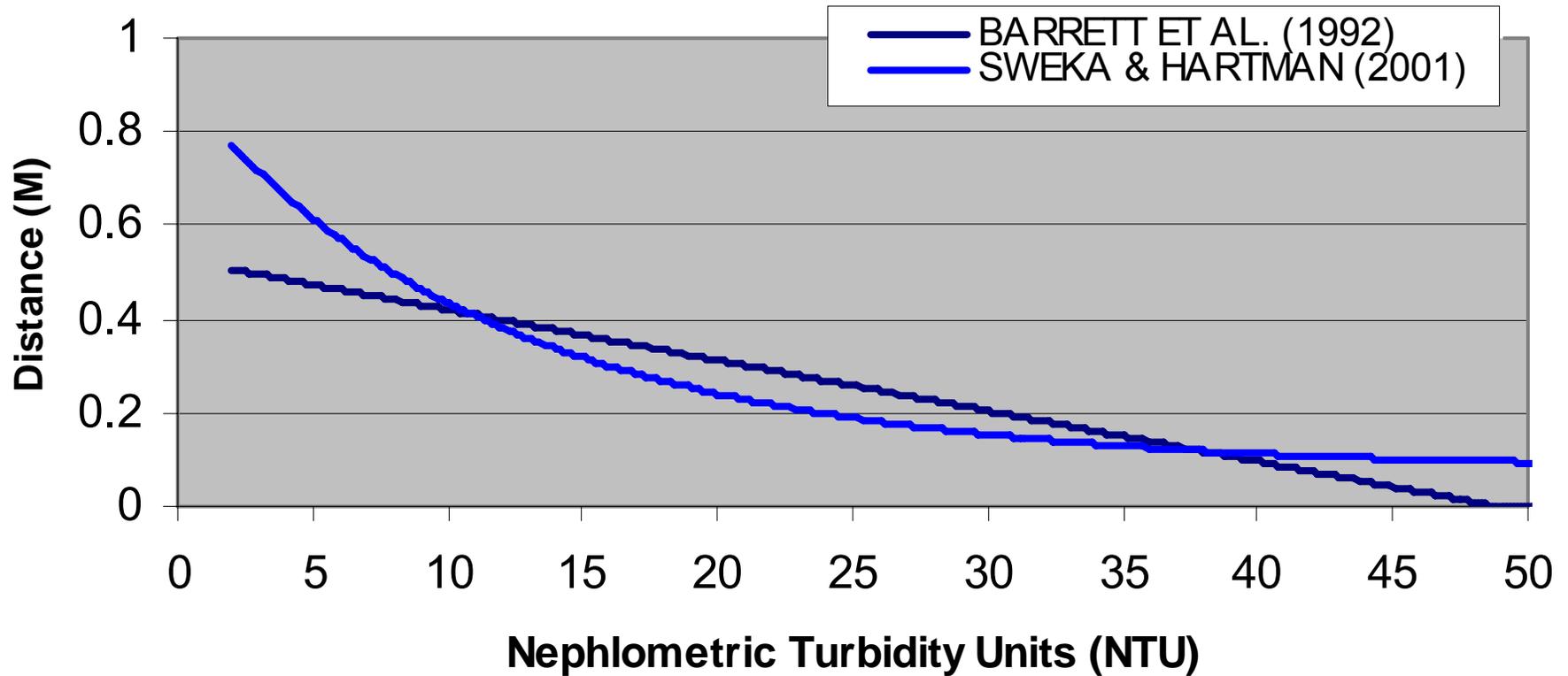


# RBT REACTIVE DISTANCE

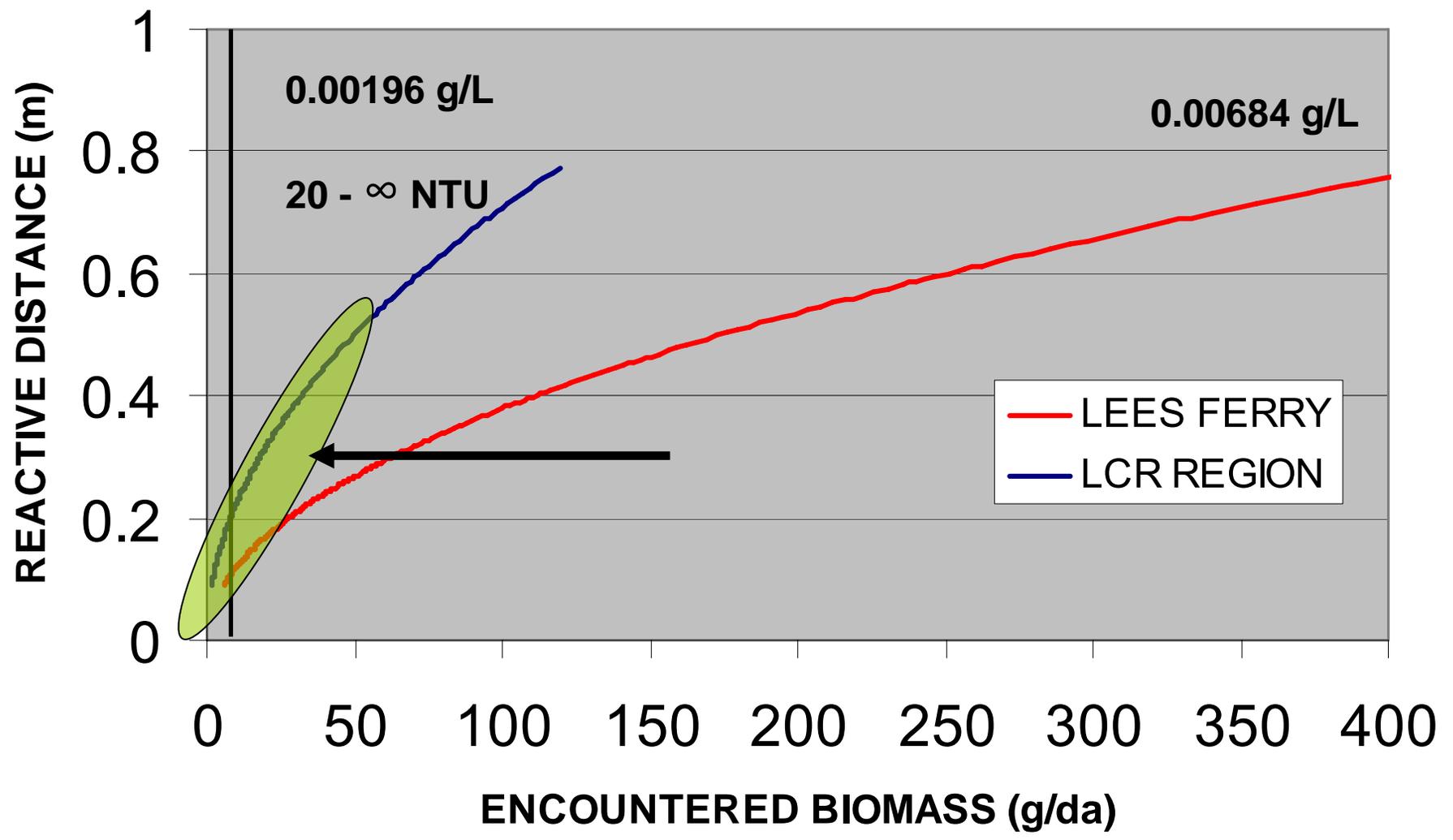


$$EncounterRate = \left( \frac{\pi \cdot ReactiveDist^2 \cdot Drift}{3} \right) \cdot \left( \frac{FishVel^2 + 3 \cdot InvertVel^2}{InvertVel} \right)$$

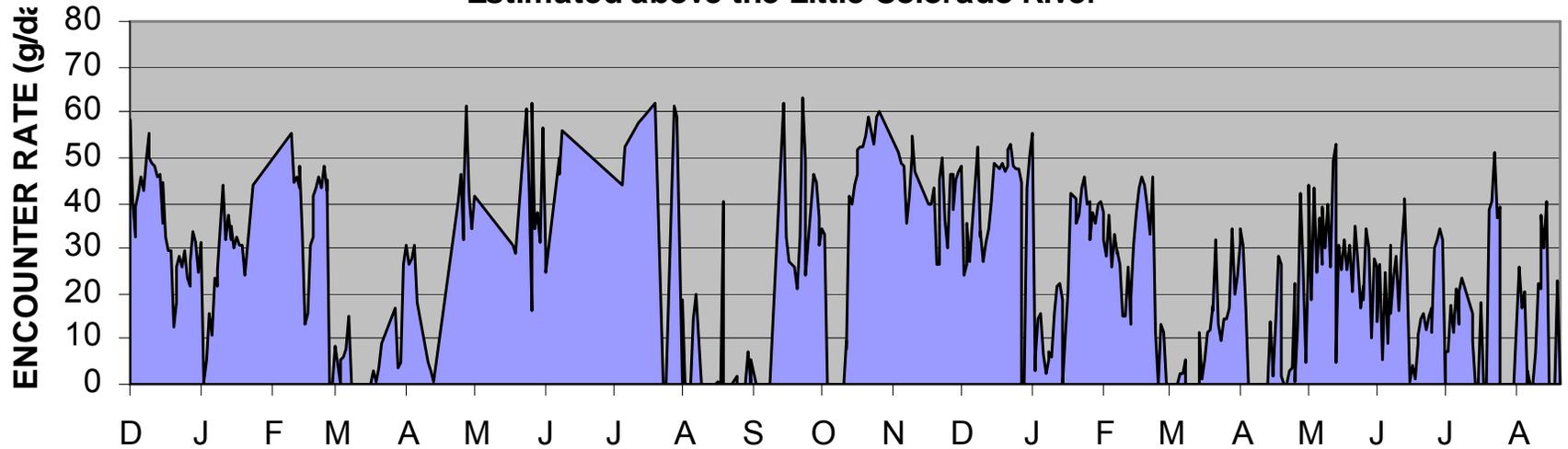
## RBT REACTIVE DISTANCE



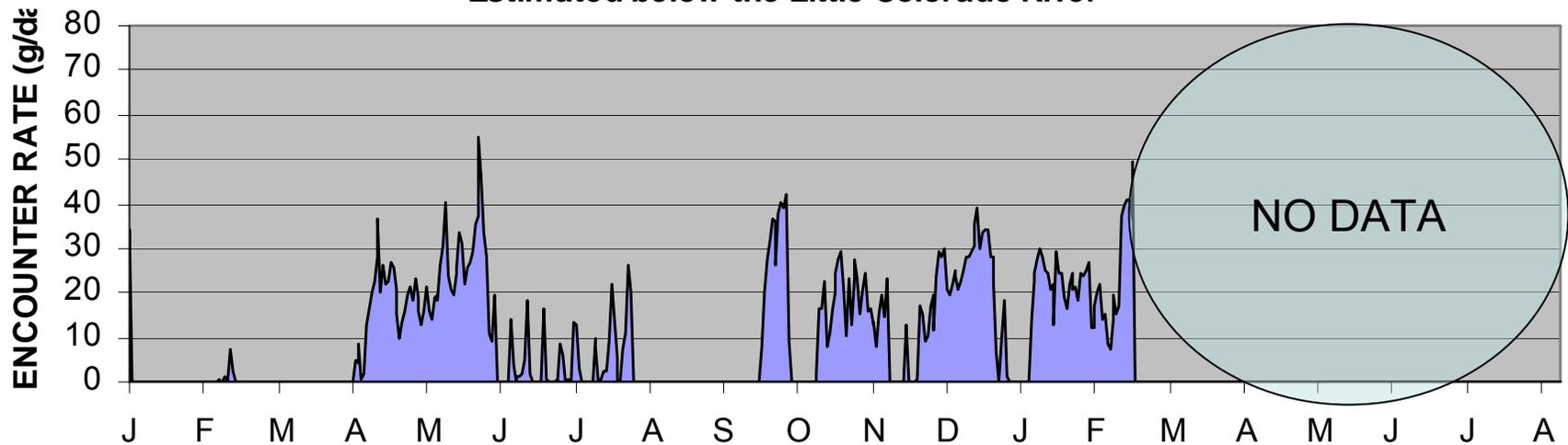
# DRIFTING INVERTEBRATE BIOMASS ENCOUNTERED PER DAY



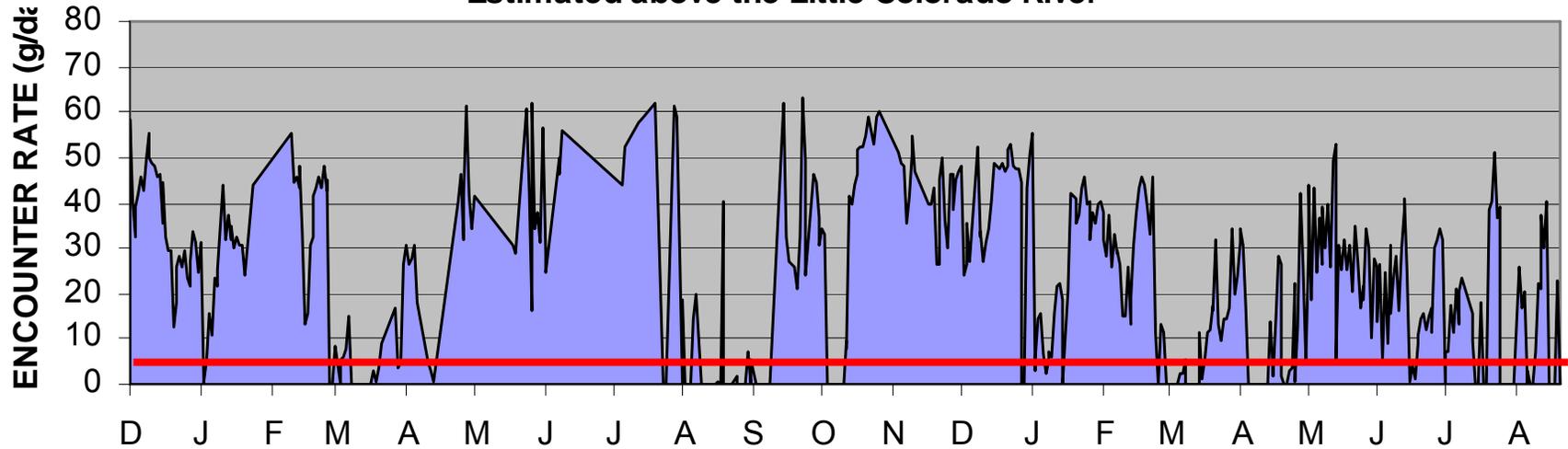
**2003 & 2004**  
**Average Daily Drift Encounter Rate**  
**Estimated above the Little Colorado River**



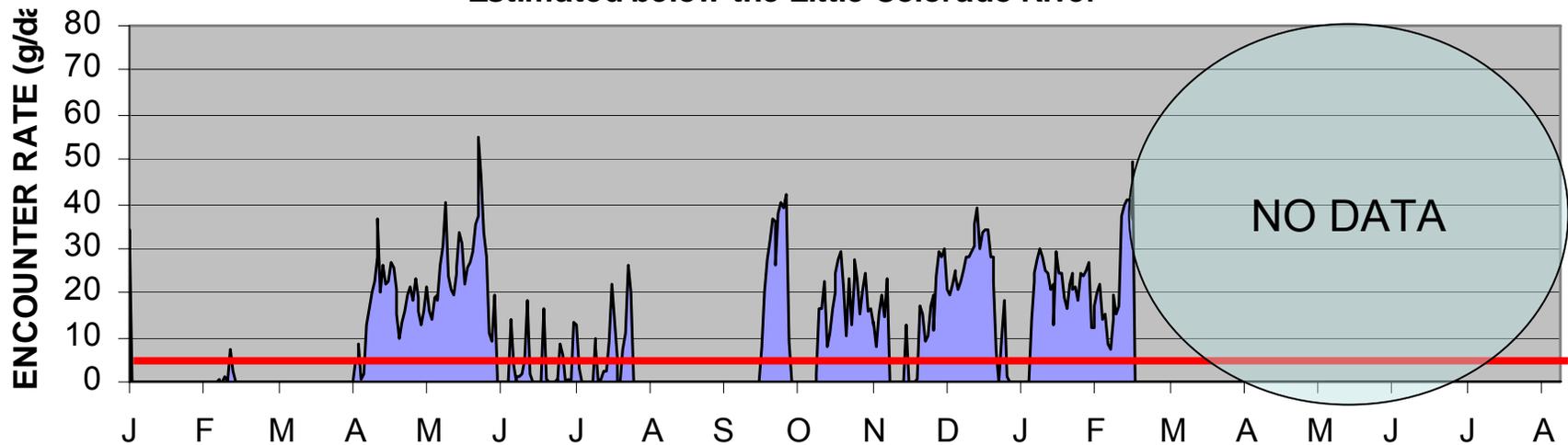
**2003-2004**  
**Average Daily Drift Encounter Rate**  
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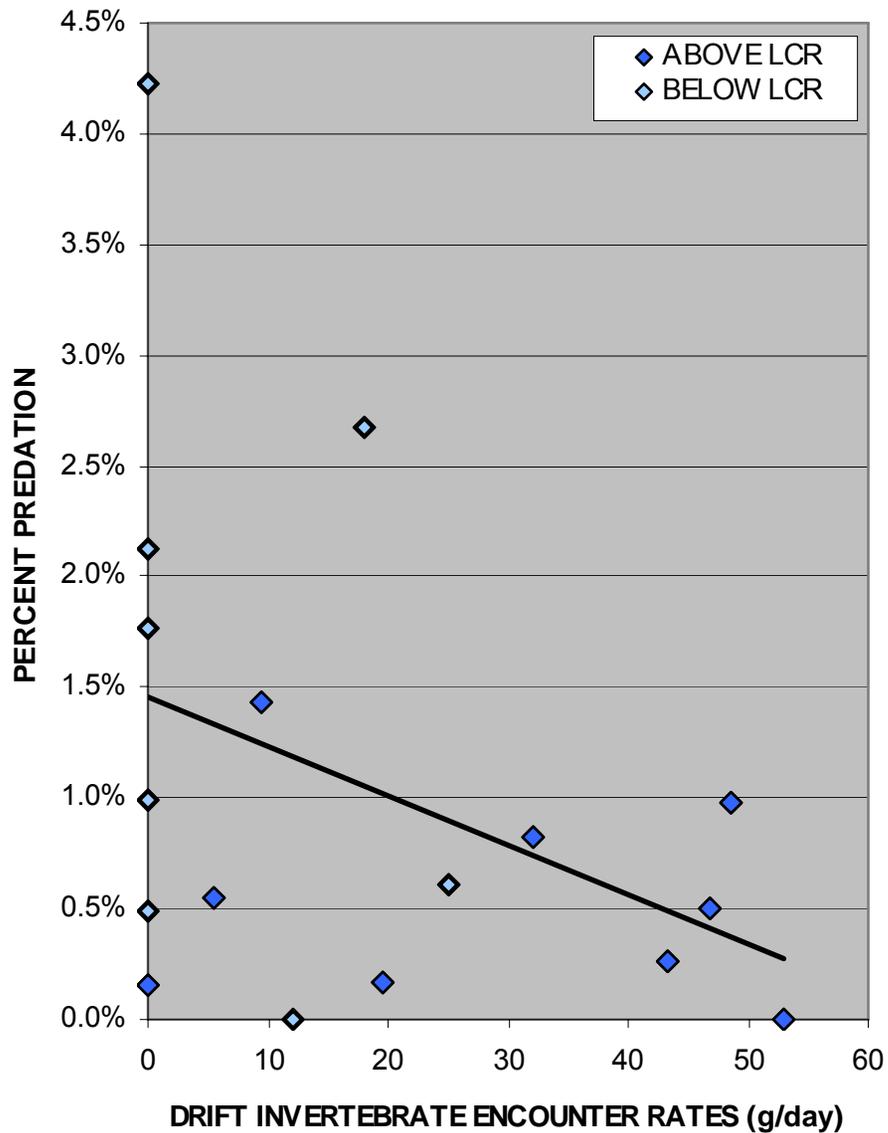


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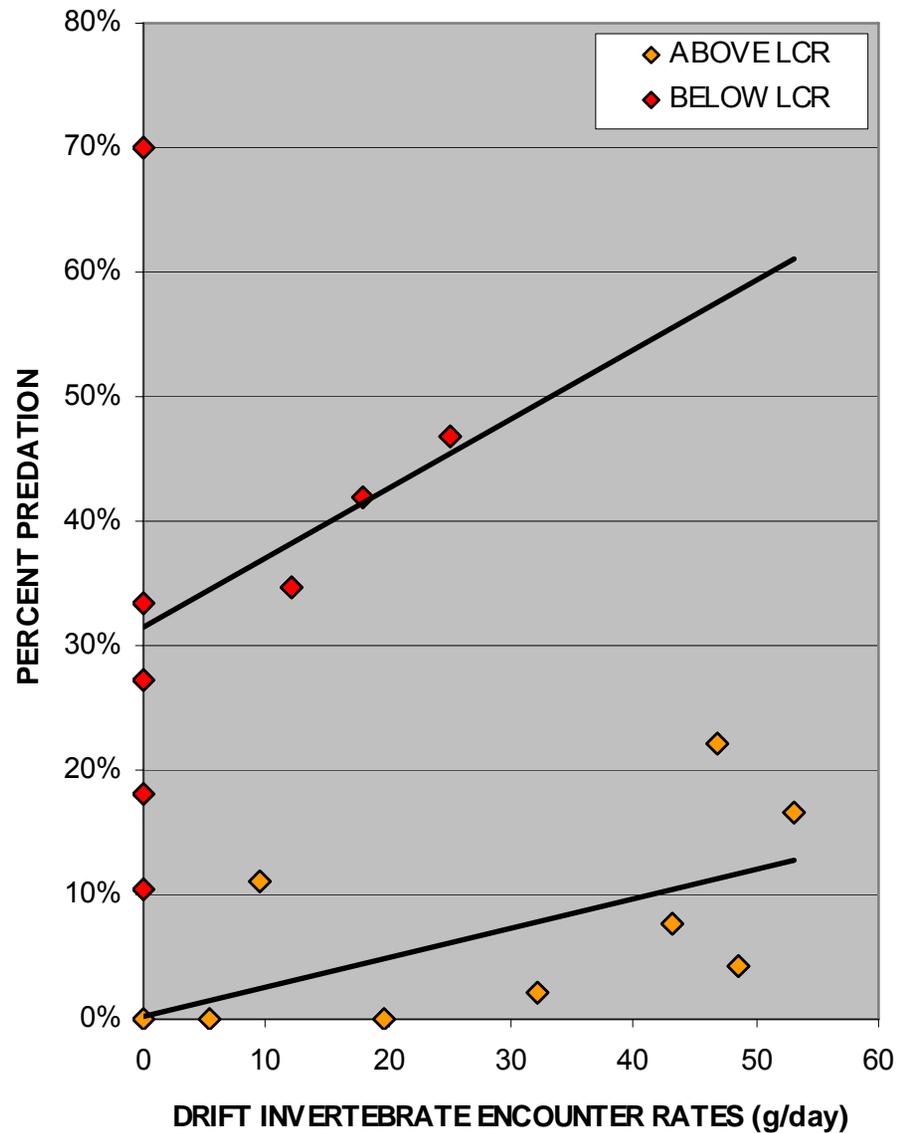


# PERCENT PREDATION BY TROUT UNDER DIFFERENT DAILY INVERTEBRATE ENCOUNTER RATES

## RAINBOW TROUT

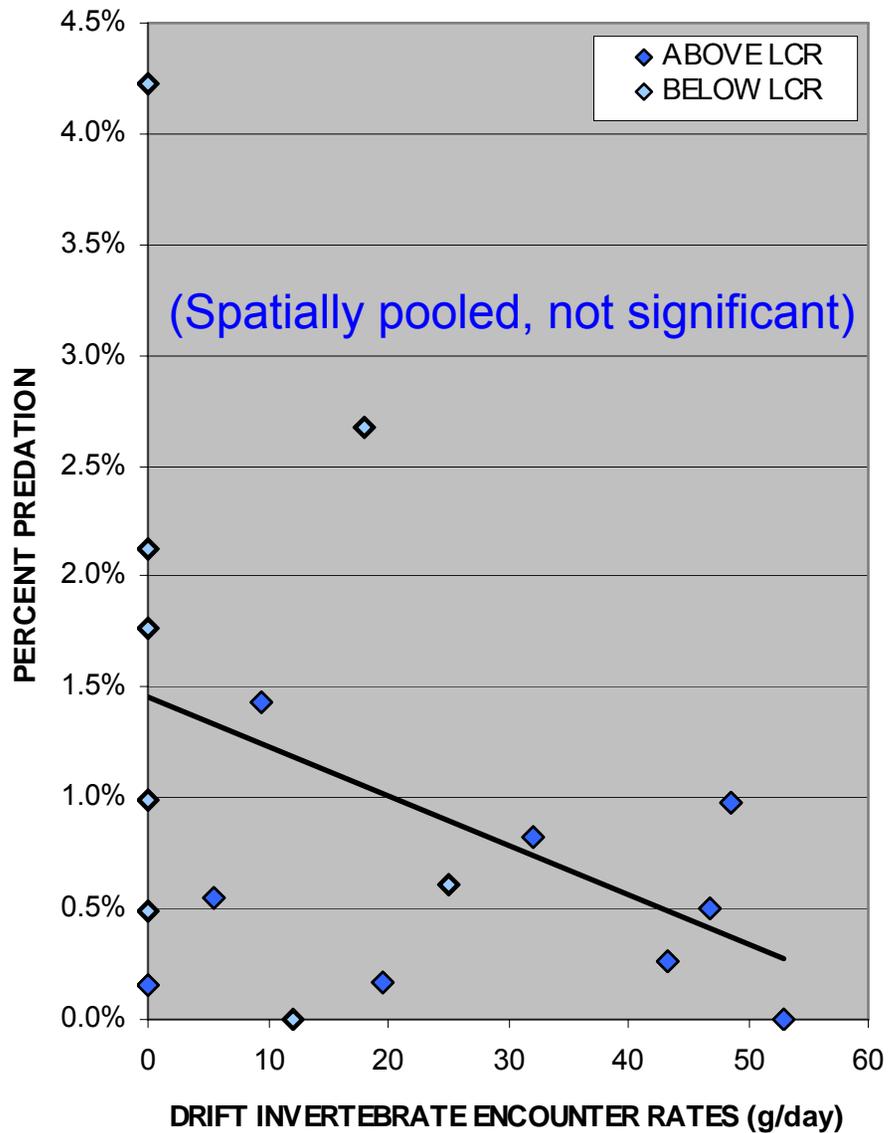


## BROWN TROUT

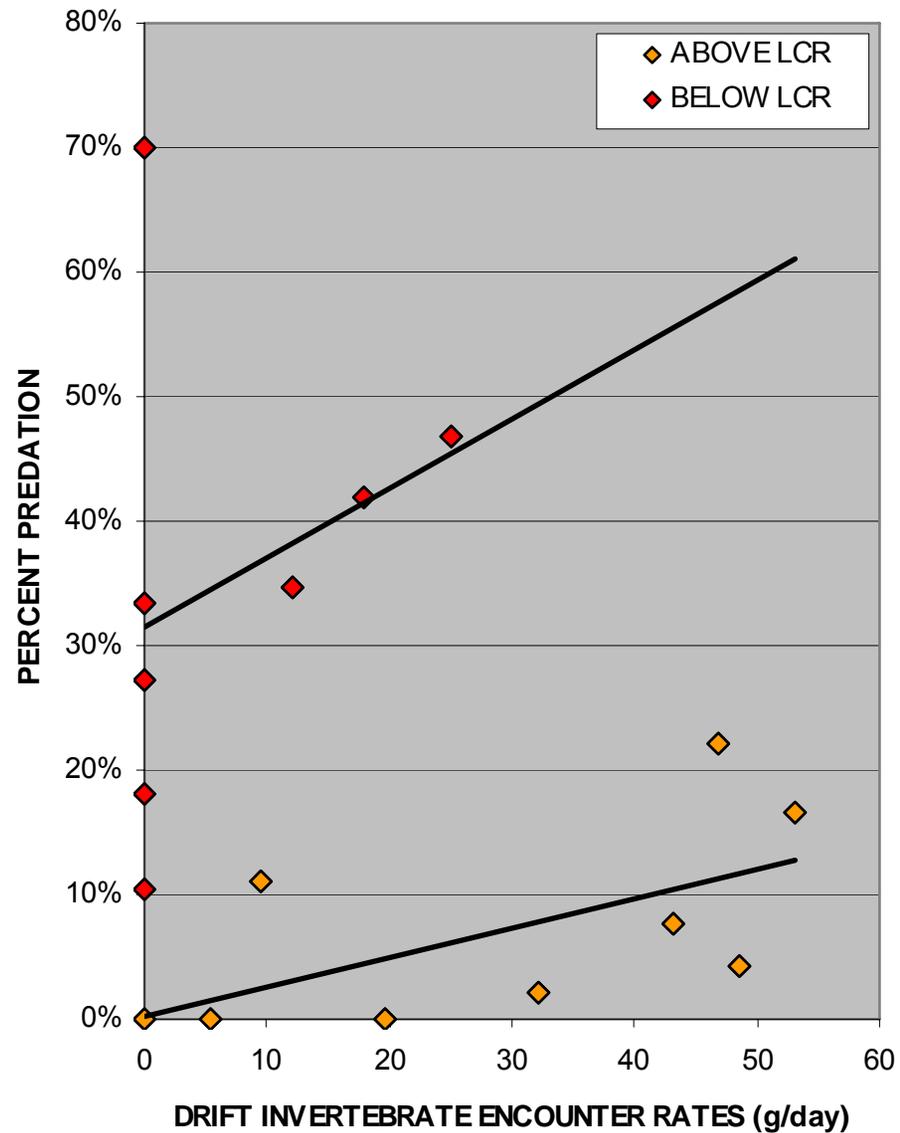


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## RAINBOW TROUT

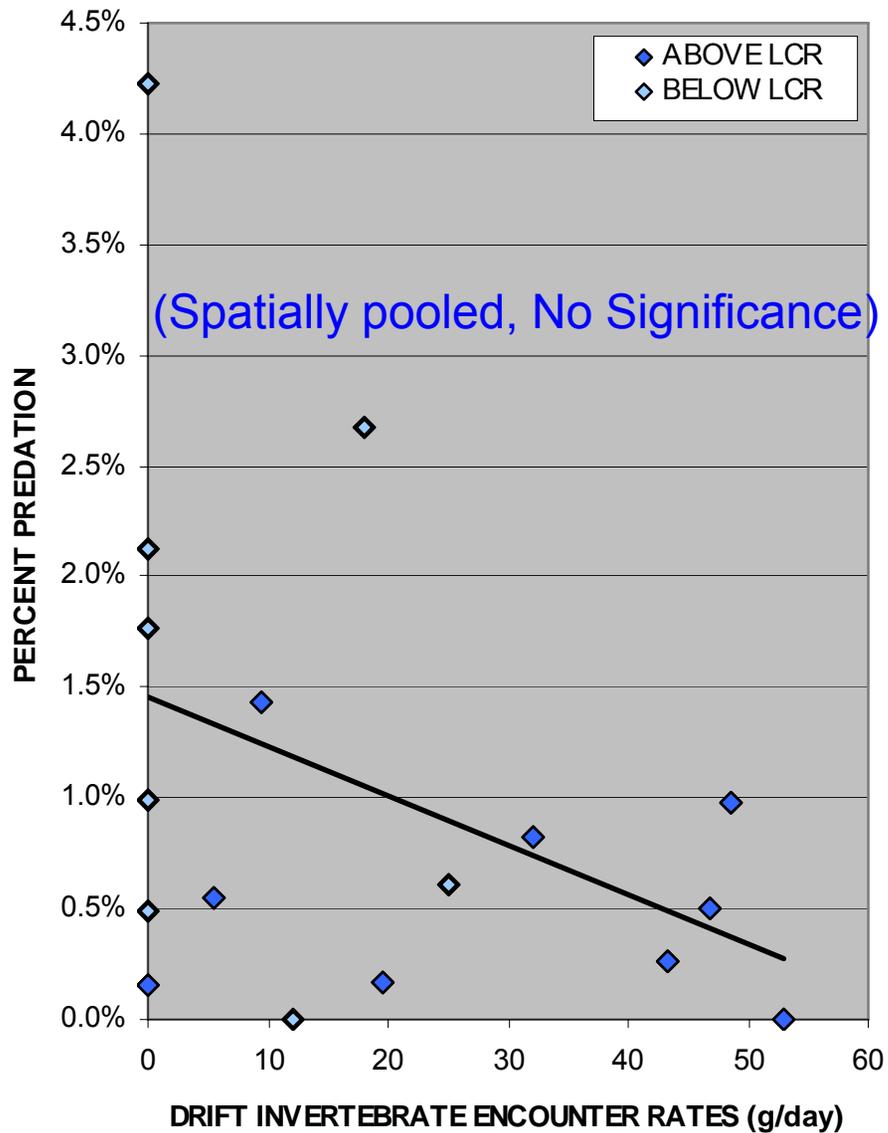


## BROWN TROUT

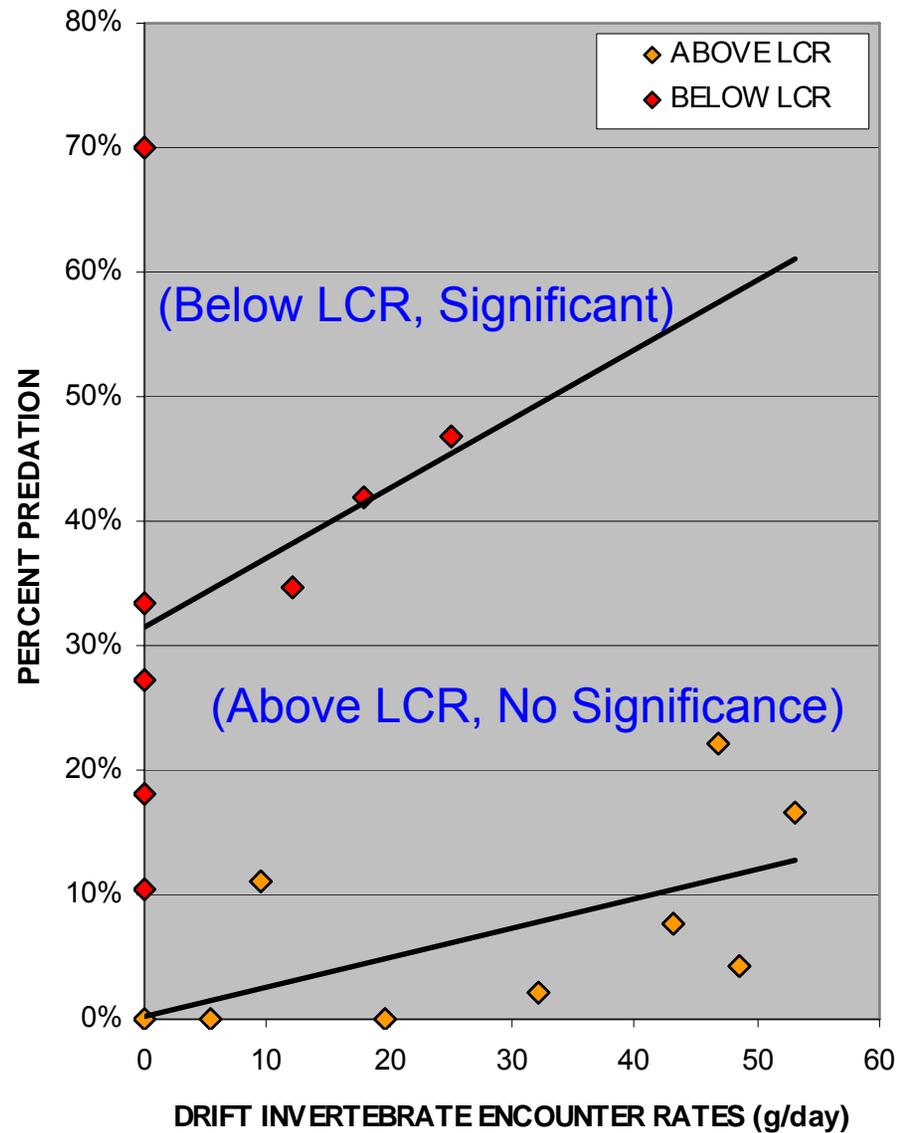


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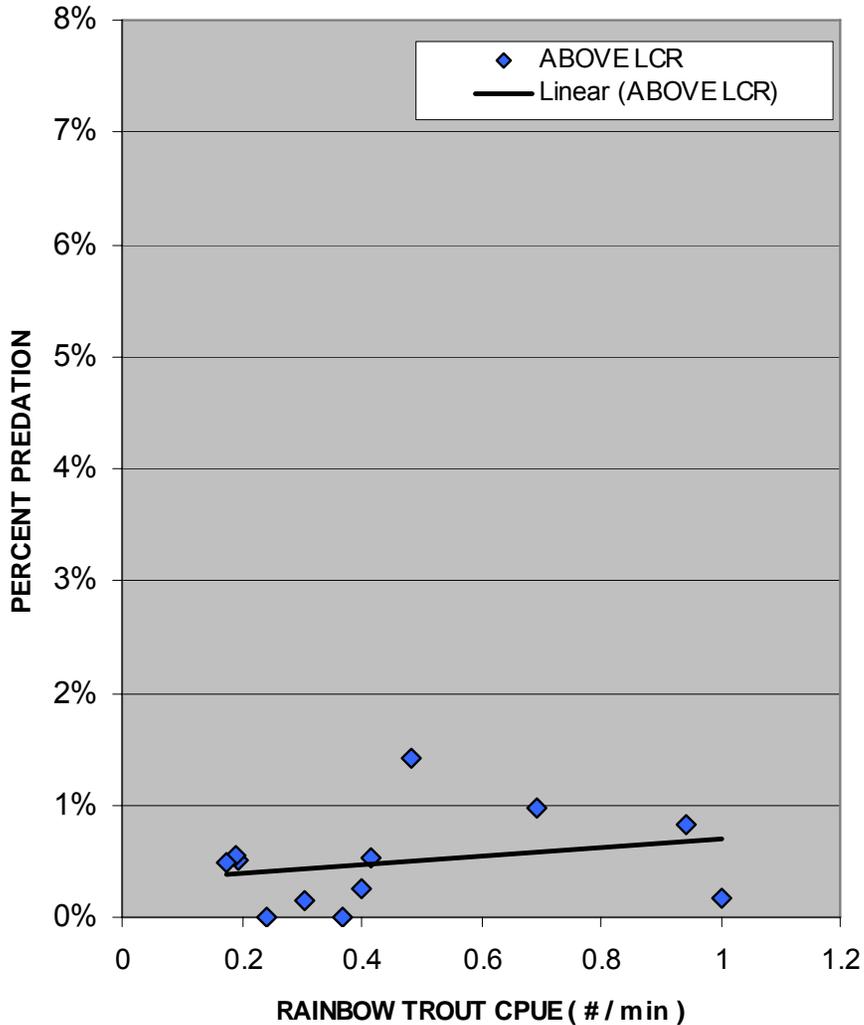


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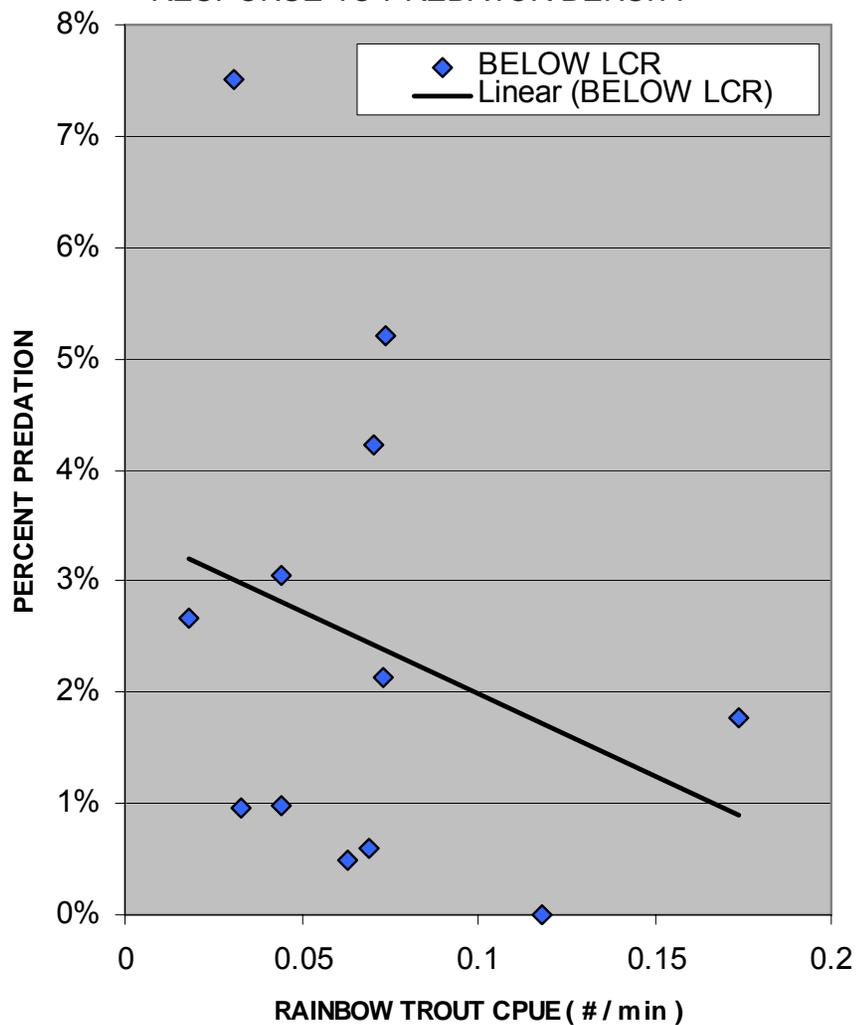


# PERCENT PREDATION BY RAINBOW TROUT UNDER VARYING PREDATOR DENSITIES (ELECTRO: CPUE)

RAINBOW TROUT PREDATION IN RESPONSE TO PREDATOR DENSITY

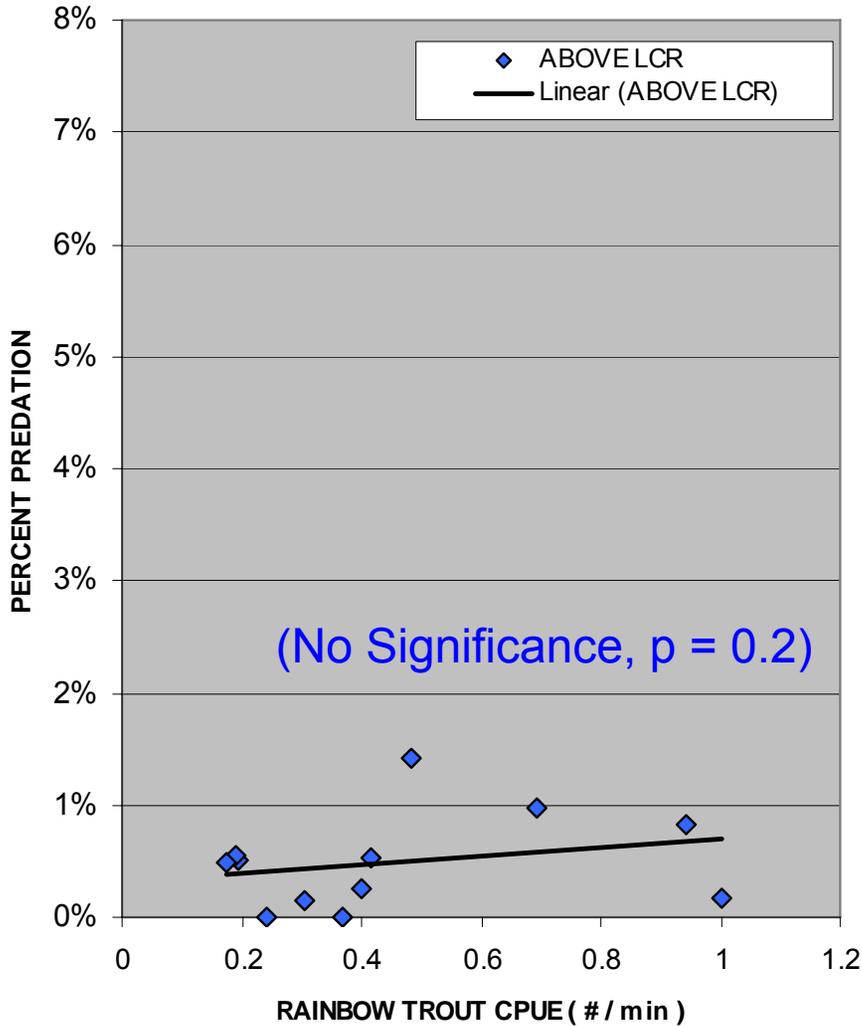


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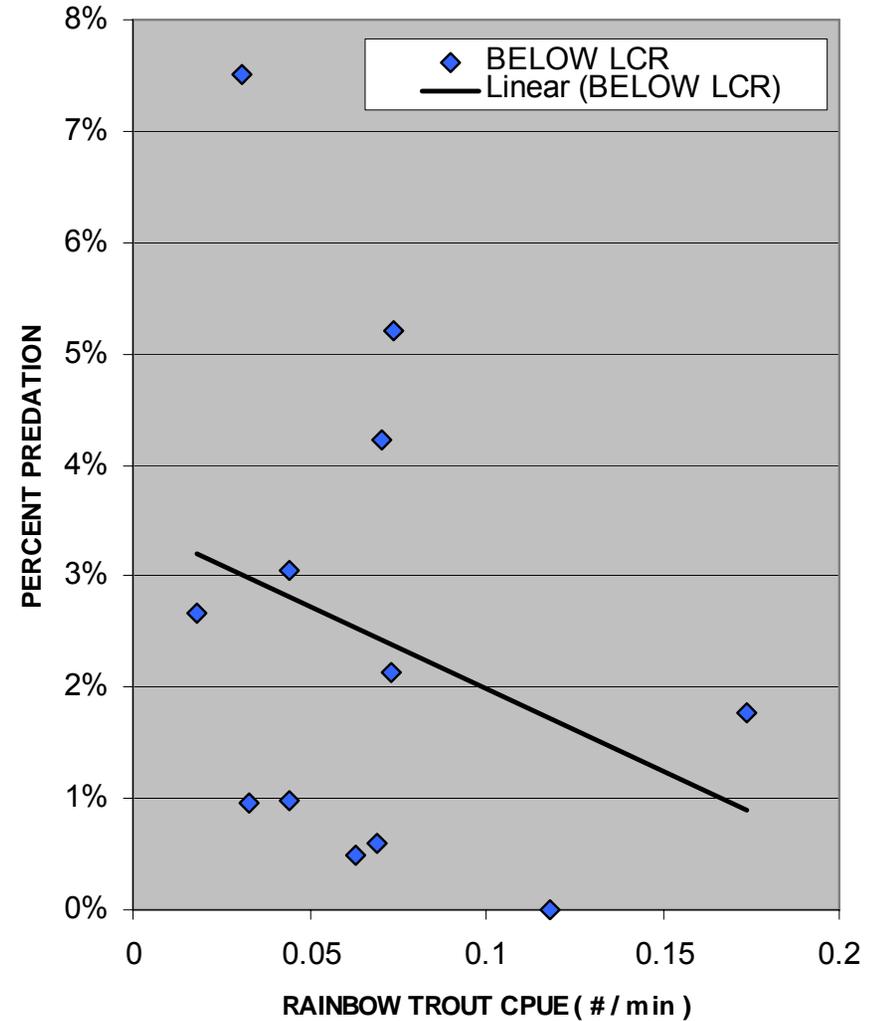


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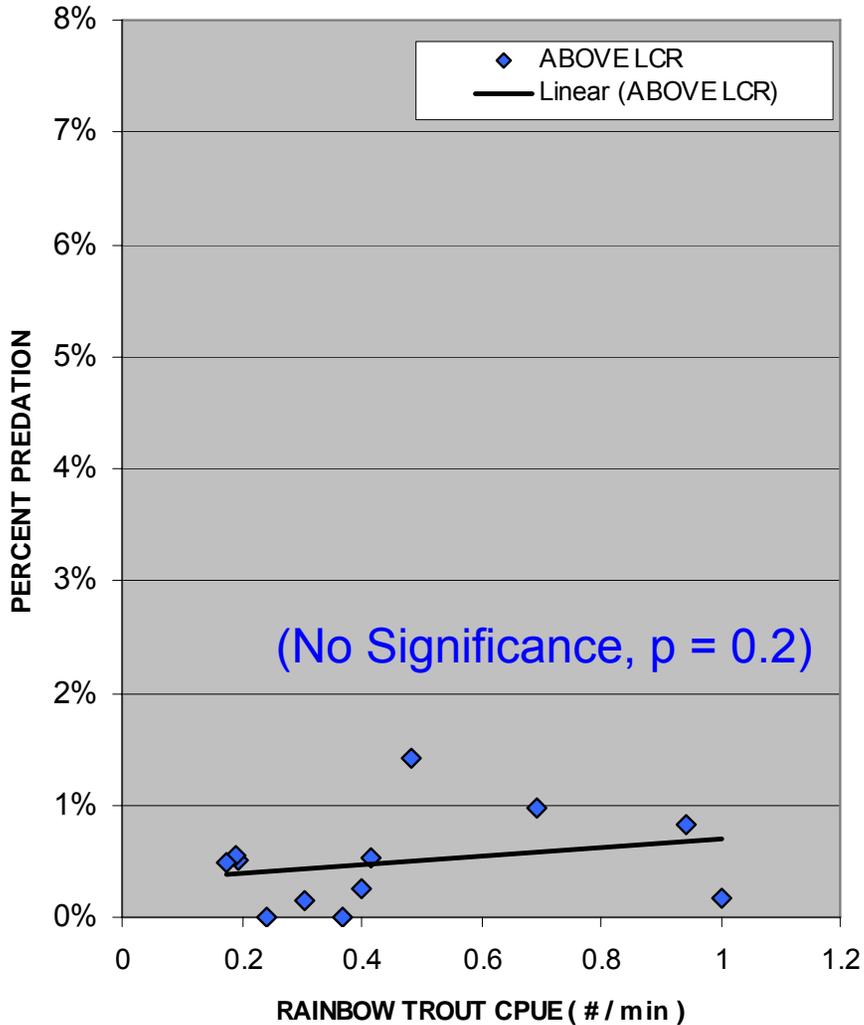


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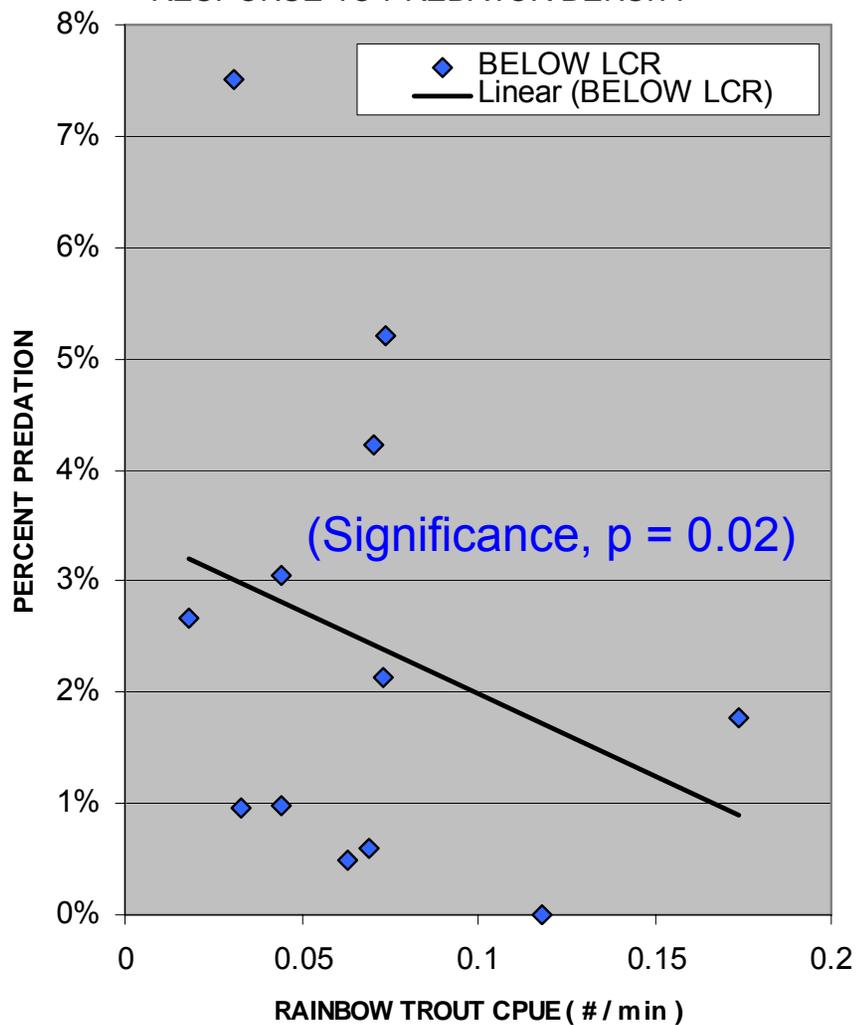


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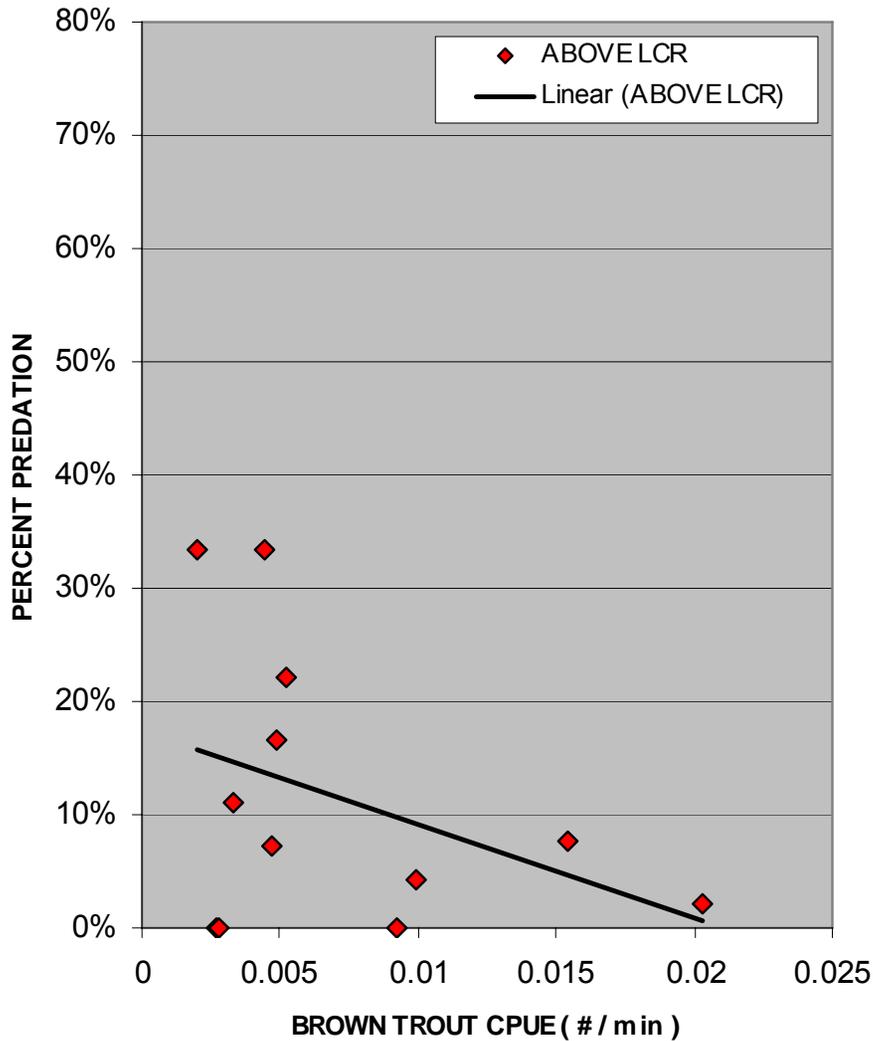


RAINBOW TROUT PREDATION IN RESPONSE TO PREDATOR DENSITY

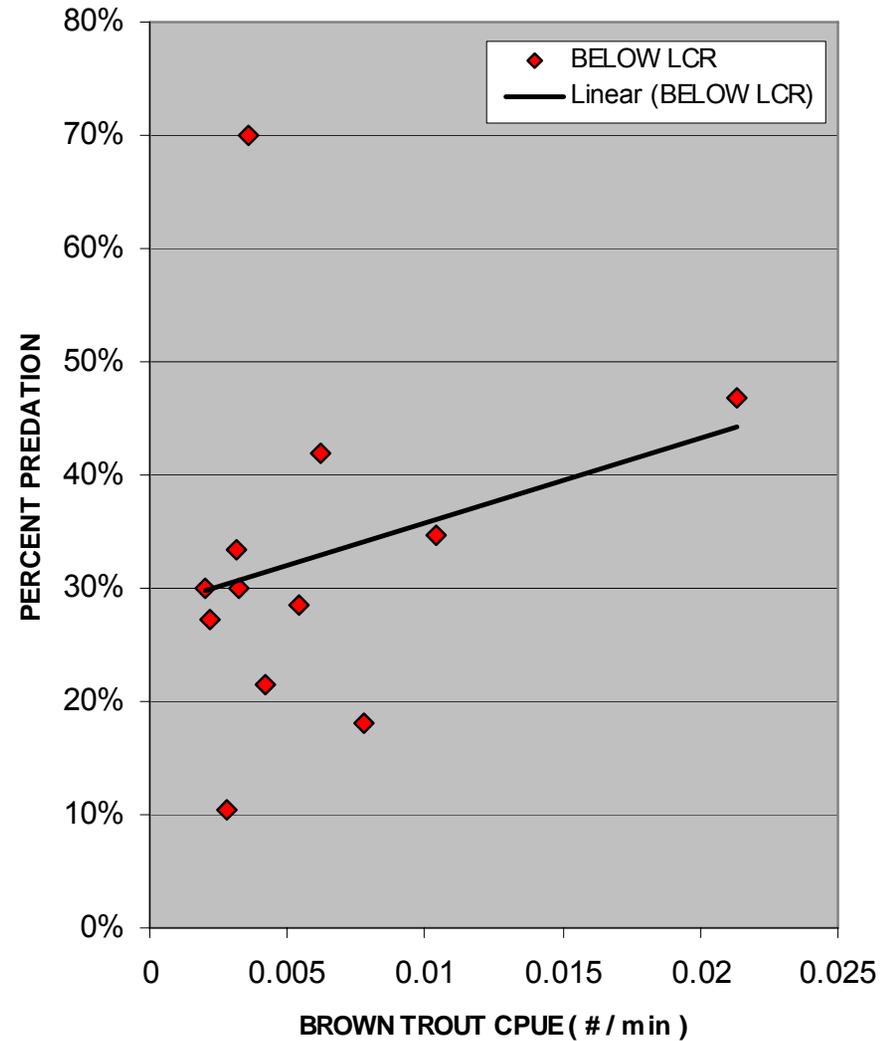


# PERCENT PREDATION BY BROWN TROUT UNDER VARYING PREDATOR DENSITIES (ELECTRO: CPUE)

BROWN TROUT PREDATION IN  
RESPONSE TO PREDATOR DENSITY

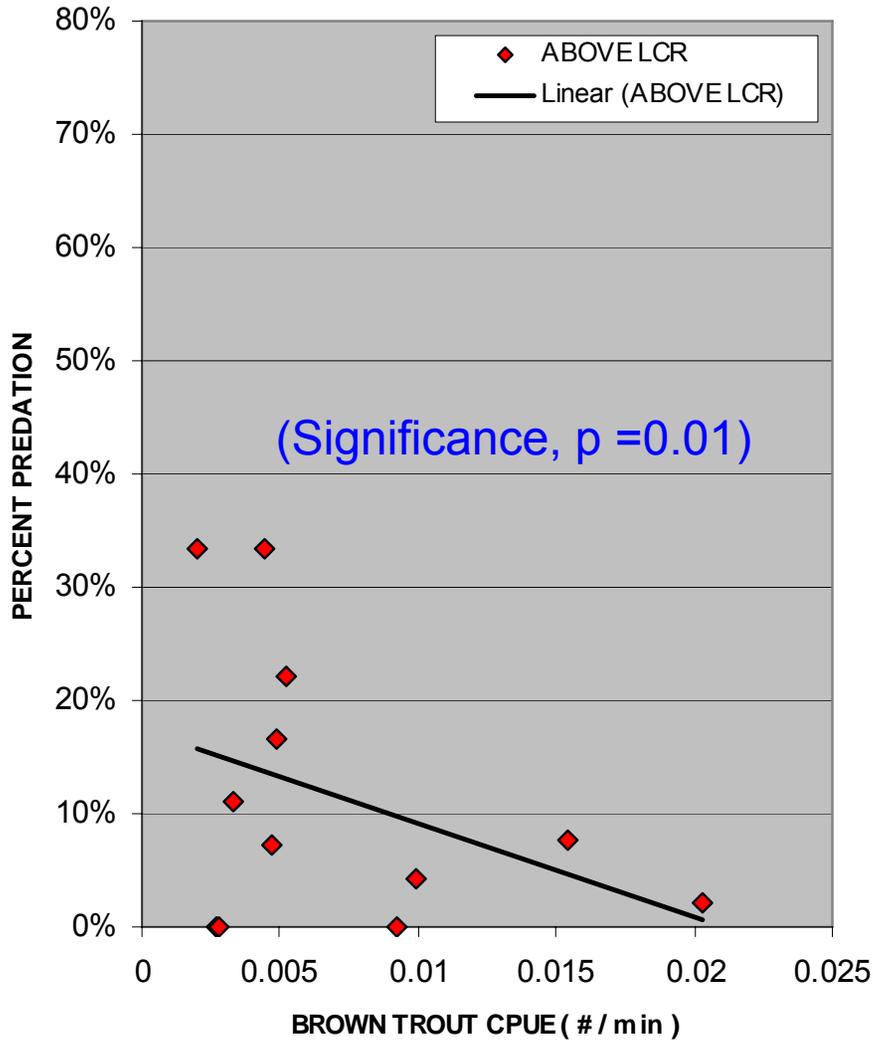


BROWN TROUT PREDATION IN  
RESPONSE TO PREDATOR DENSITY

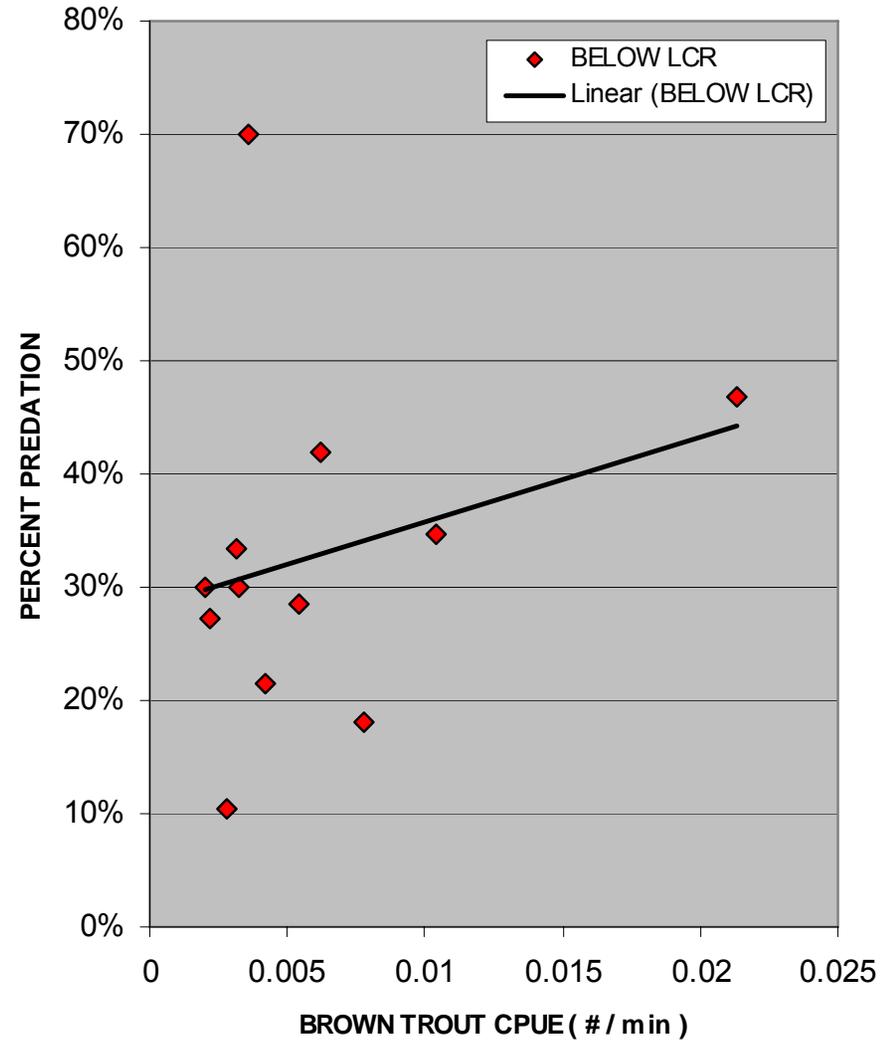


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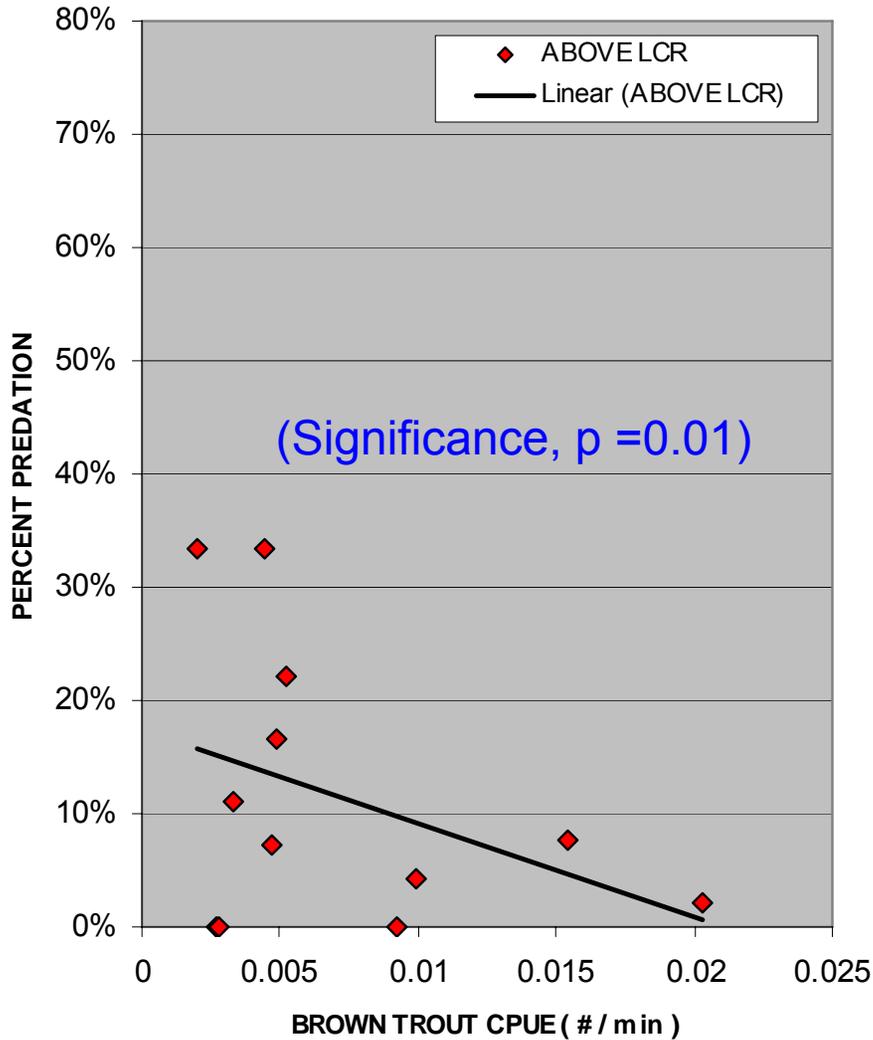


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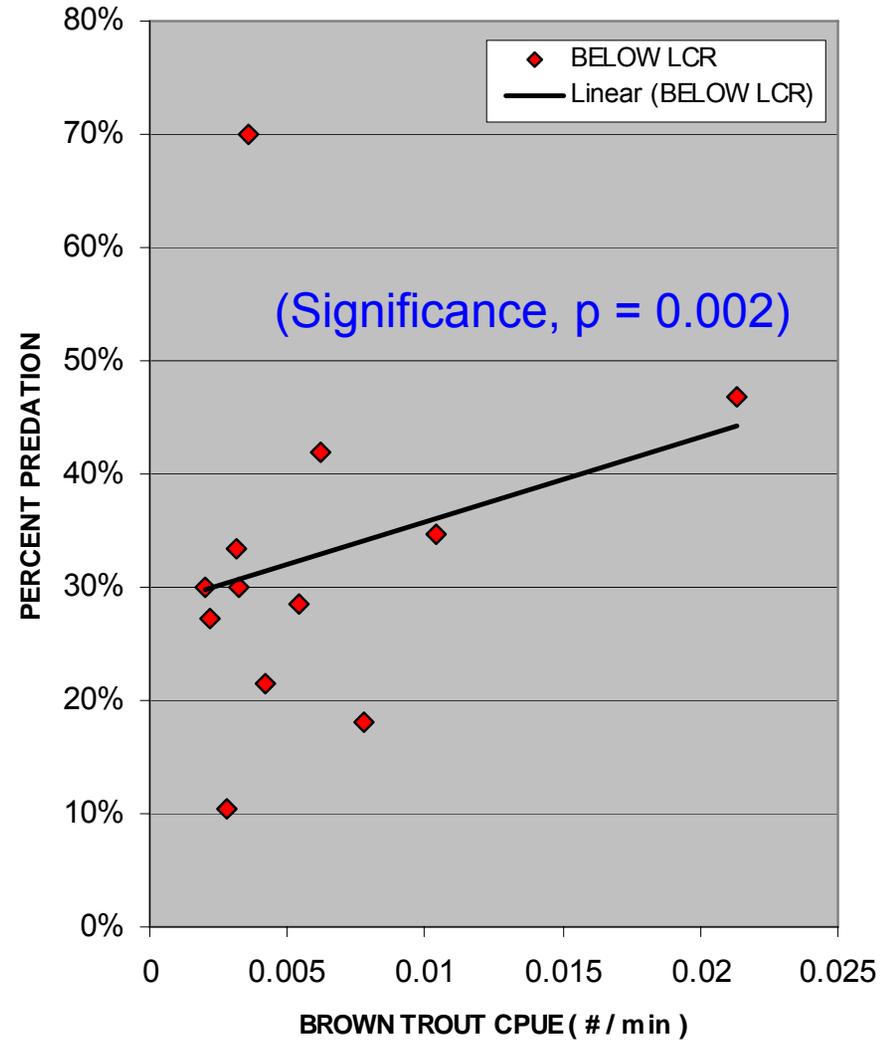


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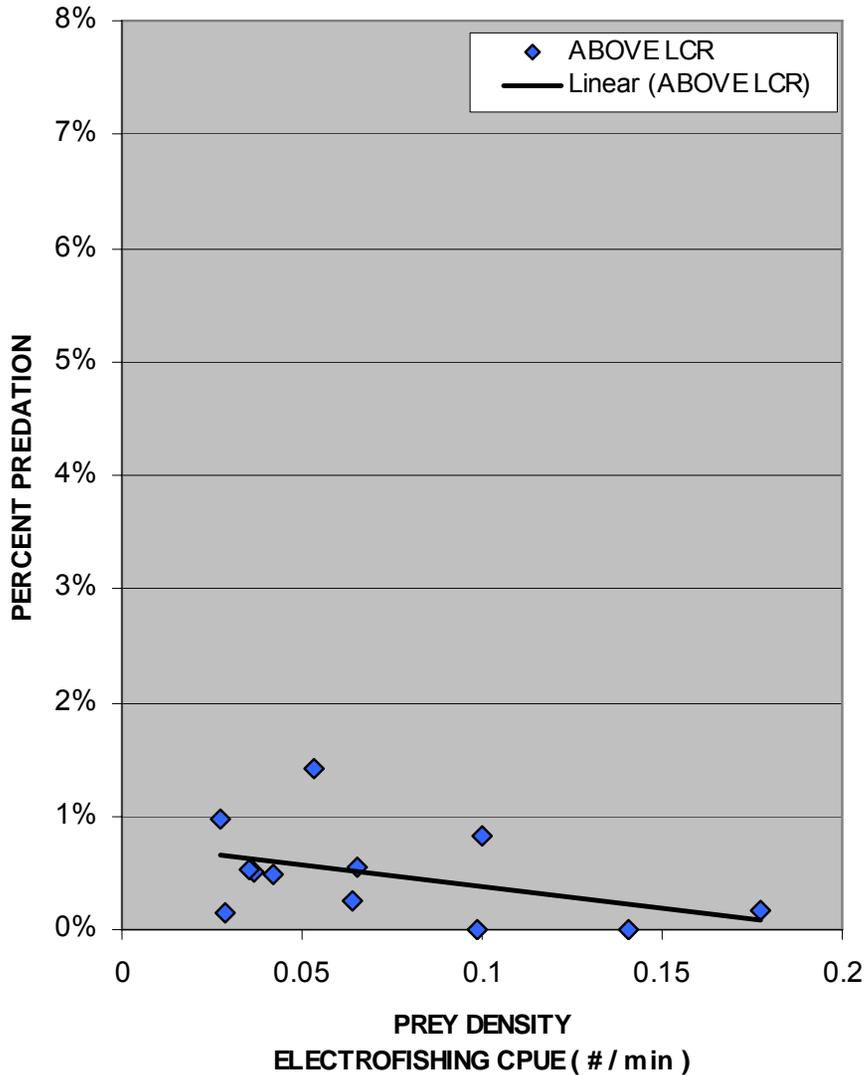


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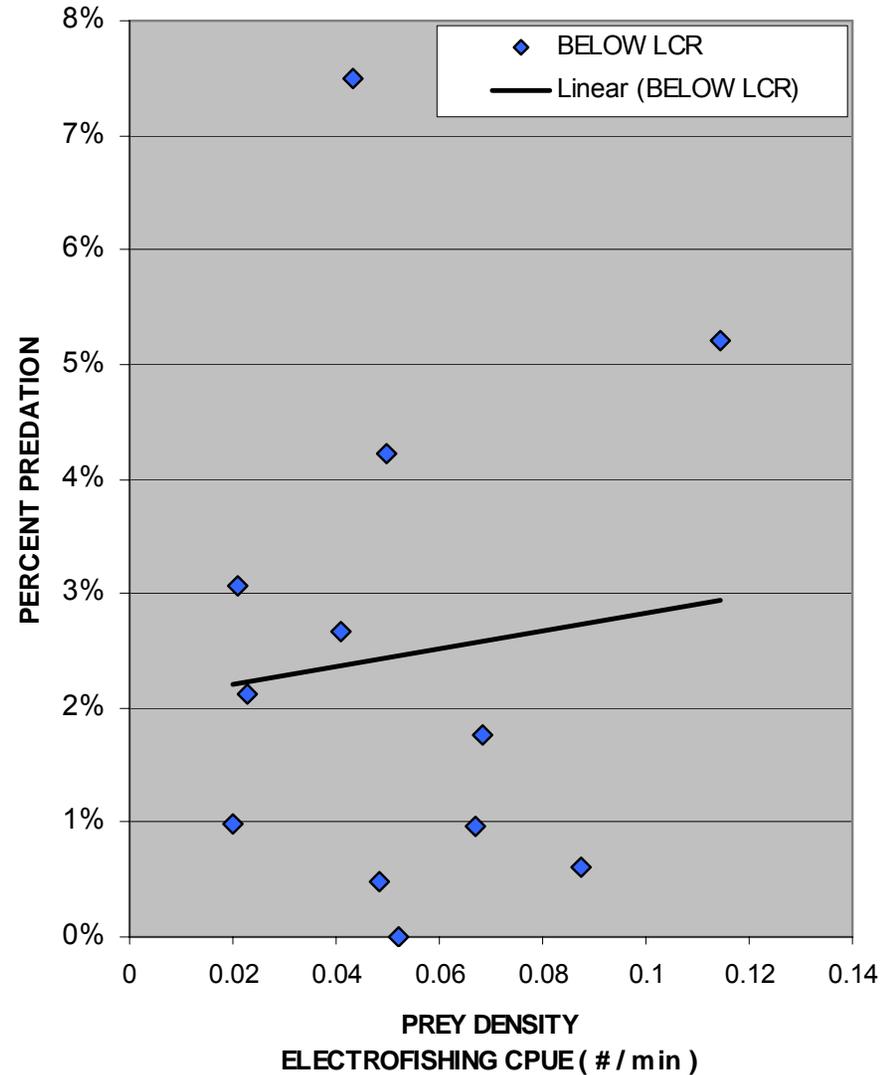


# PERCENT PREDATION BY RAINBOW TROUT UNDER VARYING PREY DENSITIES (ALL FISH < 150 mm)

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RESPONSE TO PREY DENSITY

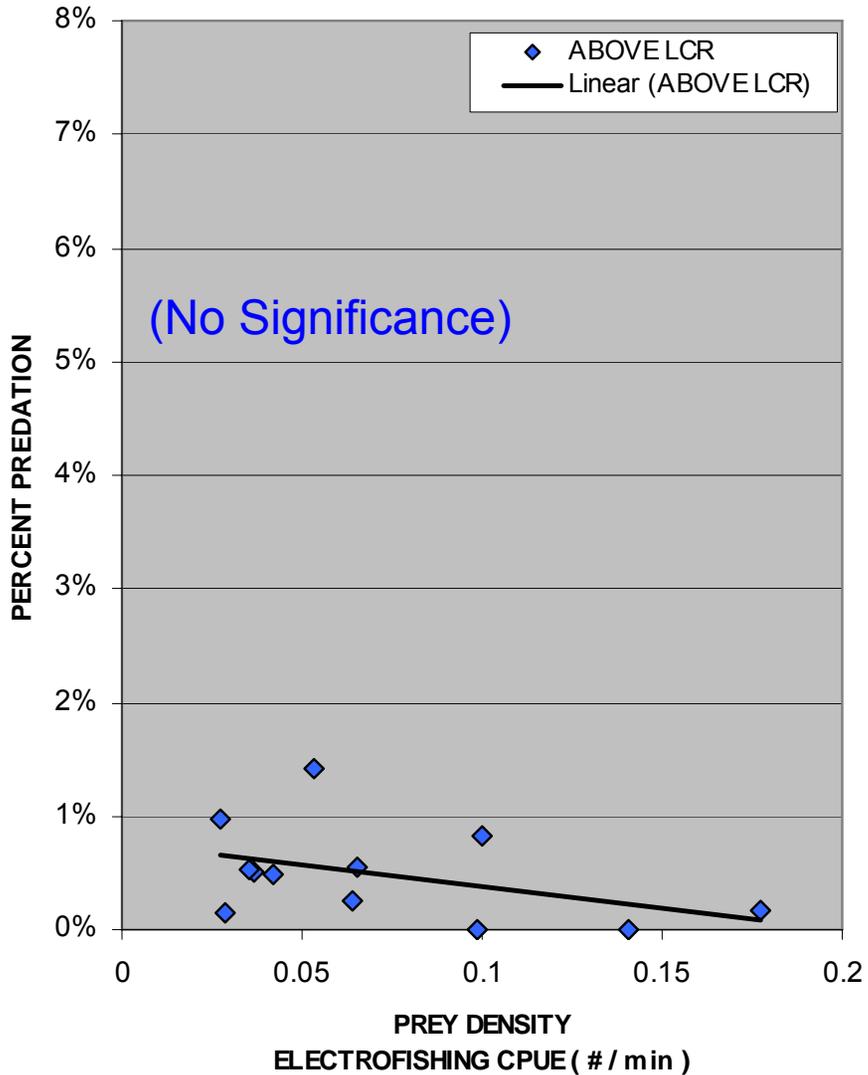


RAINBOW TROUT PREDATION IN  
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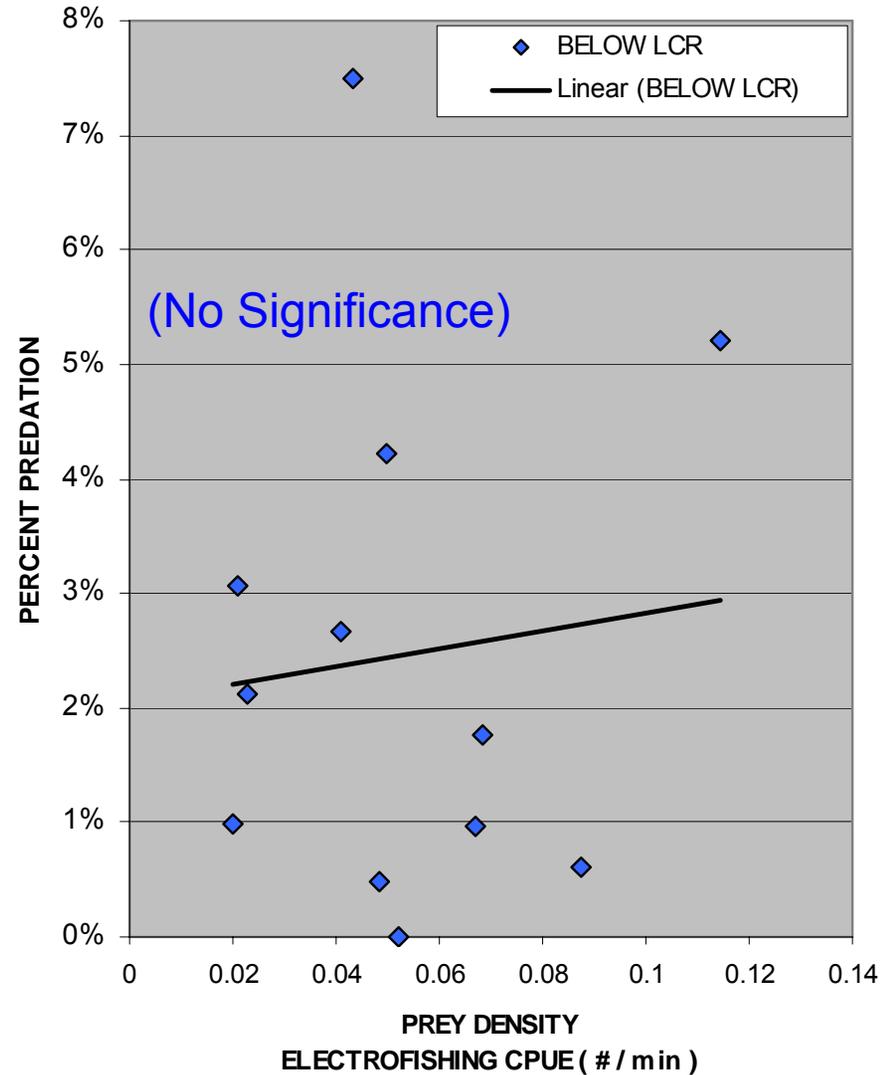


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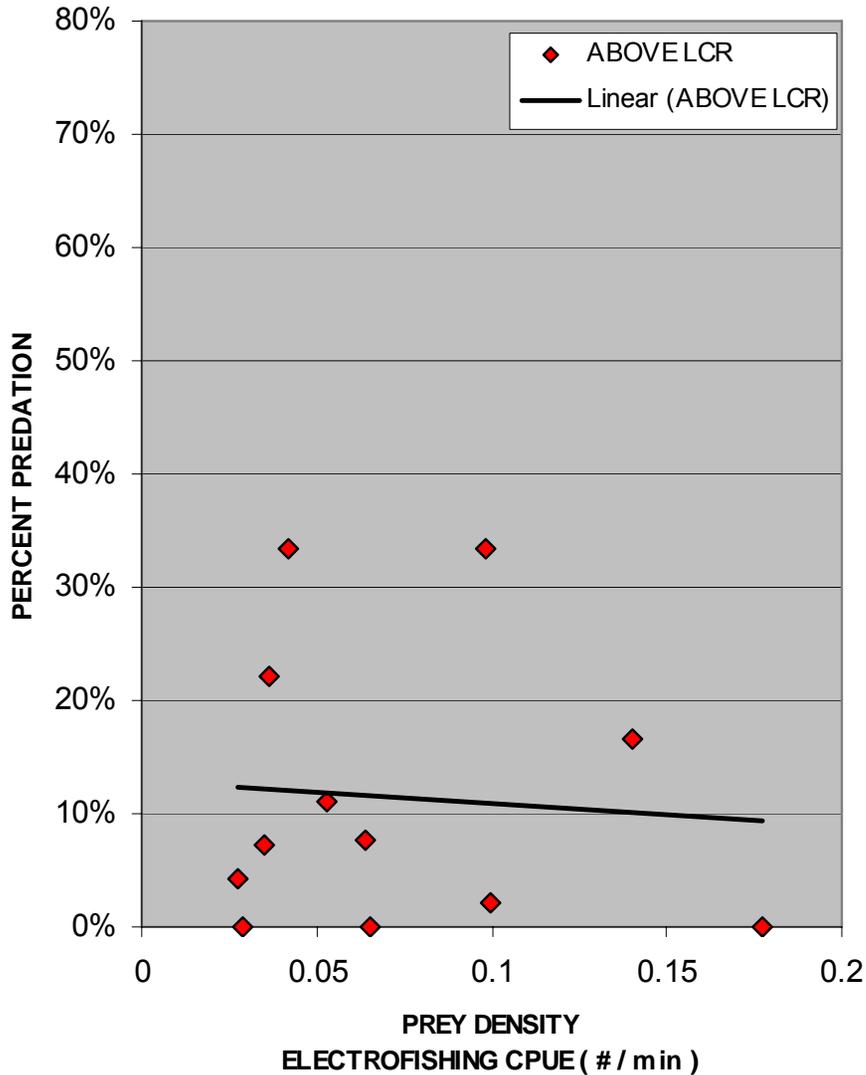


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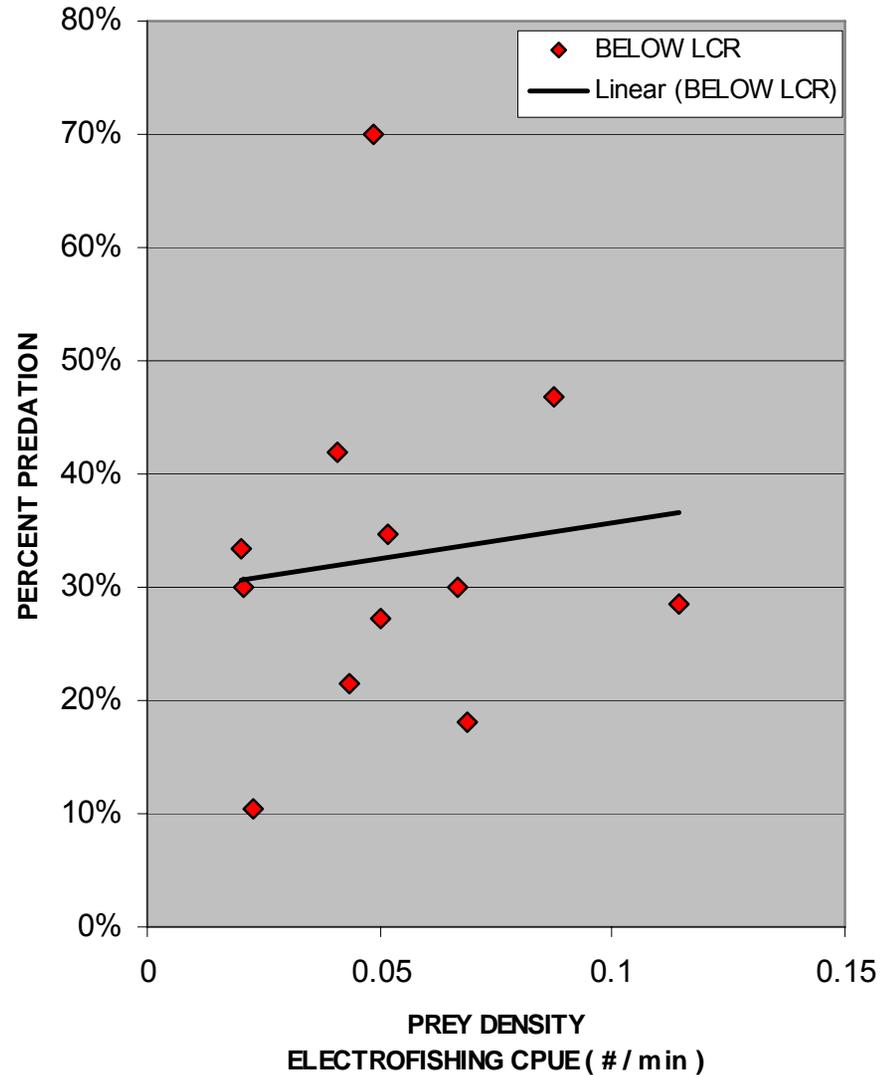


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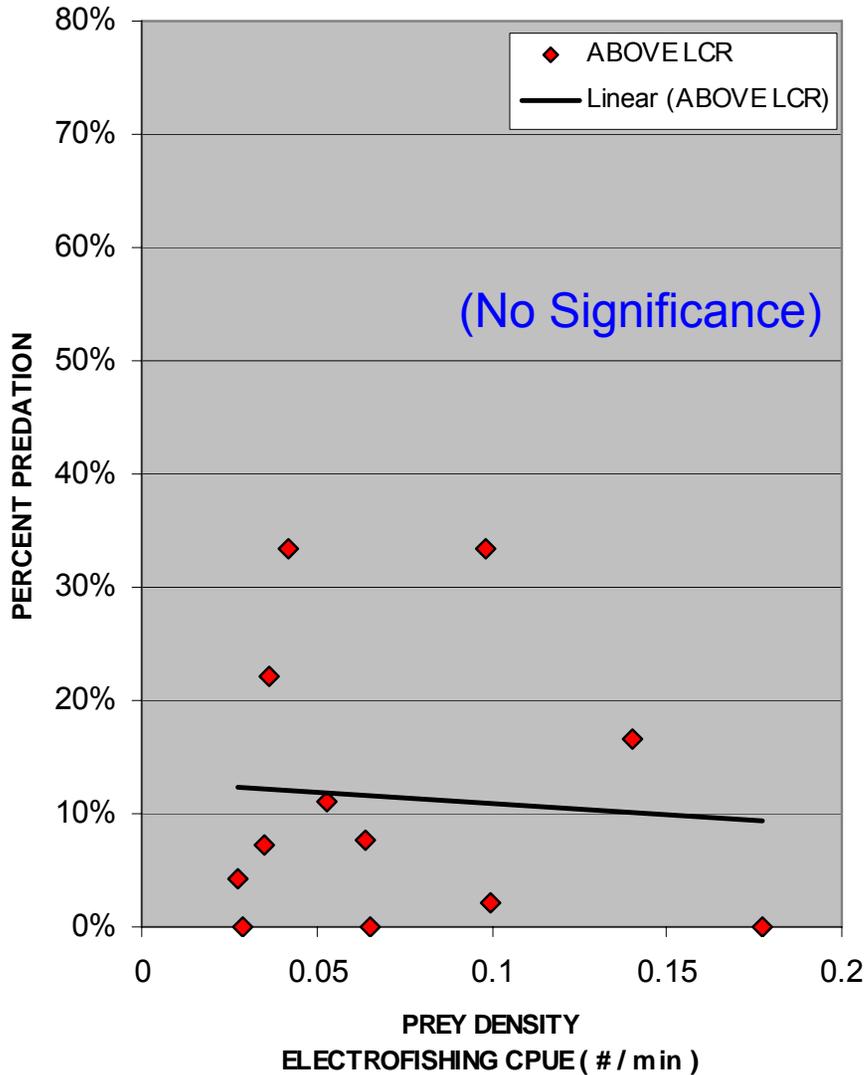


BROWN TROUT PREDATION IN  
RESPONSE TO PREY DENSITY

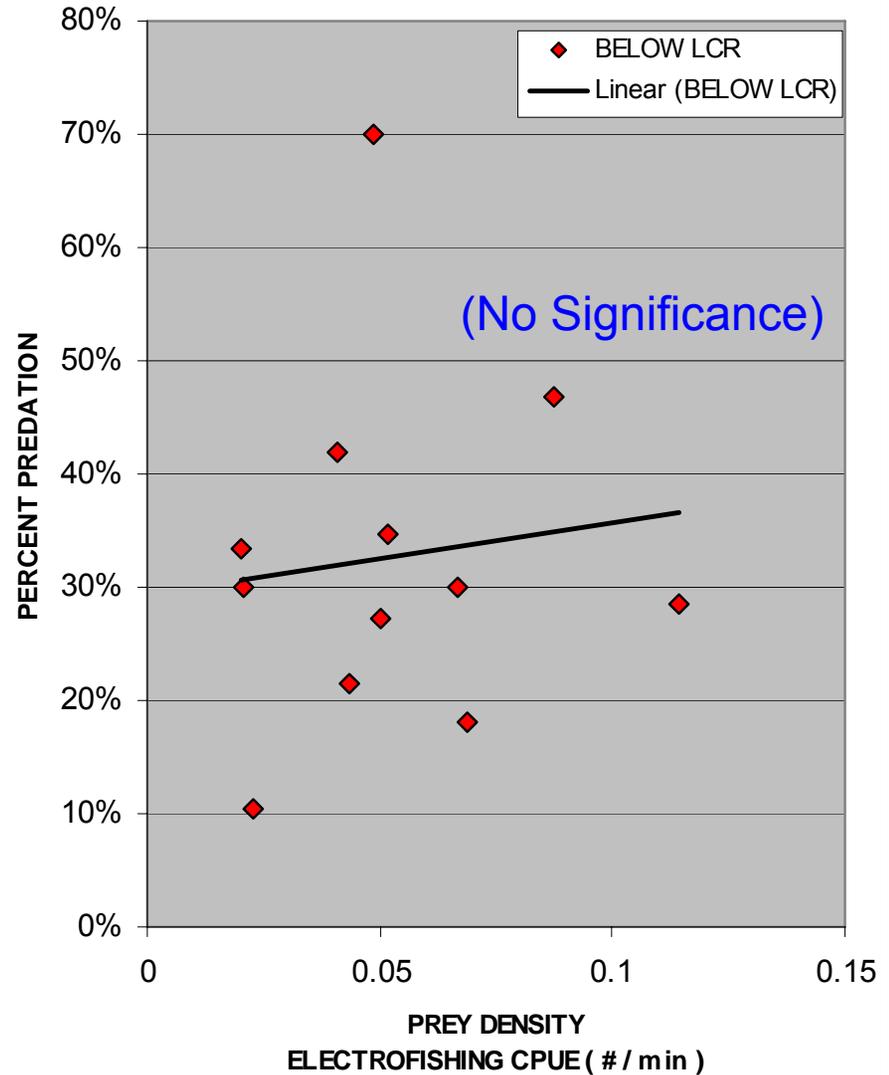


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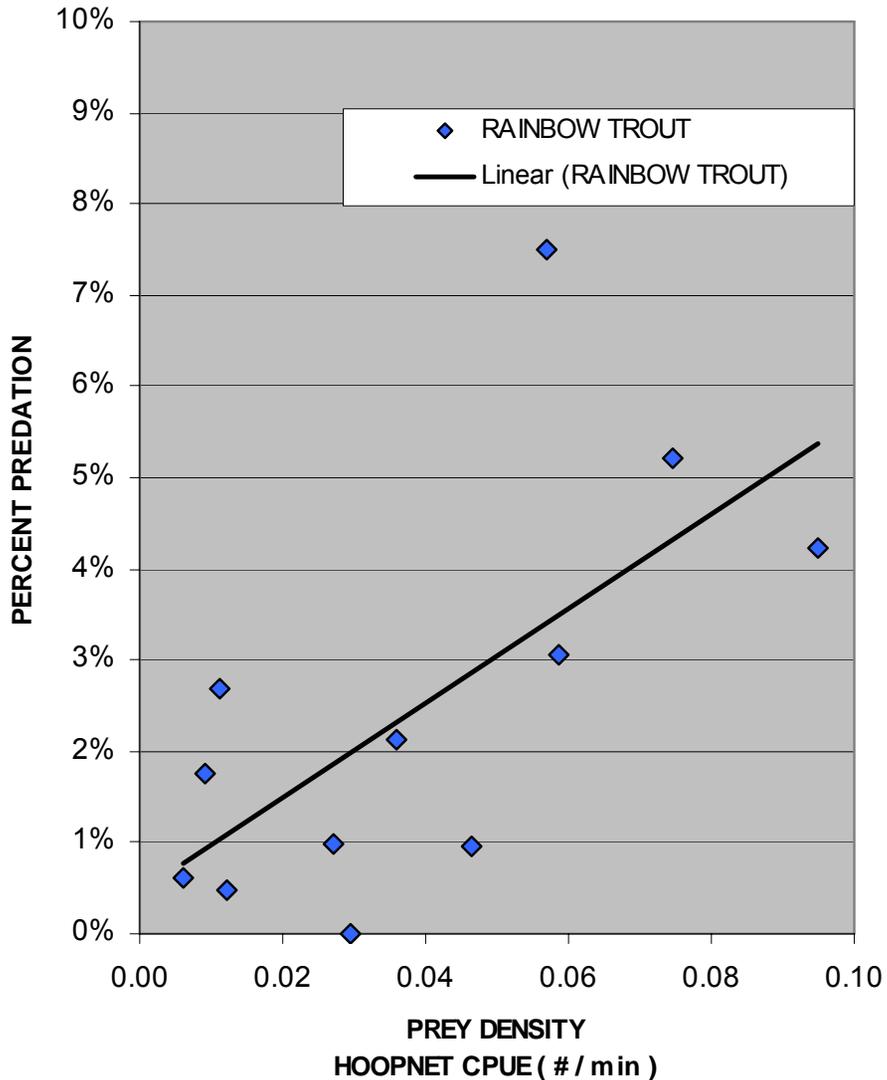


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RESPONSE TO PREY DENSITY

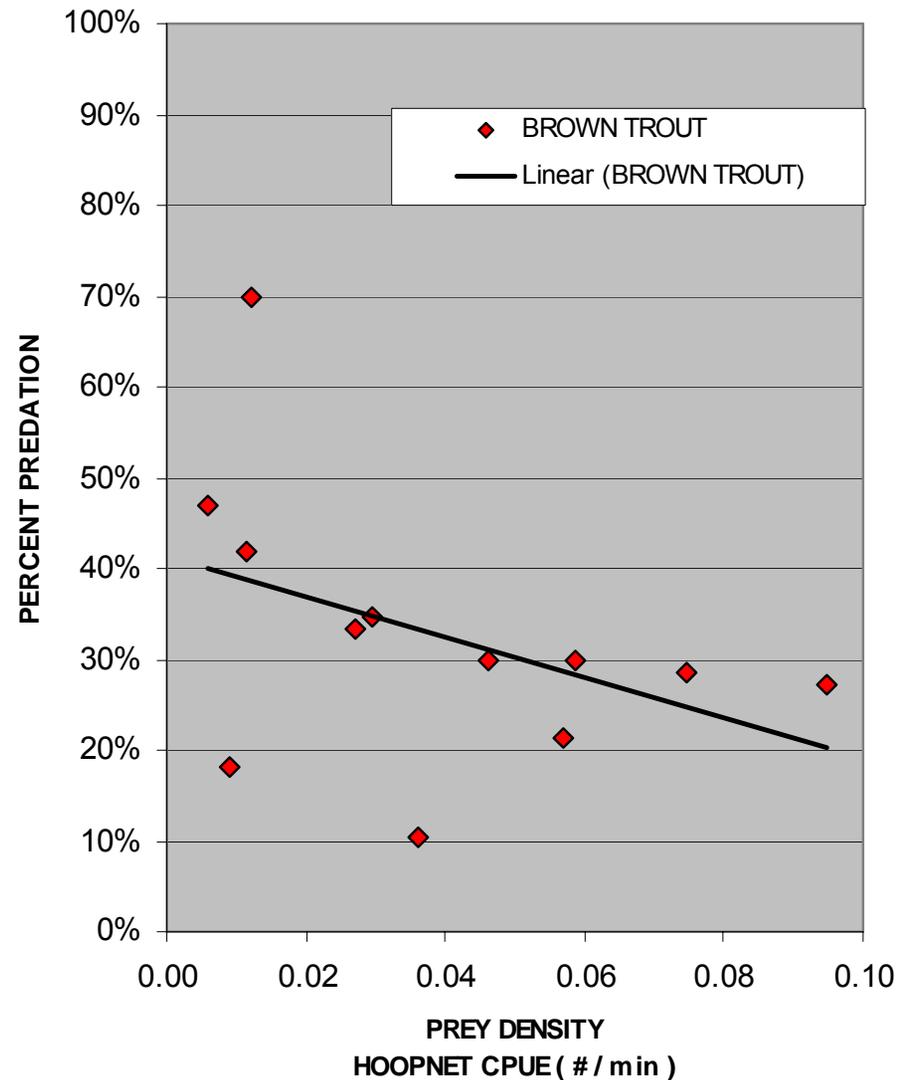


# PERCENT PREDATION BY RAINBOW TROUT UNDER VARYING PREY DENSITIES (HBC < 150 mm)

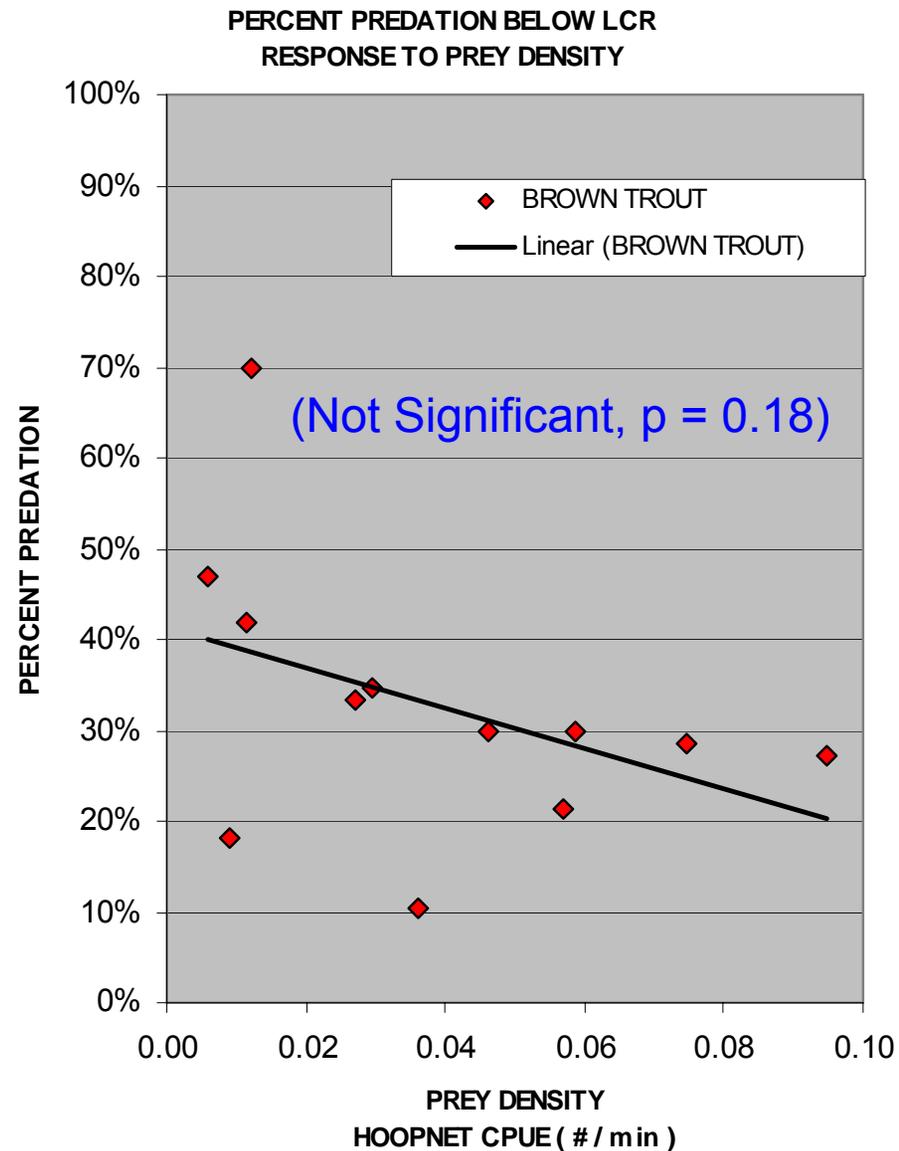
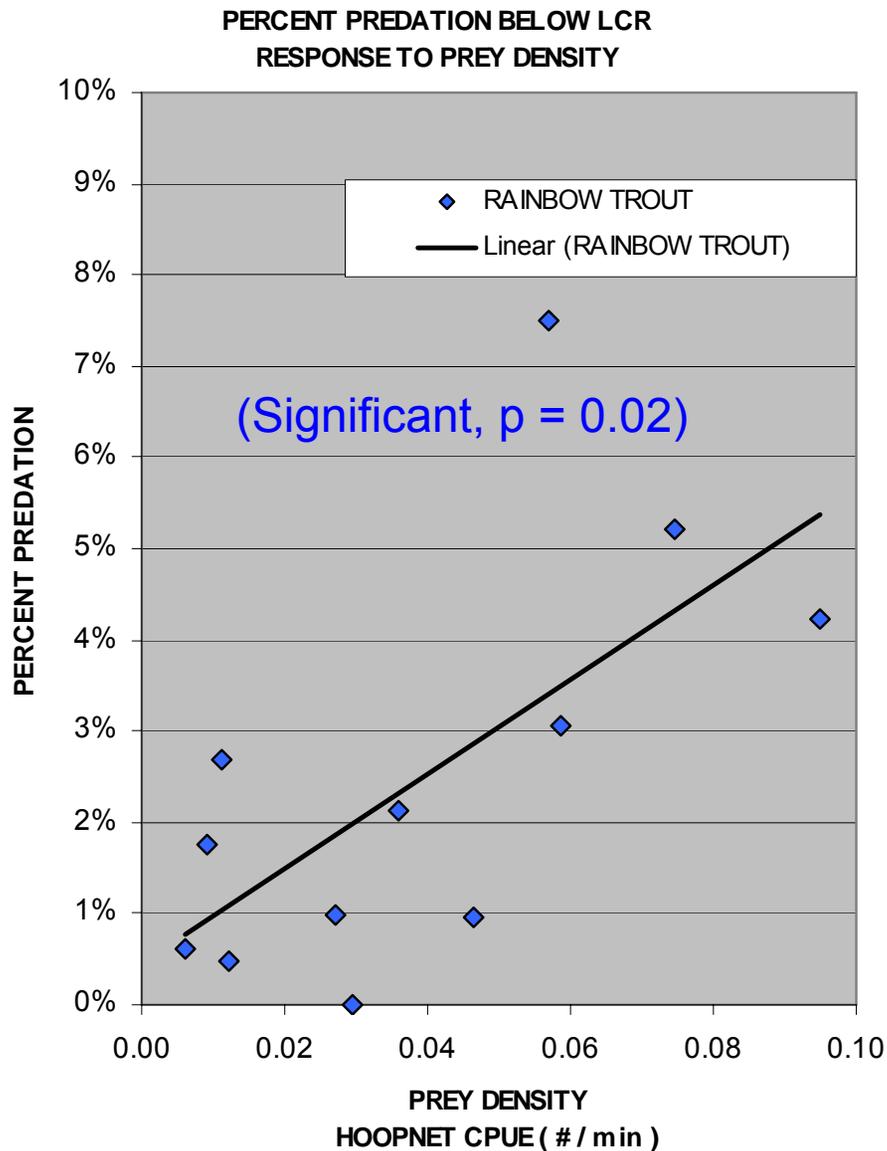
PERCENT PREDATION BELOW LCR  
RESPONSE TO PREY DENSITY



PERCENT PREDATION BELOW LCR  
RESPONSE TO PREY DENSITY

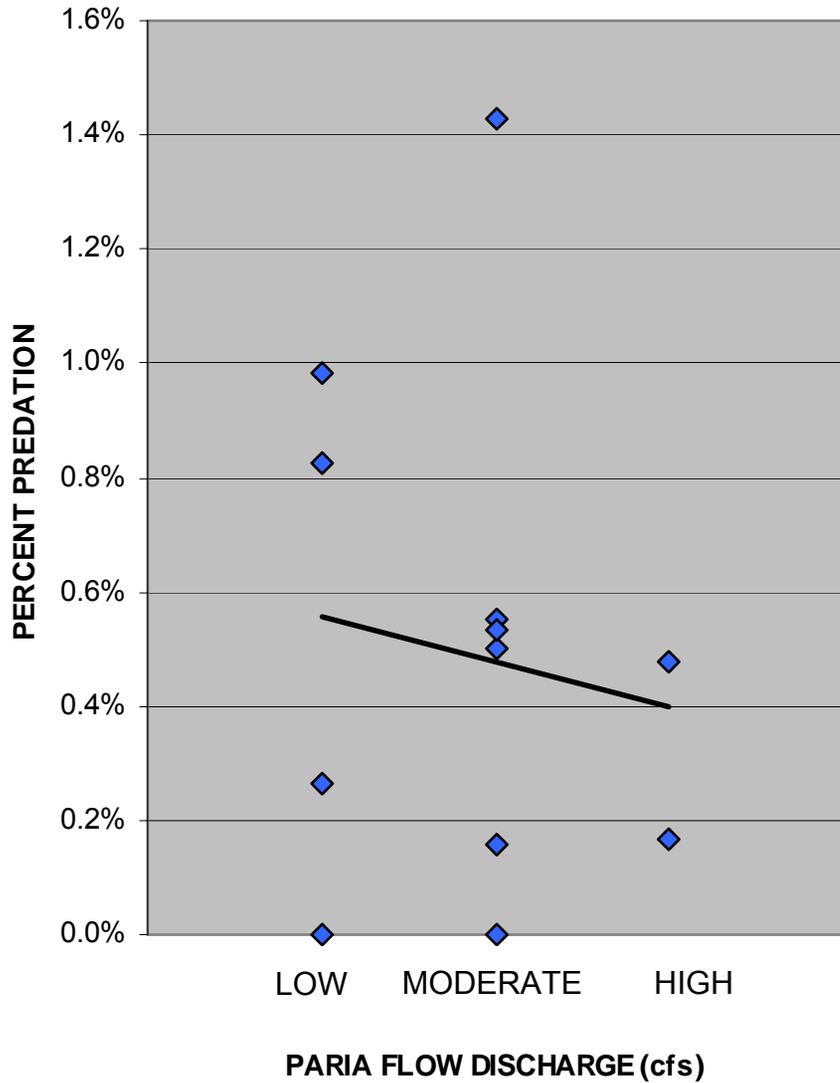


# PERCENT PREDATION BY RAINBOW TROUT UNDER VARYING PREY DENSITIES (HBC < 150 mm)

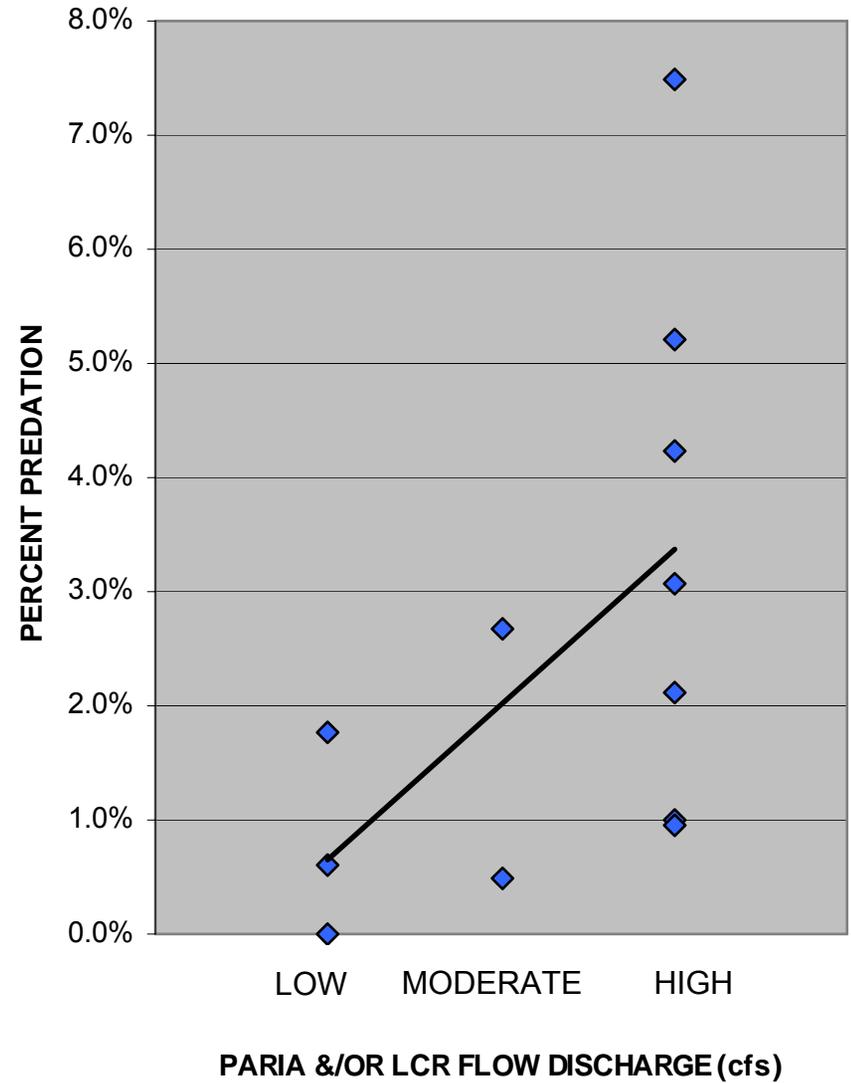


# PERCENT PREDATION BY RAINBOW TROUT UNDER VARYING TRIBUTARY DISCHARGE

## RAINBOW TROUT ABOVE LCR

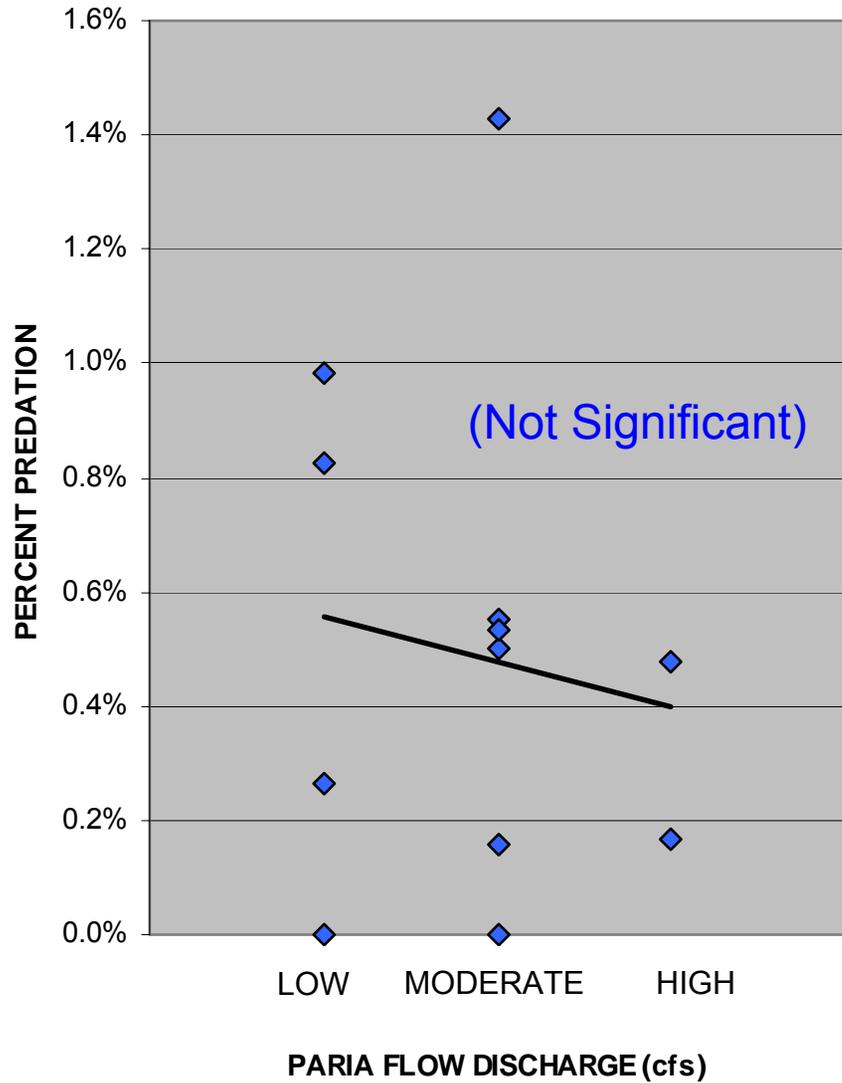


## RAINBOW TROUT BELOW LCR

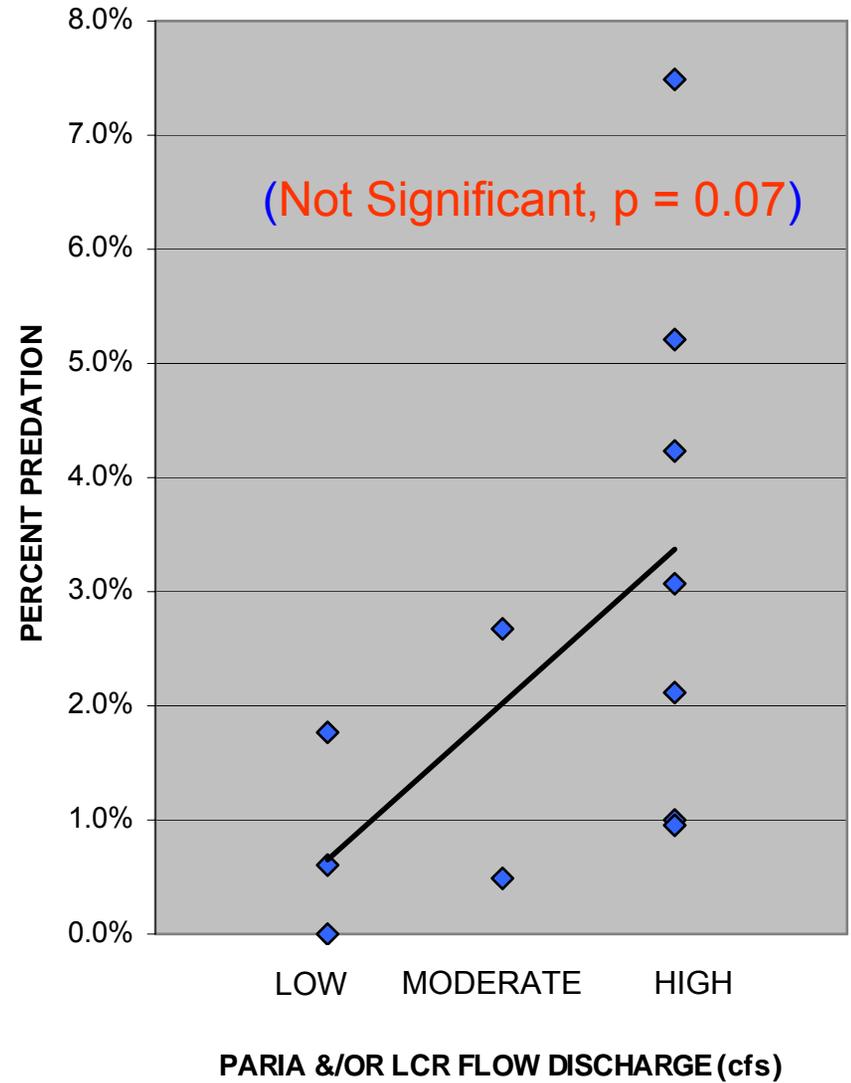


# PERCENT PREDATION BY RAINBOW TROUT UNDER VARYING TRIBUTARY DISCHARGE

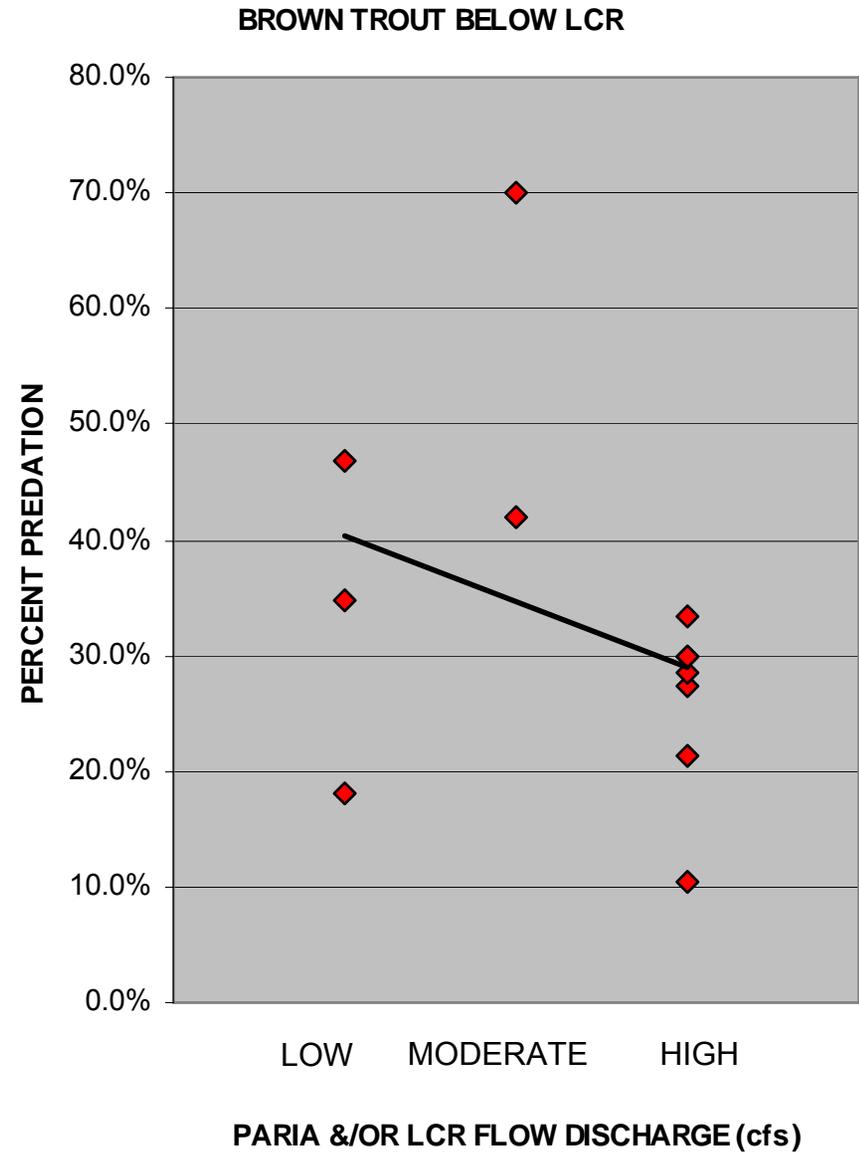
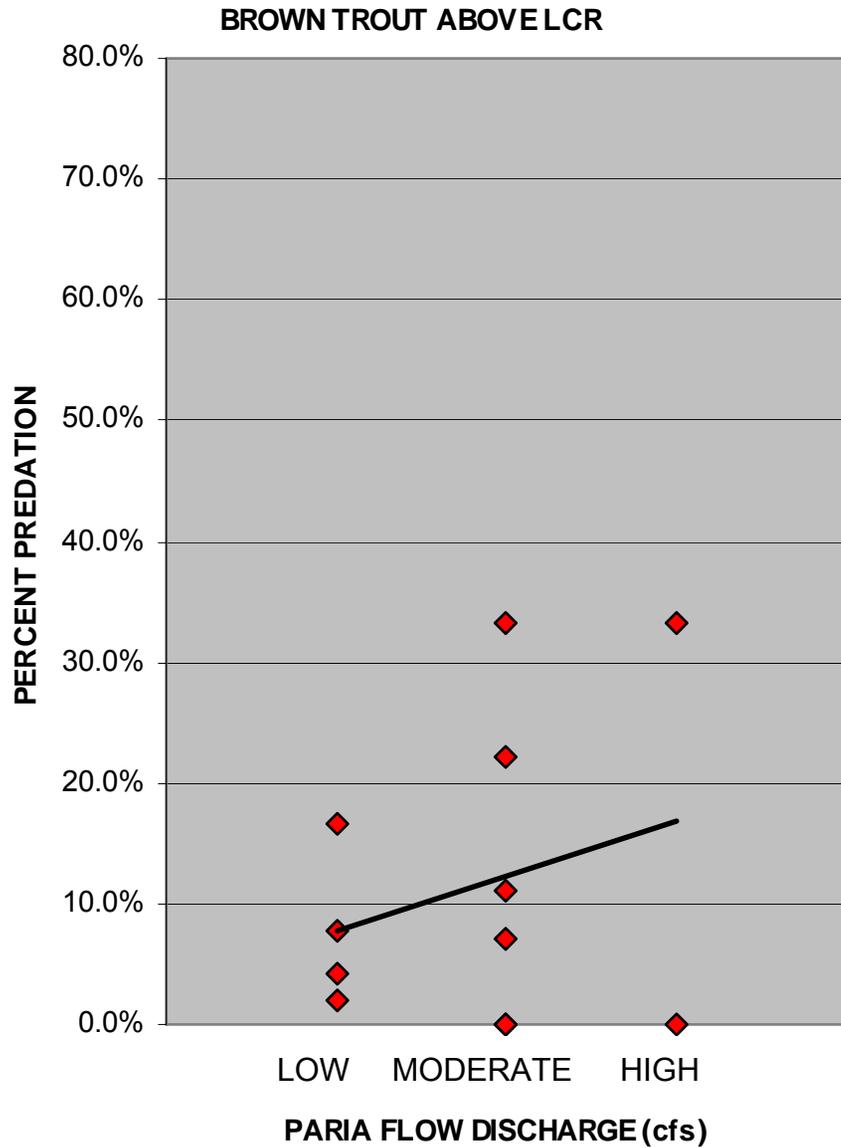
## RAINBOW TROUT ABOVE LCR



## RAINBOW TROUT BELOW LCR

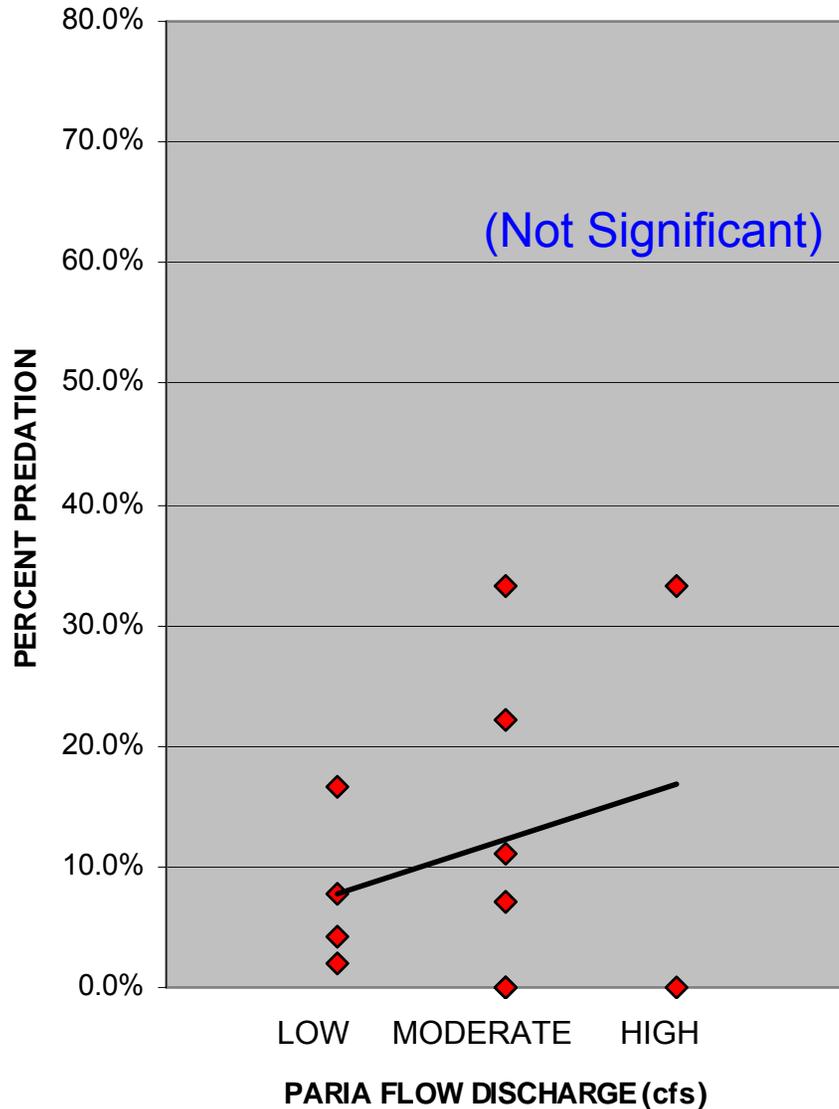


# PERCENT PREDATION BY RAINBOW TROUT UNDER VARYING TRIBUTARY DISCHARGES

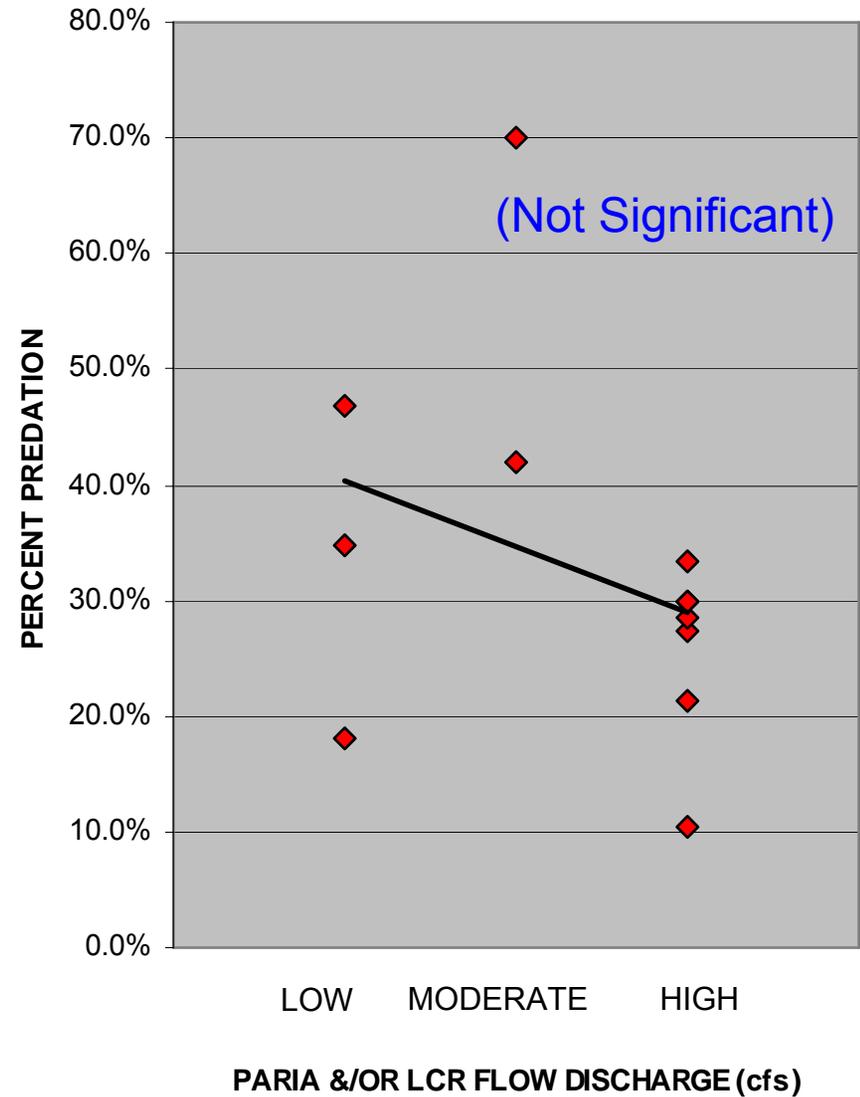


# PERCENT PREDATION BY RAINBOW TROUT UNDER VARYING TRIBUTARY DISCHARGES

## BROWN TROUT ABOVE LCR

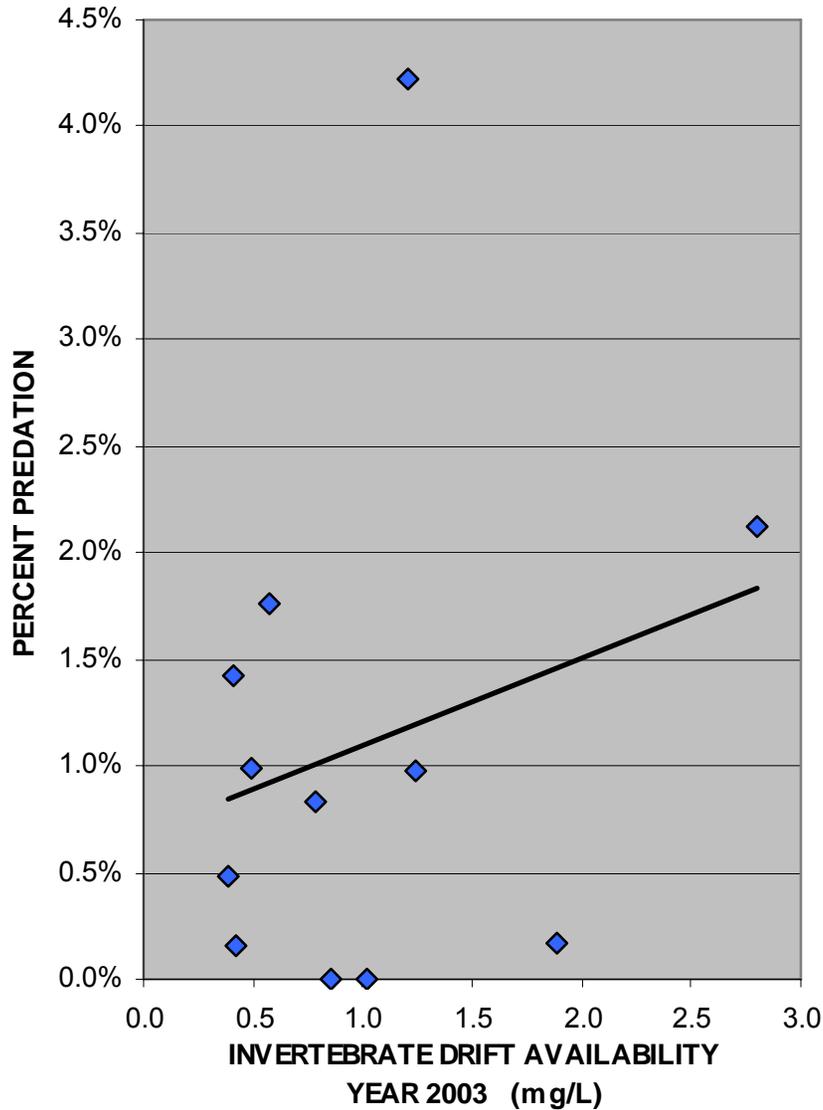


## BROWN TROUT BELOW LCR

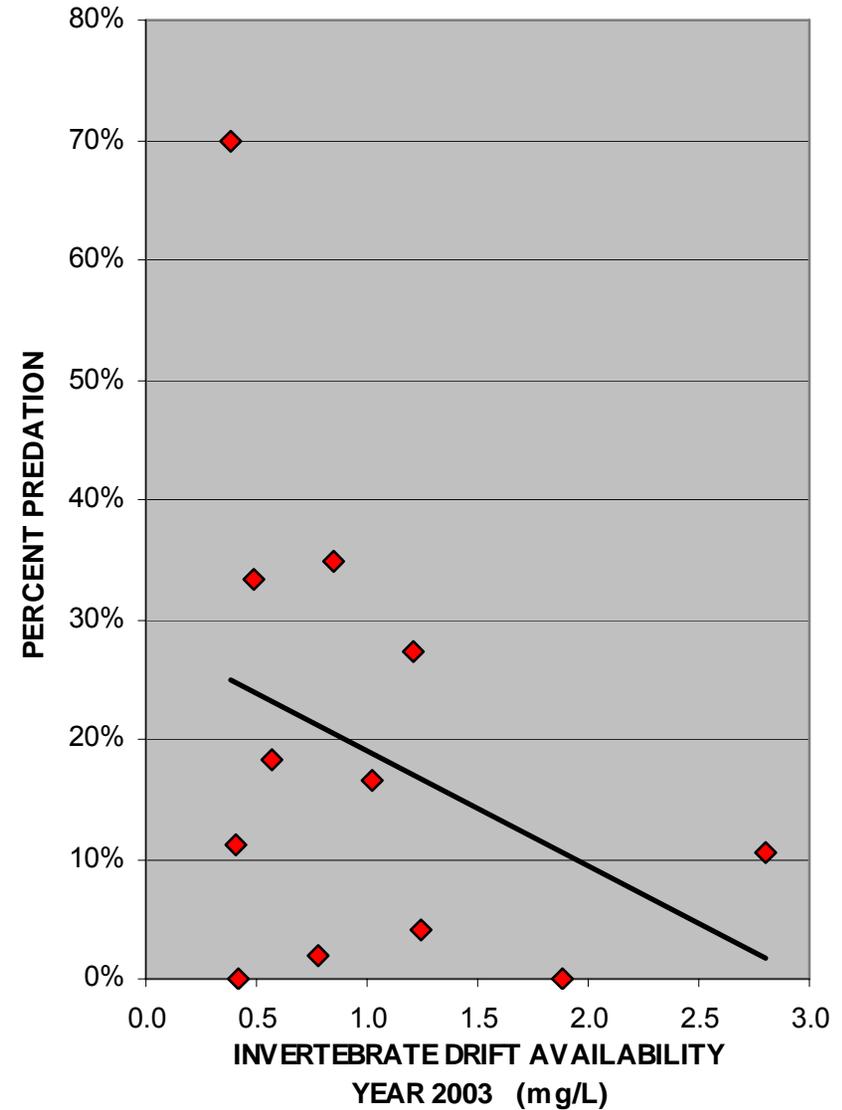


# PERCENT PREDATION BY TROUT UNDER VARYING INVERTEBRATE DRIFT LEVELS

## RAINBOW TROUT

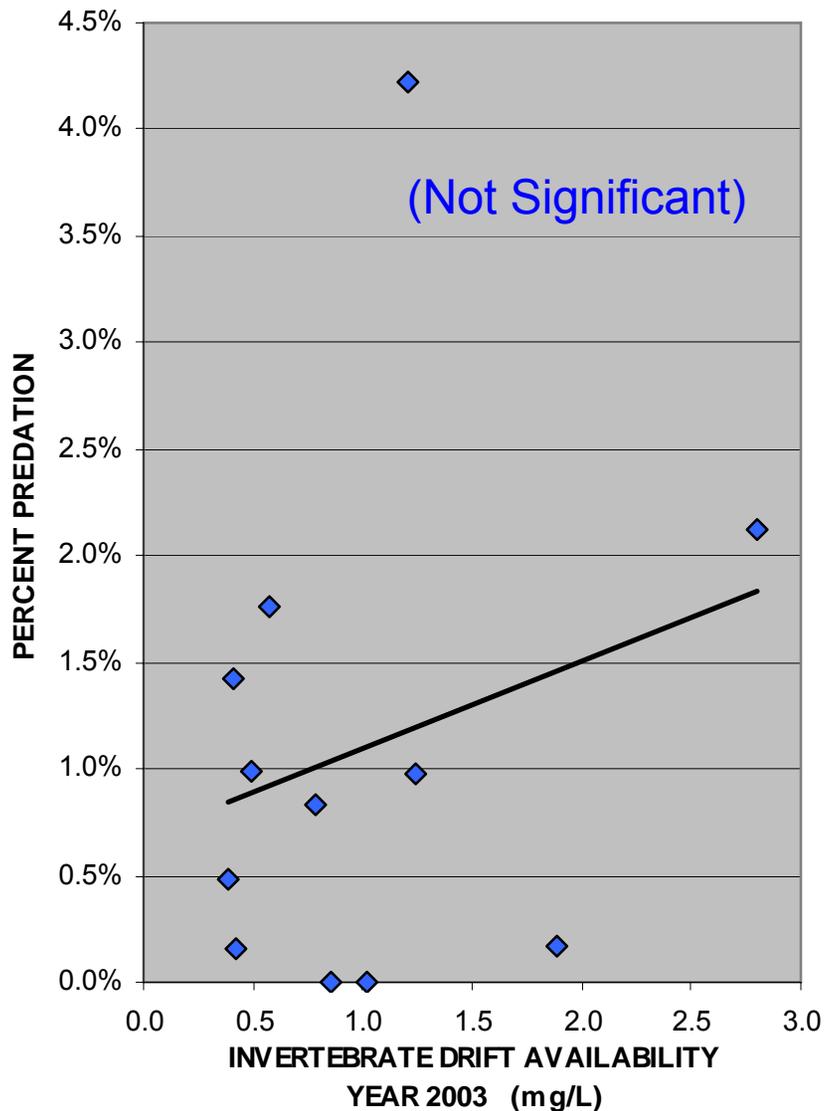


## BROWN TROUT

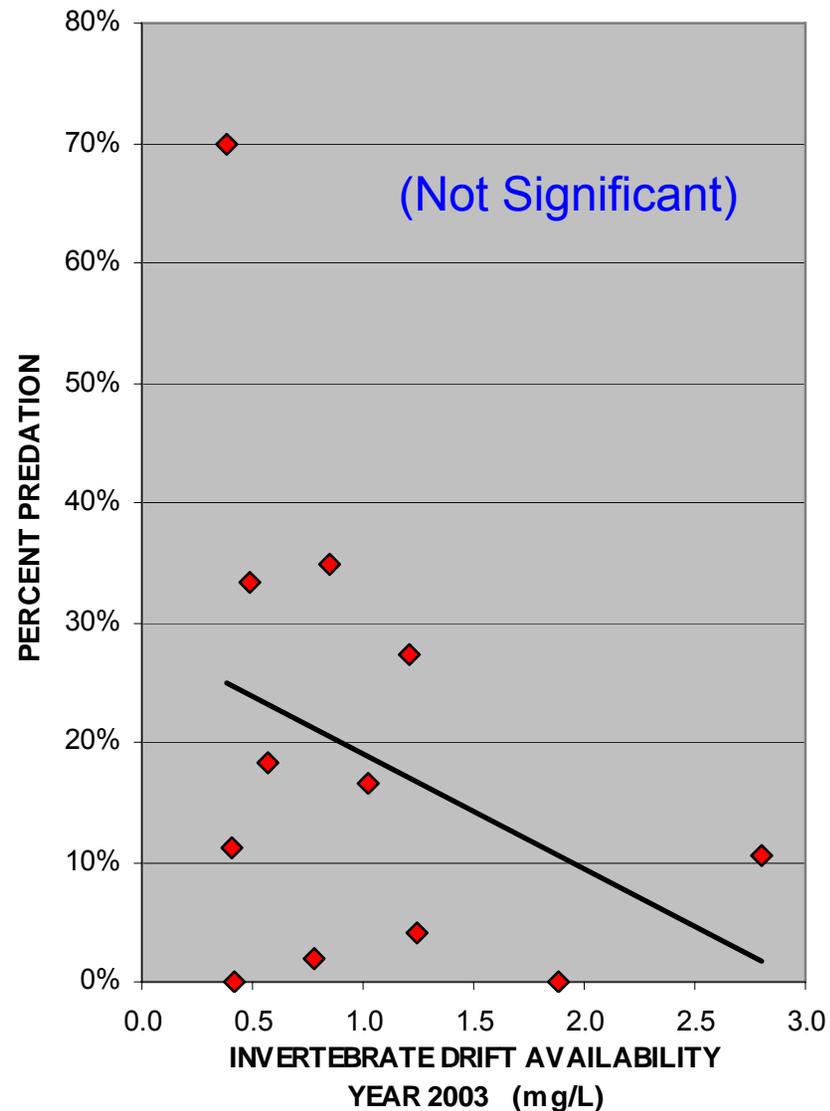


# PERCENT PREDATION BY TROUT UNDER VARYING INVERTEBRATE DRIFT LEVELS

## RAINBOW TROUT

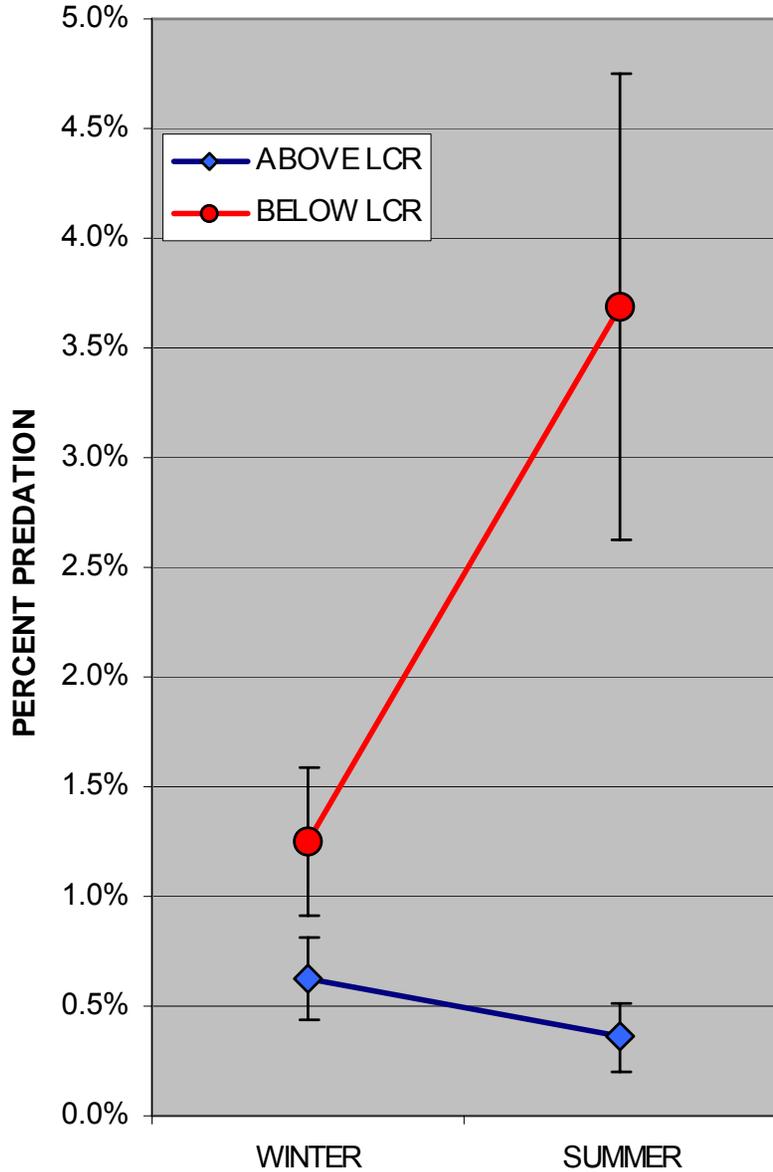


## BROWN TROUT

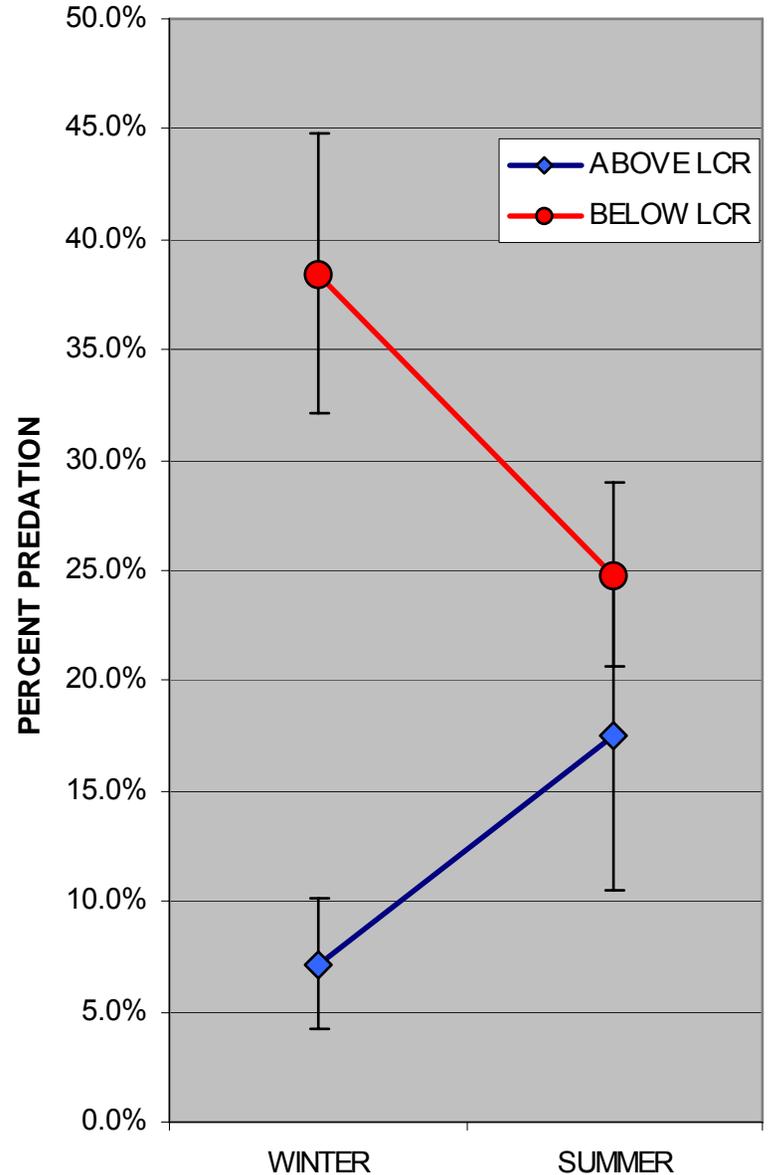


# SEASONAL DIFFERENCES IN PREDATION

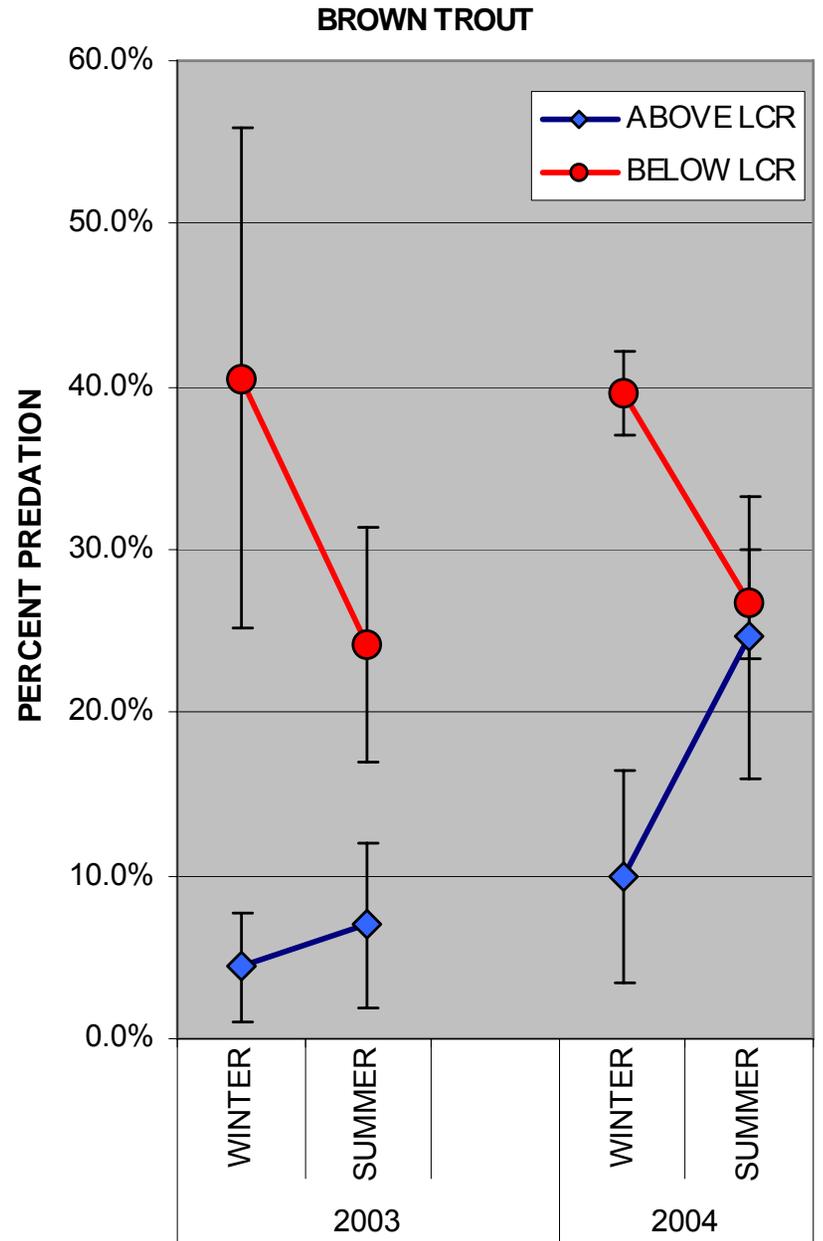
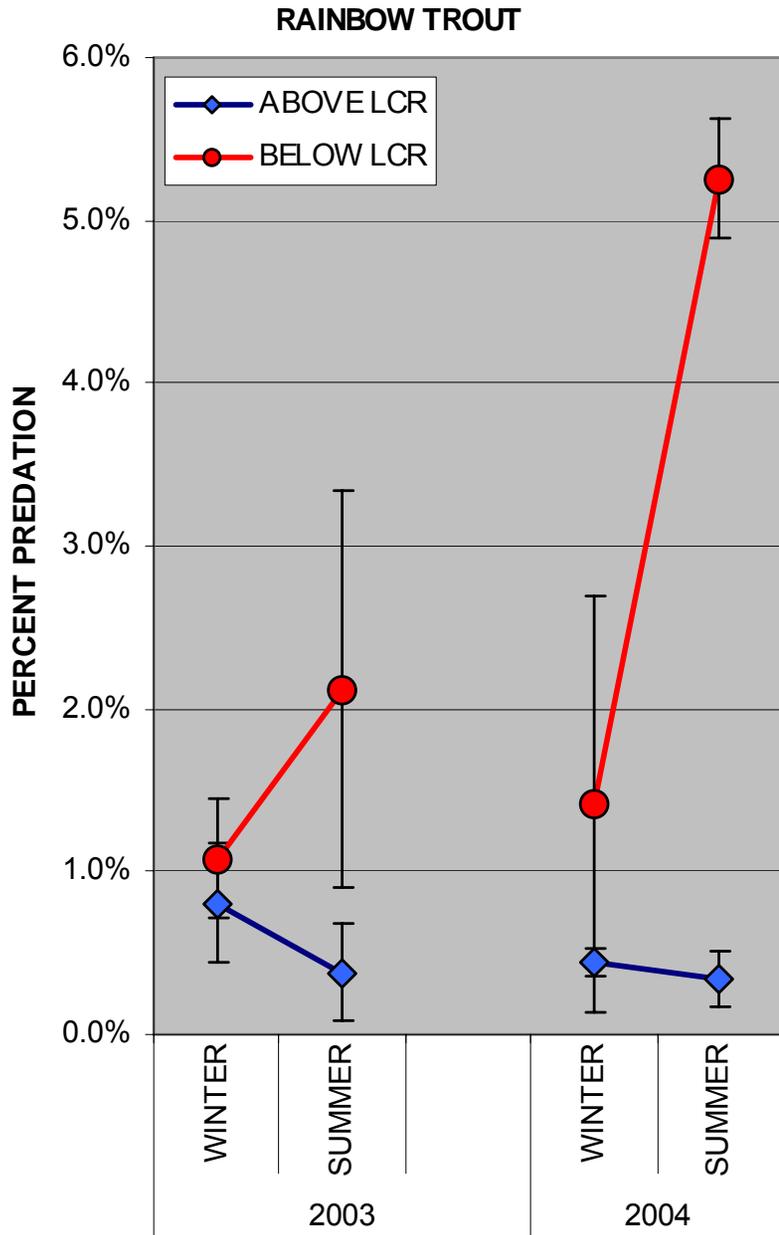
## RAINBOW TROUT



## BROWN TROUT



# TEMPORAL DIFFERENCES IN PREDATION



# NUMERICAL RESPONSE

## RELATIVE PREDATION EFFECT

### STARTING ABUNDANCE

	ABUNDANCE (N)	
	ABOVE	BELOW
RAINBOW TROUT	5270	1405
BROWN TROUT	31	173

# NUMERICAL RESPONSE

## RELATIVE PREDATION EFFECT

	WINTER		SUMMER	
	ABOVE	BELOW	ABOVE	BELOW
RAINBOW TROUT	97.7%	27.3%	87.9%	59.3%
BROWN TROUT	2.3%	72.7%	12.1%	40.7%

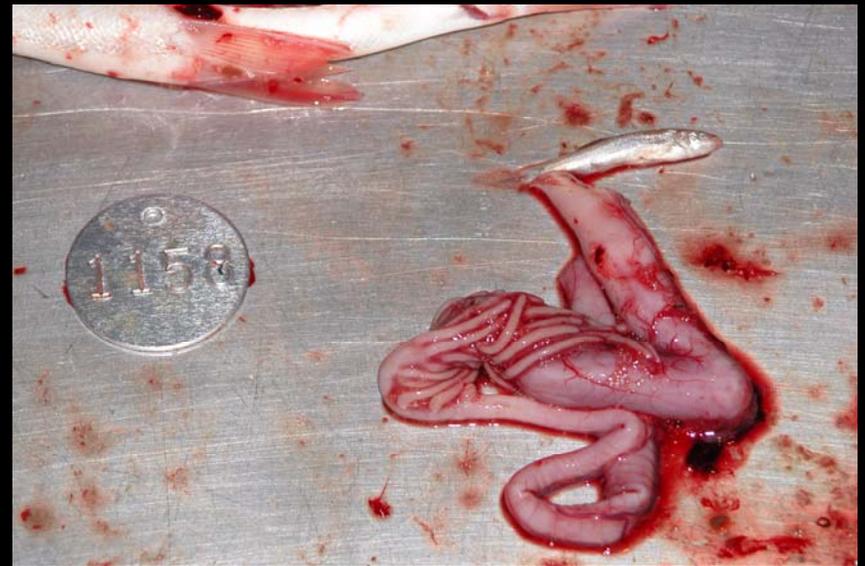
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# CONCLUSIONS

- Who
- When
- Where
- How many
- Hors d'oeuvre
- Entree



# PREDATOR CHARACTERISTICS

## RAINBOW TROUT – FACULTATIVE PREDATOR

- Lower functional response
- Seasonally variable
  - Higher in Summer
  - Lower in Winter
- Spatially variable
  - Higher downstream
- Predator Distribution
  - Higher predator densities upstream
- Prey Distribution
  - Higher prey densities downstream
- Turbidity
  - Marginally responsive to increases in sediment discharge in the downstream sections
- Food base
  - Non-responsive to invertebrate drift
  - Responsive to increases in native prey density
    - Prey selectivity & vulnerability differences
- Predator densities
  - Non-responsive to increases in predator densities
- Condition Factor
  - Higher above than below
- Foraging strategy
  - Switches from drift feeding upstream to active searching downstream

## BROWN TROUT – OBLIGATIVE PREDATOR

- Higher functional response
- Seasonally variable
  - Lower in Summer
  - Higher in Winter
- Spatially variable
  - Higher downstream
- Predator Distribution
  - Higher predator densities downstream
- Prey Distribution
  - Higher prey densities downstream
- Turbidity
  - Non-responsive to sediment discharge
- Food base
  - Non-responsive to invertebrate drift
  - Non-responsive to increases in native prey density
- Predator densities
  - Non-responsive to increases in predator densities
- Condition Factor
  - Uncertain – probably higher below
- Foraging strategy
  - Primarily active searching
  - Downstream more effective under higher reactive distances