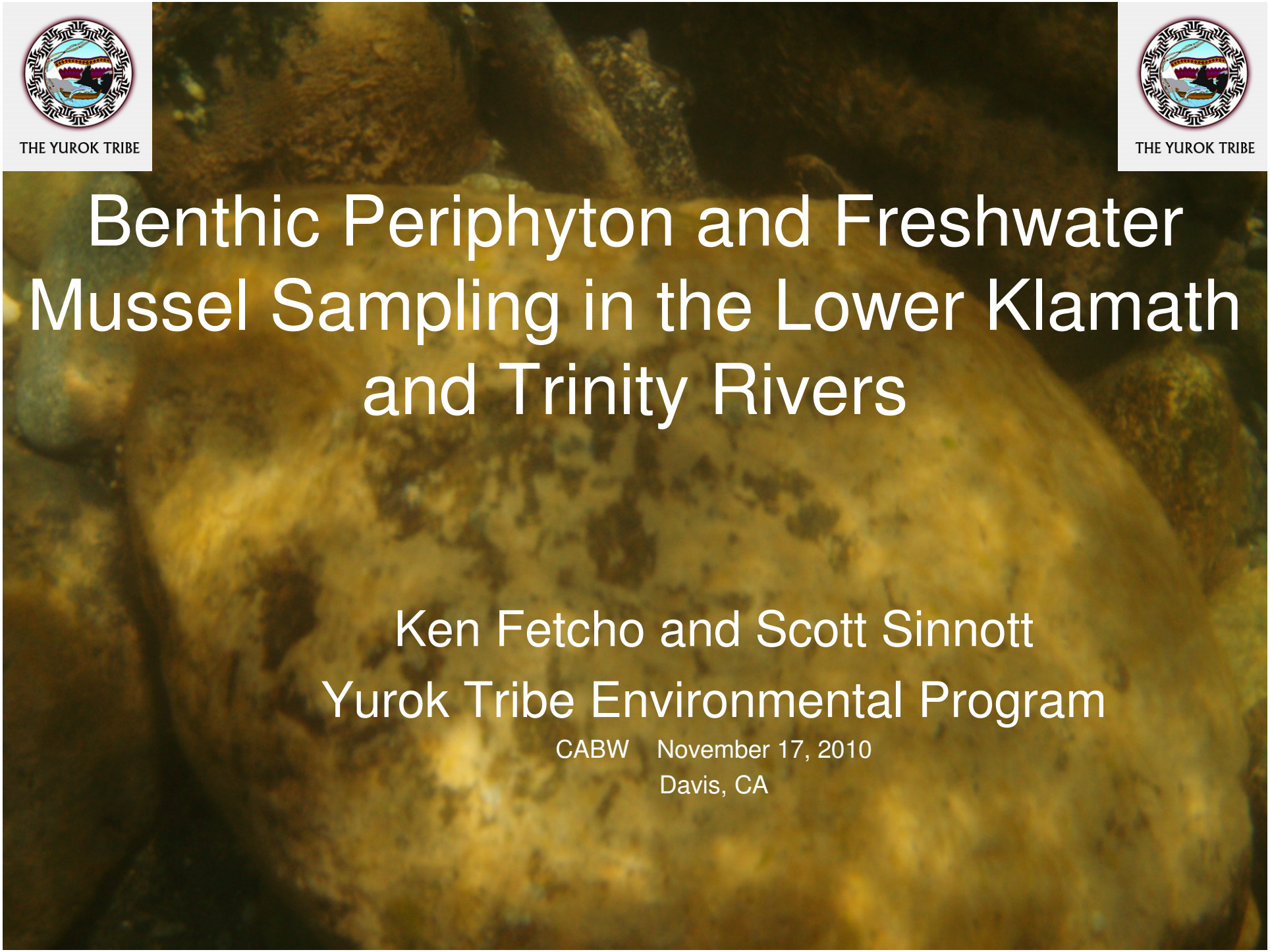

THE YUROK TRIBE

THE YUROK TRIBE

# Benthic Periphyton and Freshwater Mussel Sampling in the Lower Klamath and Trinity Rivers

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Yurok Tribe Environmental Program

CABW November 17, 2010

Davis, CA

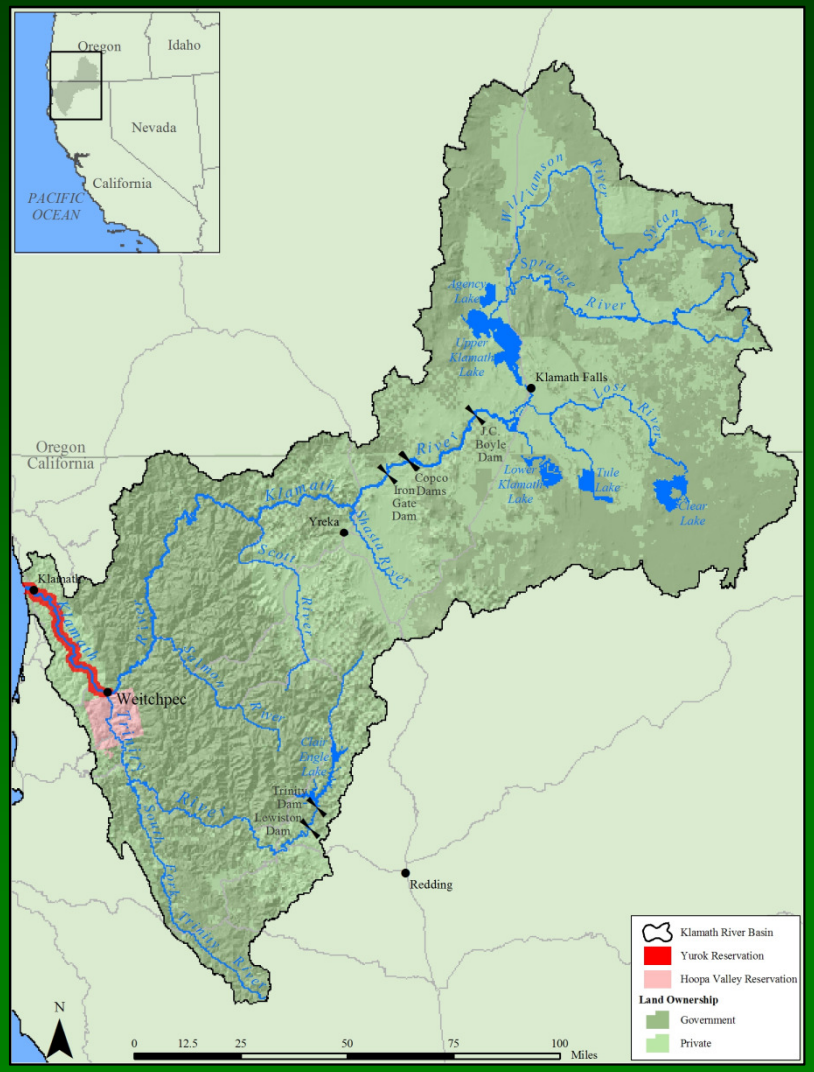
# PERIPHYTON BACKGROUND

- Periphyton sampling is one component of nutrient study
- Studying periphyton since 2004 with PacifiCorp and State of CA
- Aided in development of water quality model for FERC relicensing and TMDL technical analysis
- Relevant to KR TMDL benthic algae biomass as TMDL target
- Relevant to dam removal (potentially) to evaluate spatial and temporal hydrologic and nutrient effects
- Relevant to understanding food web dynamics

# FRESHWATER MUSSEL BACKGROUND

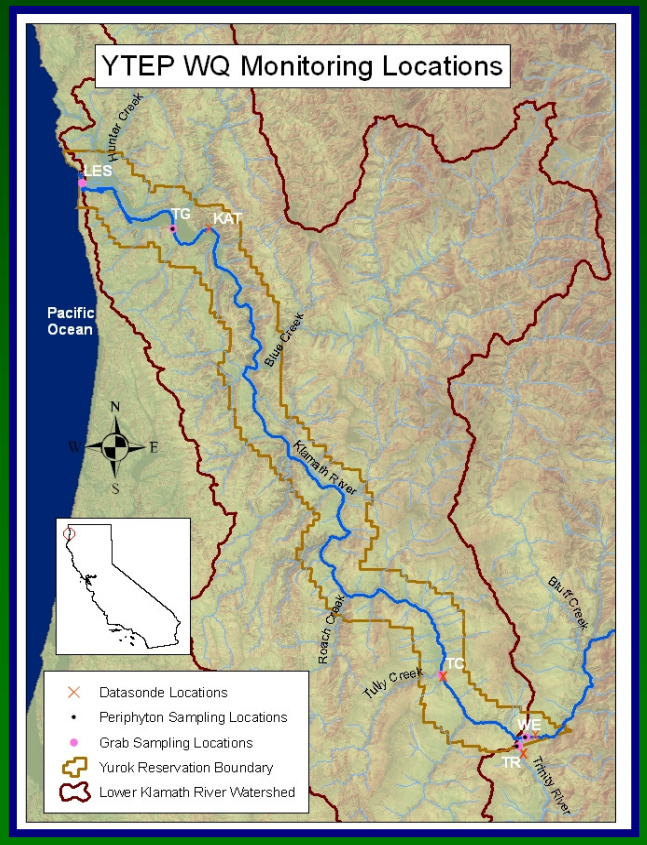
- KHSA funds provided opportunity to examine potential public health risks associated with cyanotoxins
- Building on past studies performed by Karuk Tribe upstream
- Provides insights into microcystin's potential impacts to foodweb
- Useful to inform Tribal Community and Yurok Tribe's EPA STAR Project **"Understanding the Cumulative Affects of Environmental and Psycho-social Stressors that Threaten the Yurok People"**
- Relevant to dam removal analysis to accurately describe "Current Conditions" when comparing alternatives

# Study Area


Oregon
Idaho
Nevada
California
PACIFIC OCEAN
Williamson River
Sycan River
Sprague River
Agency Lake
Upper Klamath Lake
Klamath Falls
Lost River
J.C. Boyle Dam
Copco Dam
Iron Gate Dam
Lower Klamath Lake
Tule Lake
Clear Lake
Oregon
California
Yreka
Klamath River
Shasta River
Scott River
Klamath
Weitchpec
Salmon River
Trinity River
Clair Engle Lake
Trinity Dam
Lewiston Dam
South Fork Trinity River
Redding
N
0 12.5 25 50 75 100
Miles
Klamath River Basin
Yurok Reservation
Hoopa Valley Reservation
Land Ownership
Government
Private


Oregon
Nevada
California
PACIFIC OCEAN
Requa
Klamath
Hoopaw
Klamath Glen
PACIFIC OCEAN
Johnsons
Pecwan
Sregon
Orleans
Orick
Notchko
Cappell
Martins Ferry
Weitchpec
Big Lagoon
Trinidad
Hoopa
Lower Klamath Watershed
Yurok Reservation
Yurok Ancestral Territory

# Sampling Locations




WE– Klamath River at Weitchpec

TG– Klamath River at Turwar Ramp

TR– Trinity River near mouth

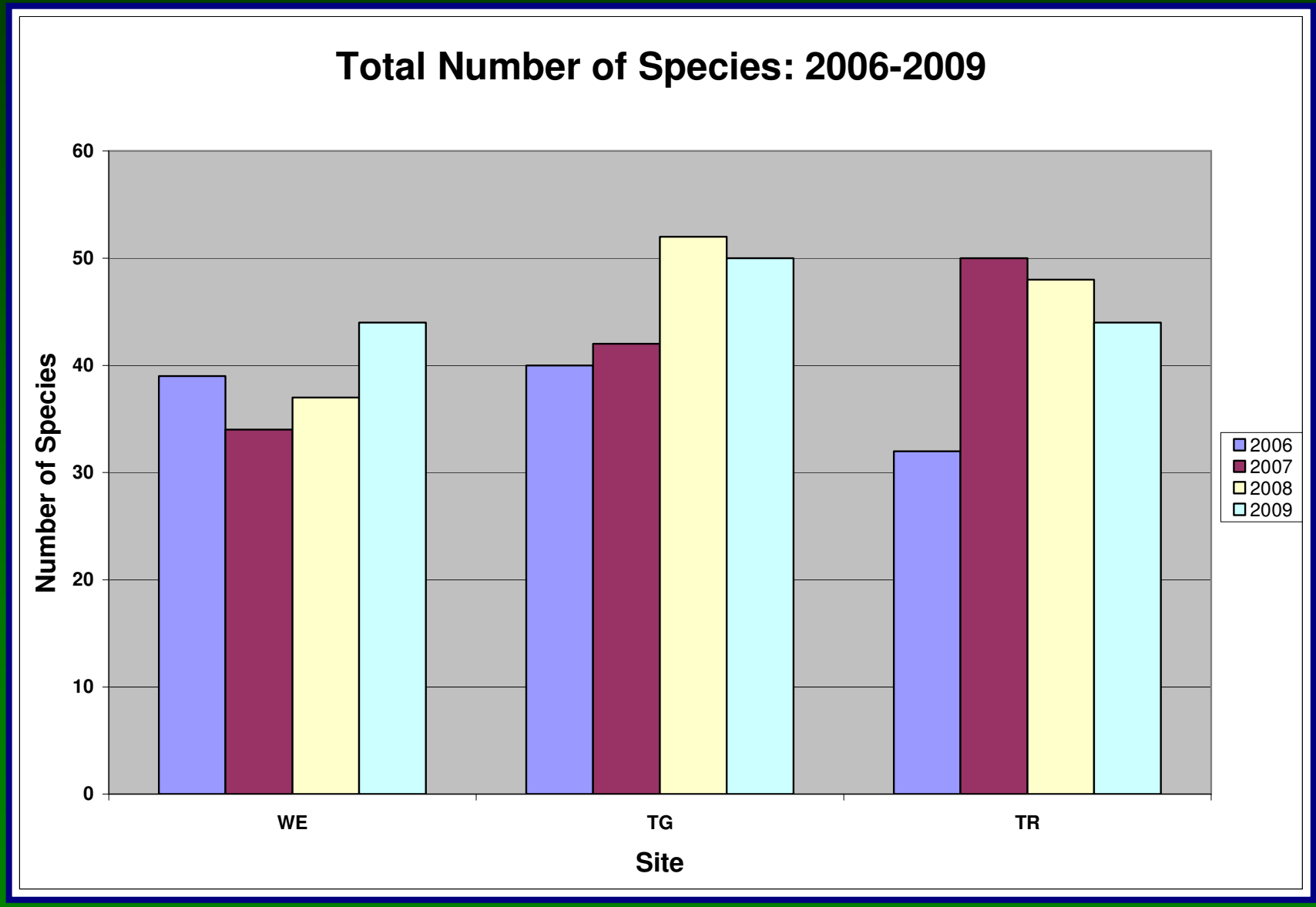
# Methods

- Sampling procedures adapted from the U.S. EPA (2002) and USGS (Porter et al., 1995) as previously used on the Klamath River by Eilers (2005).
- Similar microhabitats at sample locations
  - Depth: 1-2 ft
  - Velocity: 1-2 ft/sec
  - Exposure: Clear solar path (i.e., no serious topographic or riparian shading)
- Place 1.5 square foot grid on stream bed where cobbles are to be collected and make note of percent cover of algae within the total grid area

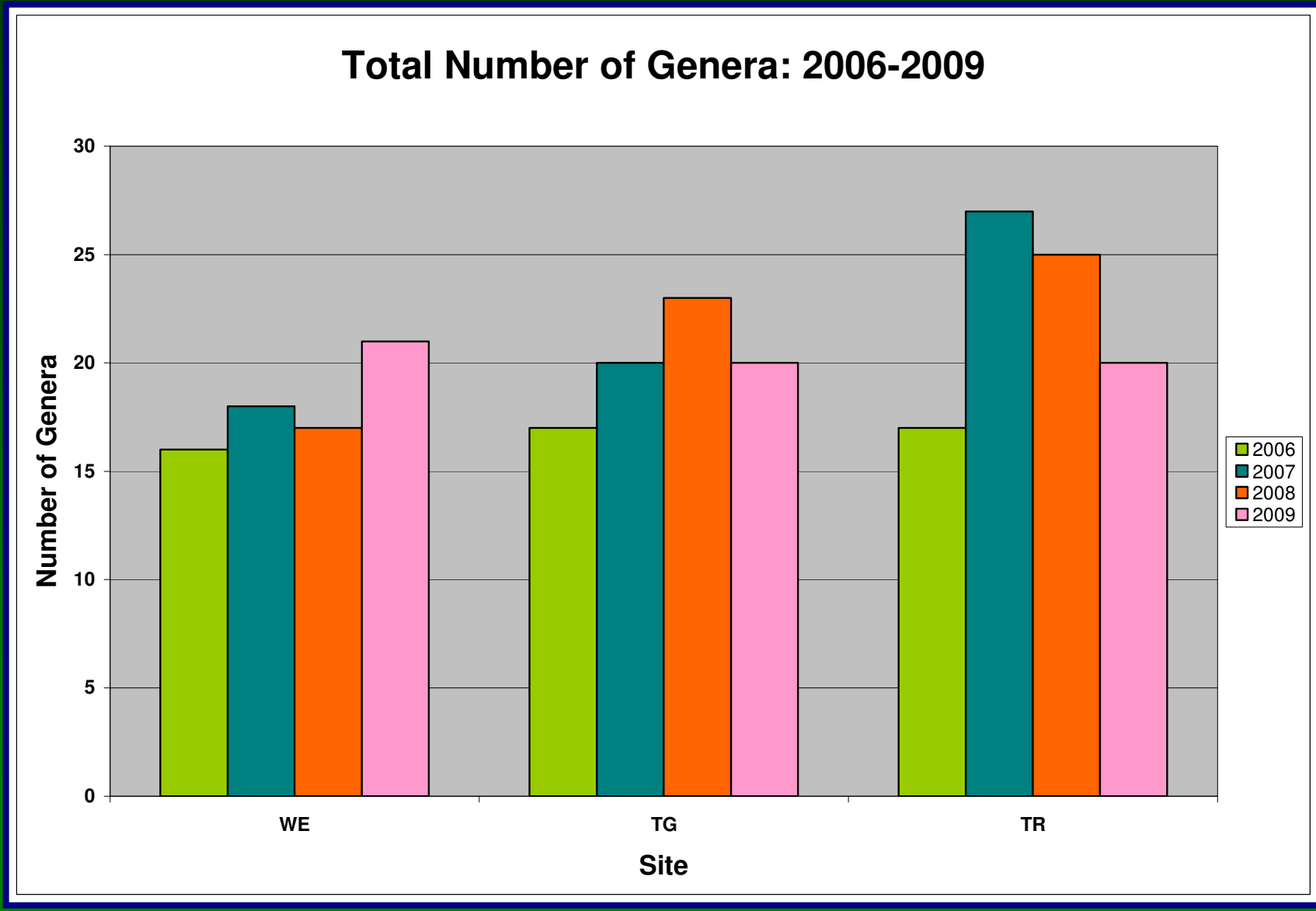
# Methods

- Select 10 cobbles from sampling area and place in 2 tubs containing water of sufficient depth to keep them submerged
- Select an area the size of a 1 inch by 3 inch microscope slide on an area of the clast that is representative and can be easily scraped
- Collected two samples (5 rock composite) at each location
  - Species identification and enumeration
  - Periphyton chlorophyll-a

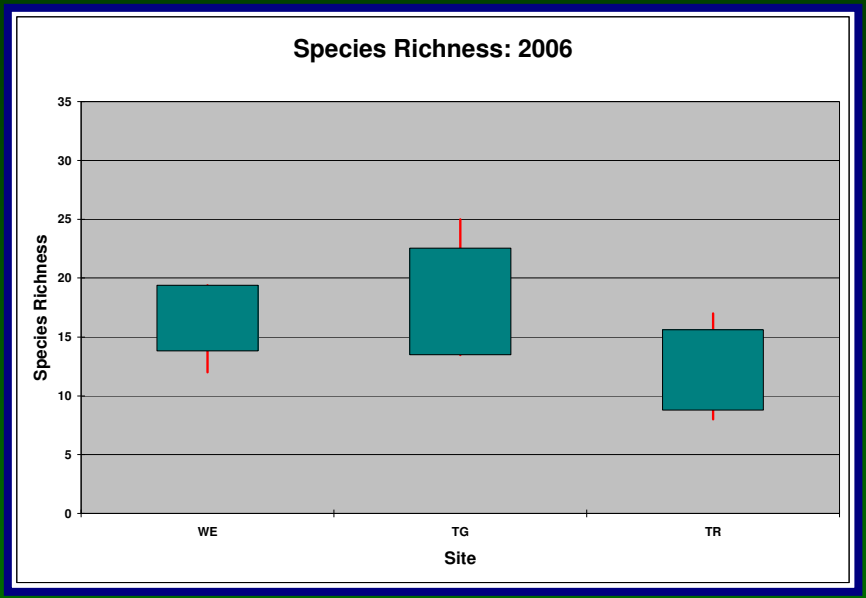
# Species Richness

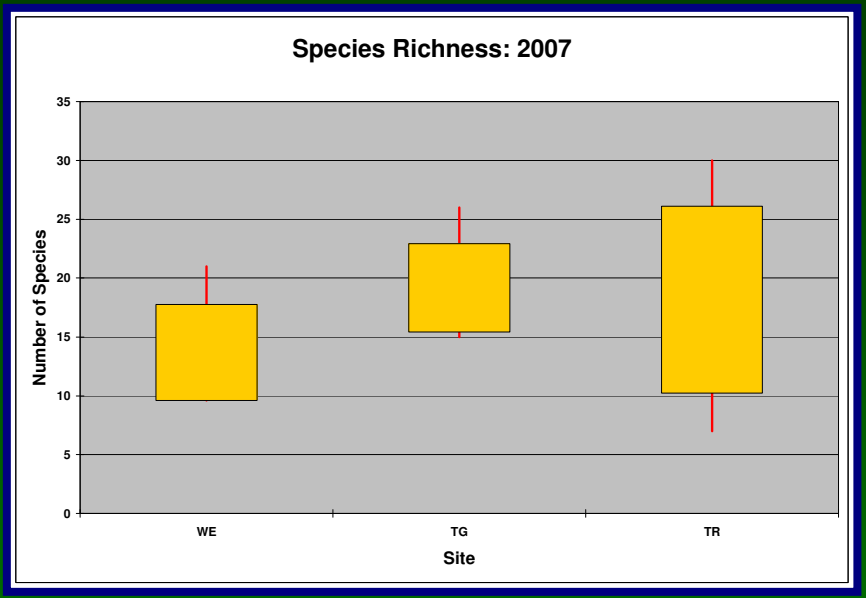


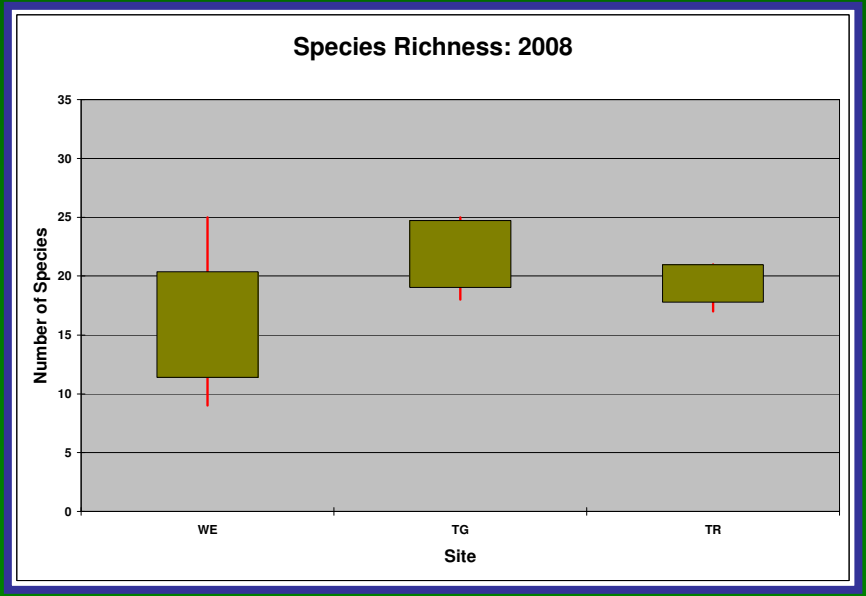
# Genera Richness

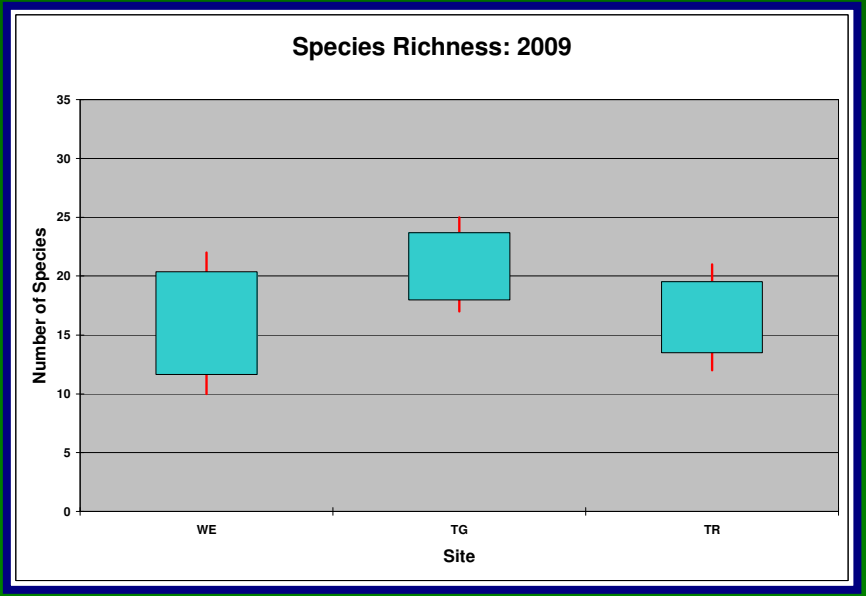


# Species Richness

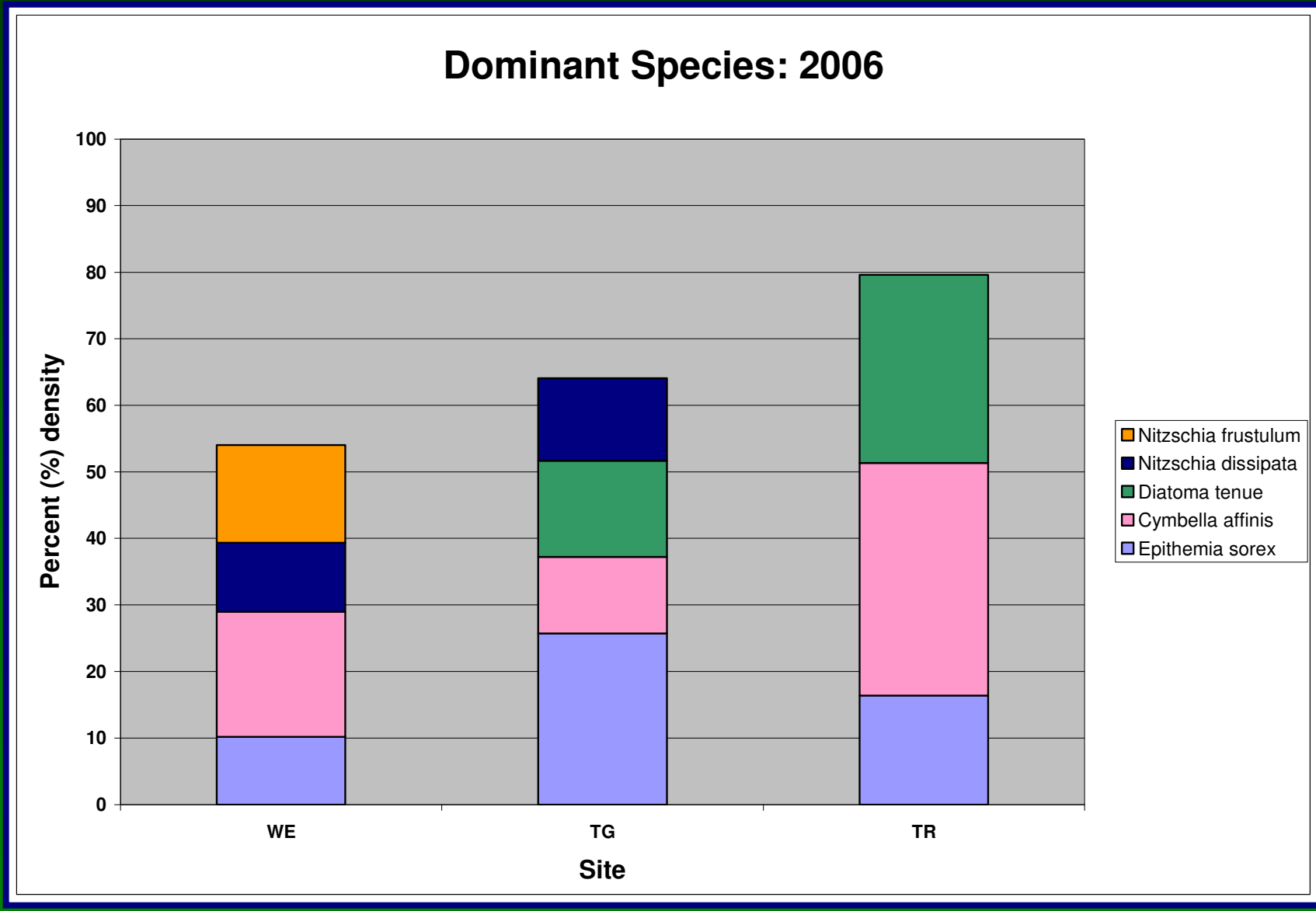


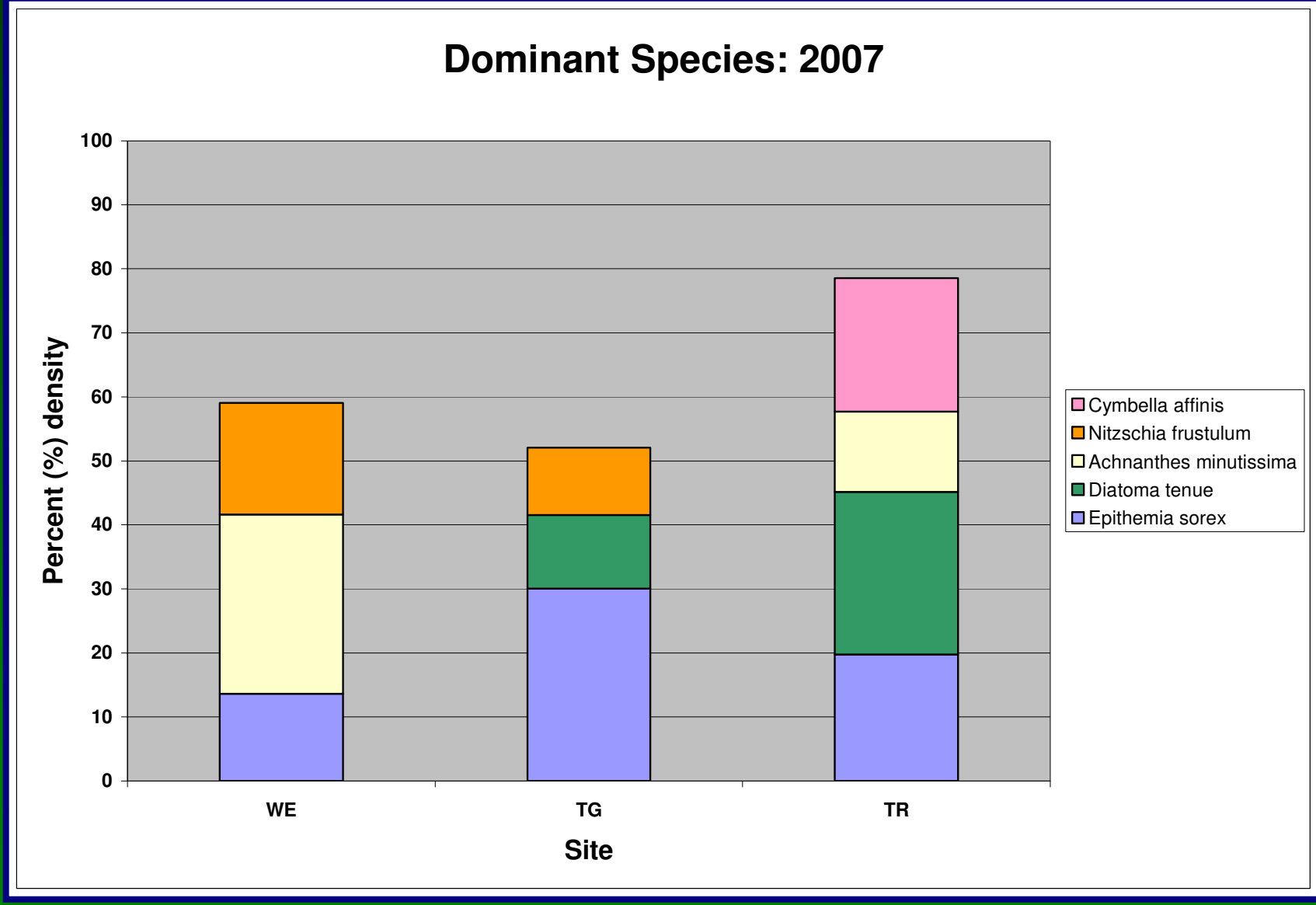



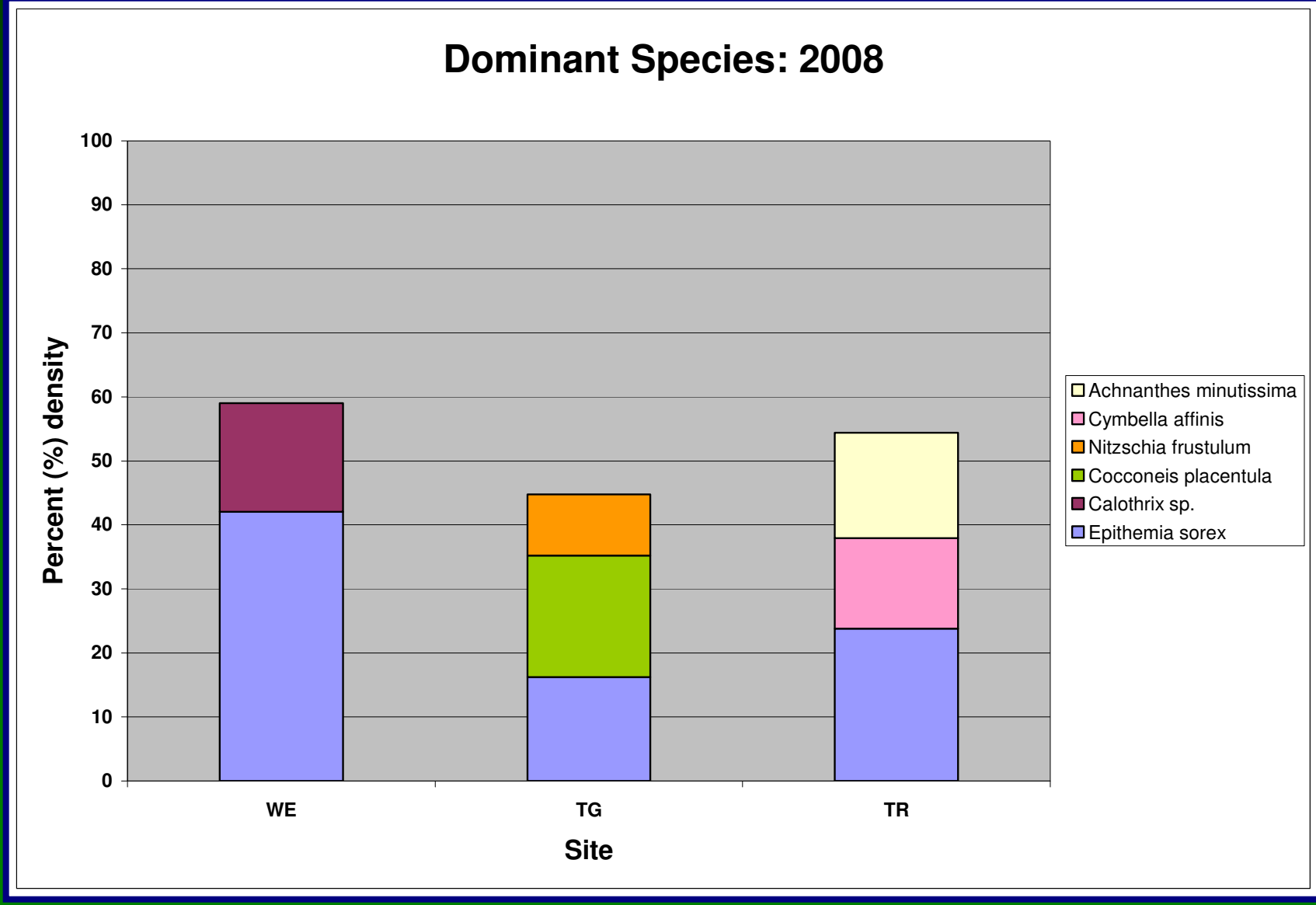
# Dominant Species: 2006



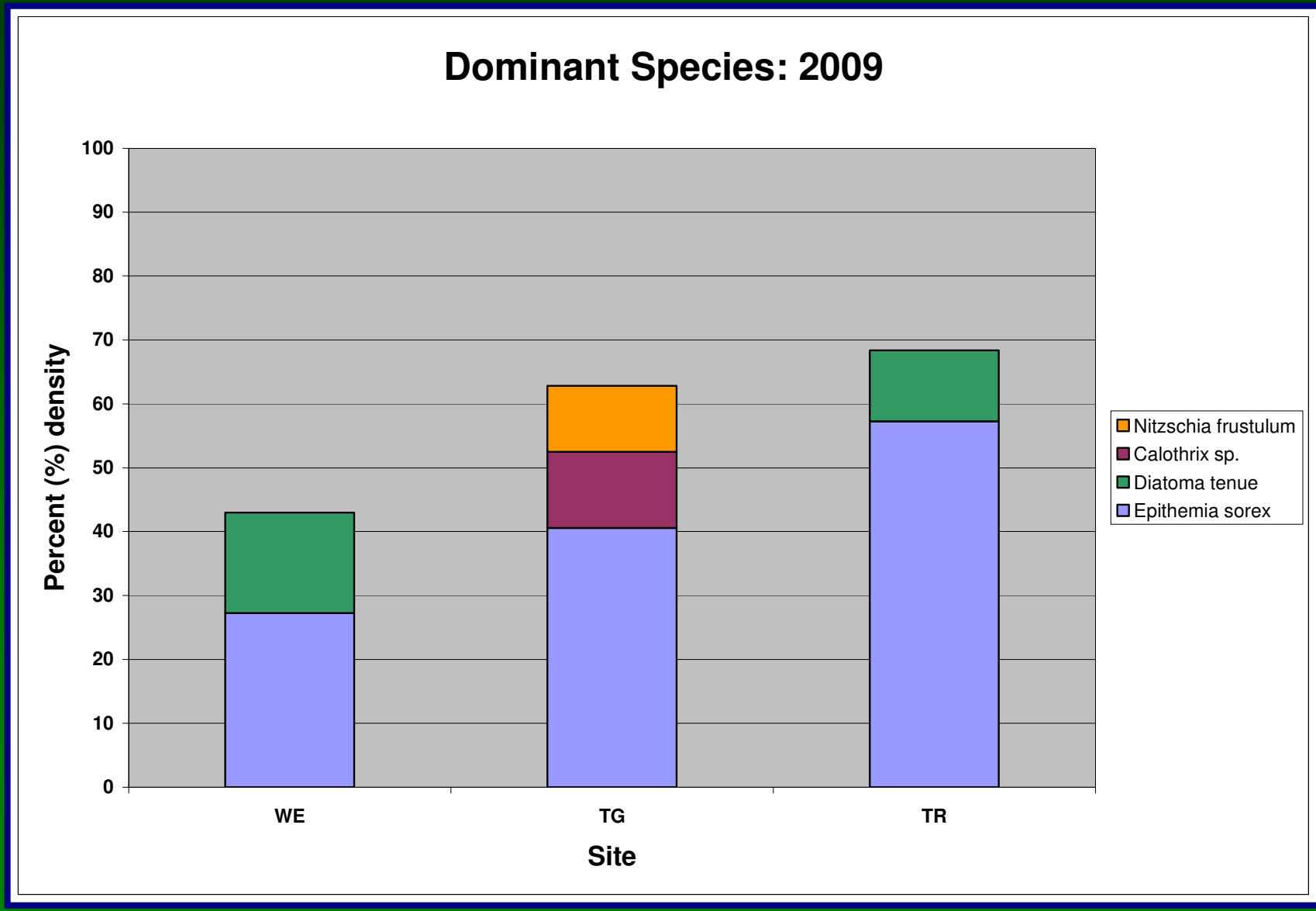
# Dominant Species: 2007



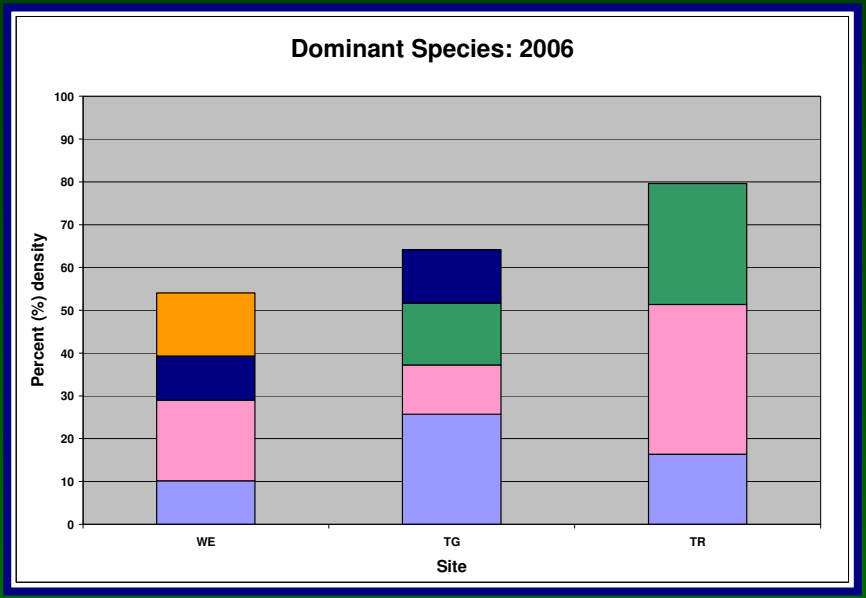
# Dominant Species: 2008

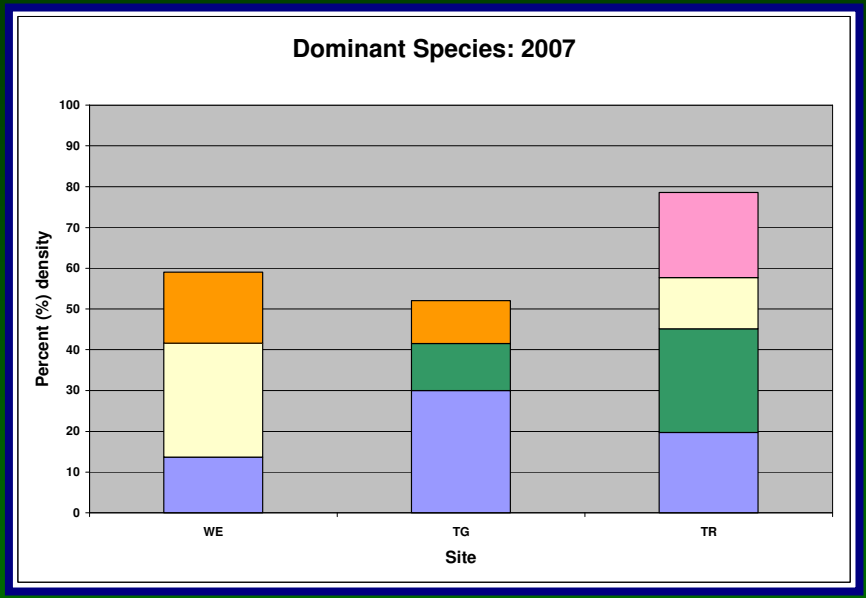


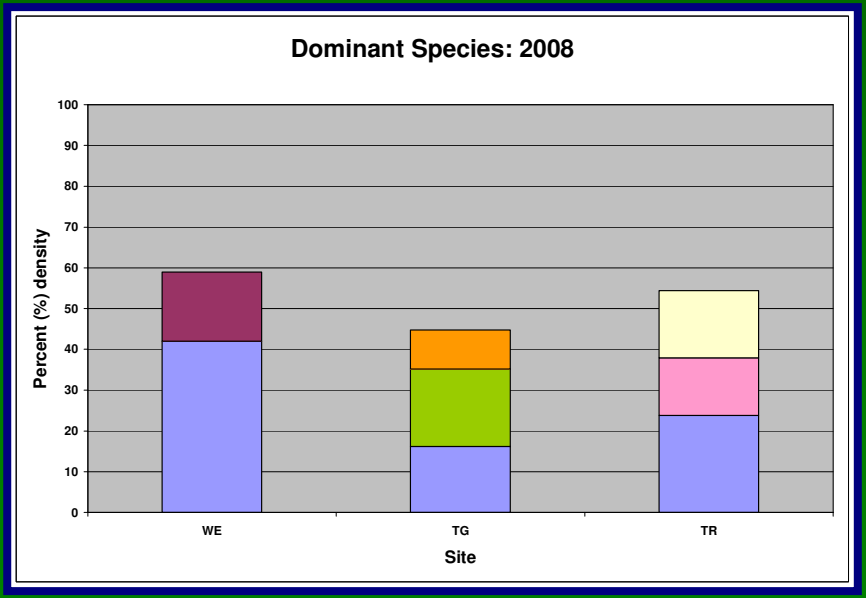
# Dominant Species: 2009

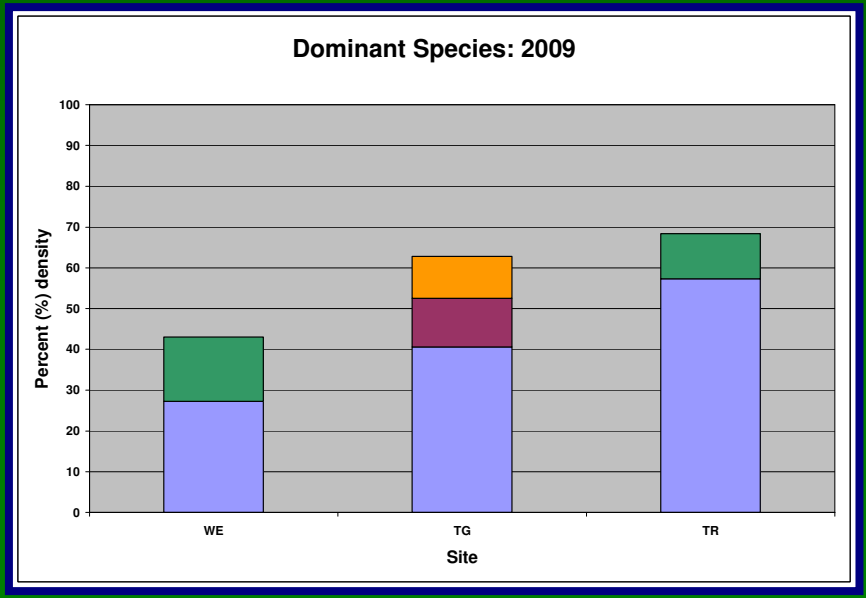


# Dominant Species



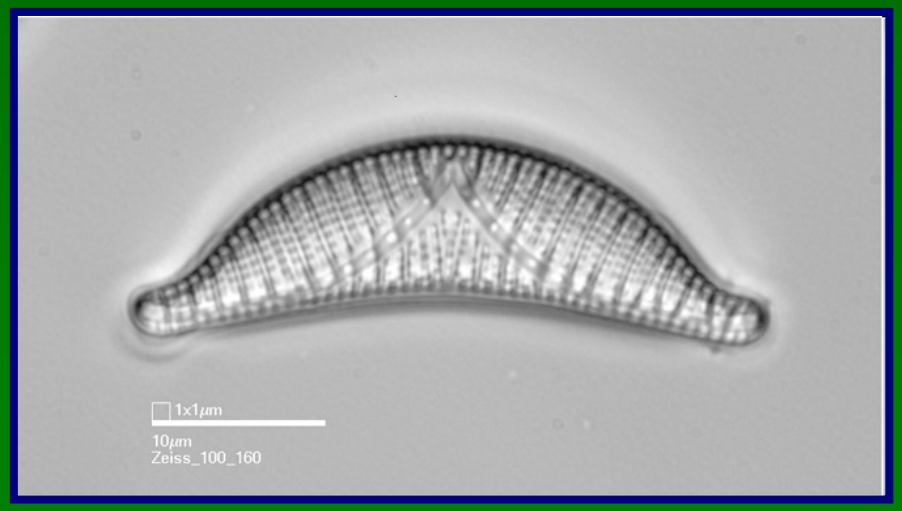



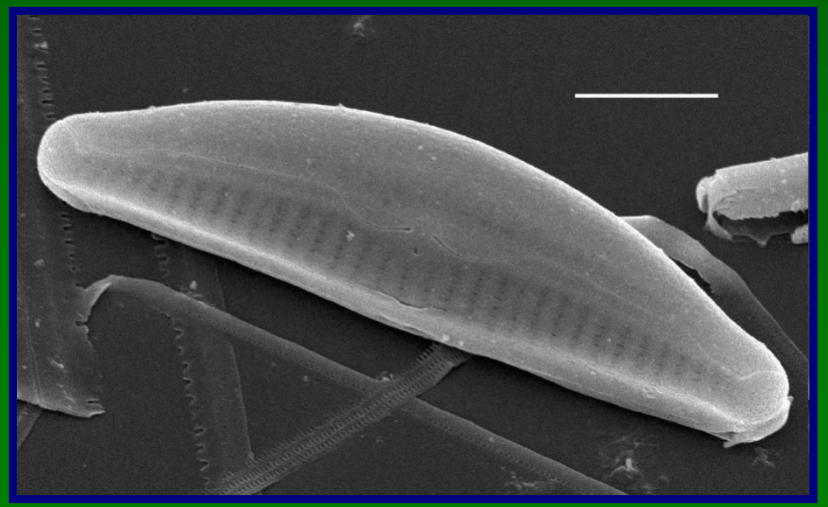
# *Epithemia sorex*

- Reaches maximum abundance in micro-habitats where phosphorus is relatively more available (nitrogen limitation)
- Found in eutrophic (nutrient rich), alkaliphilic (pH >7) environments
- Prefers flowing water with high nutrient content
- USGS classification: nitrogen fixers, eutrophic, alkaliphilic



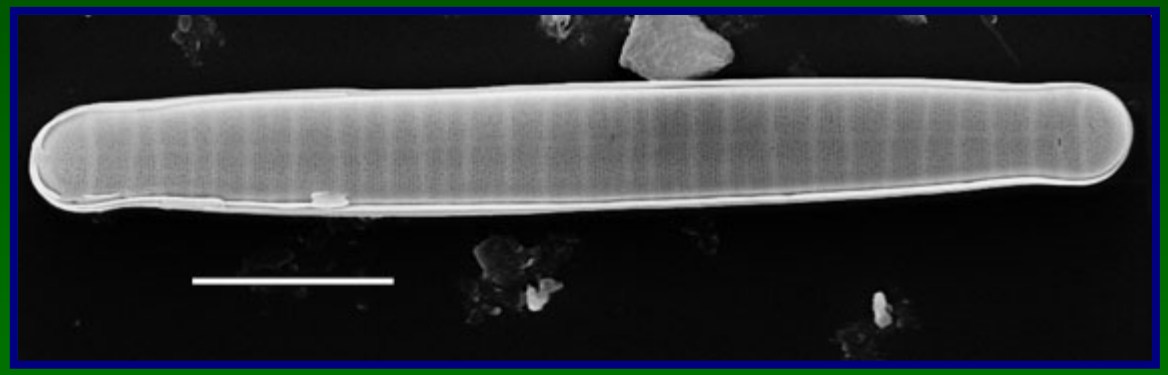

# *Cymbella affinis*

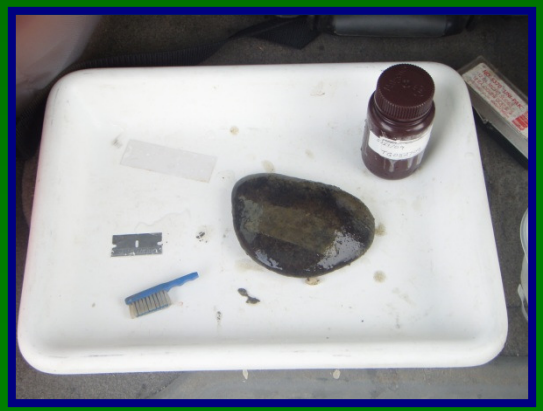
- Often found in benthic habitats across North America
- Found in eutrophic, alkaliphic waters
- USGS Classification: eutrophic, alkaliphic



# *Diatoma tenue*

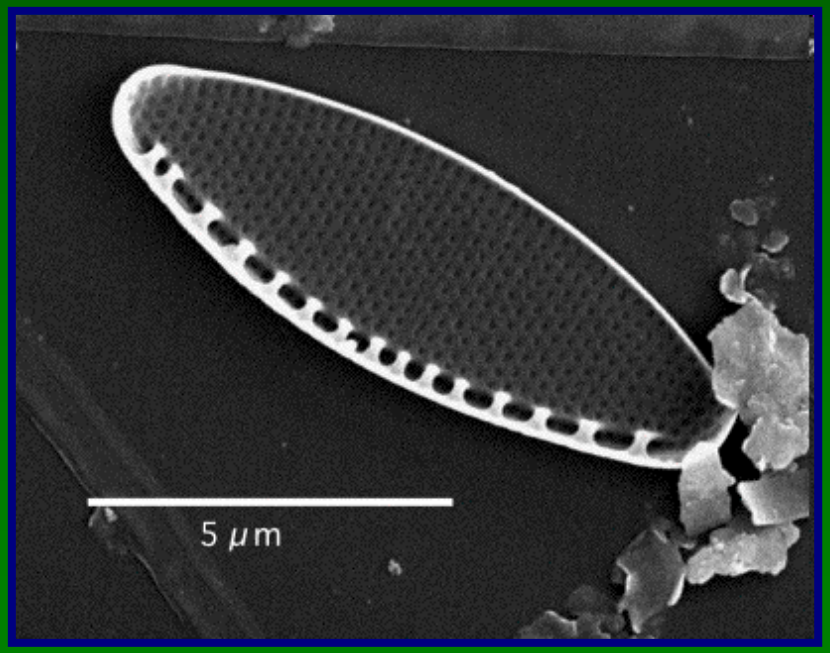
- Found in eutrophic, alkaliphilic waters
- USGS classification: eutrophic, alkaliphilic



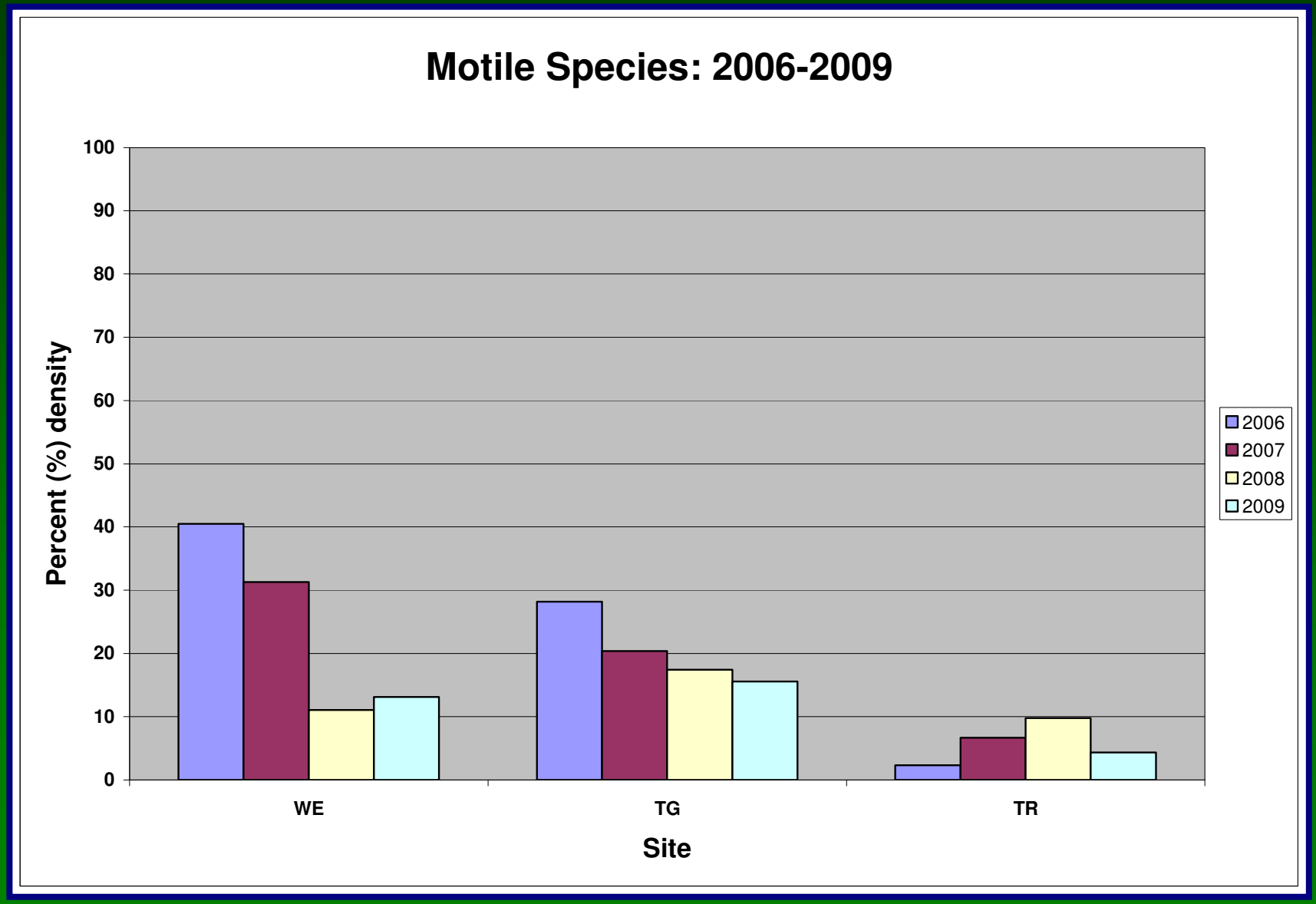


# *Nitzschia frustulum*

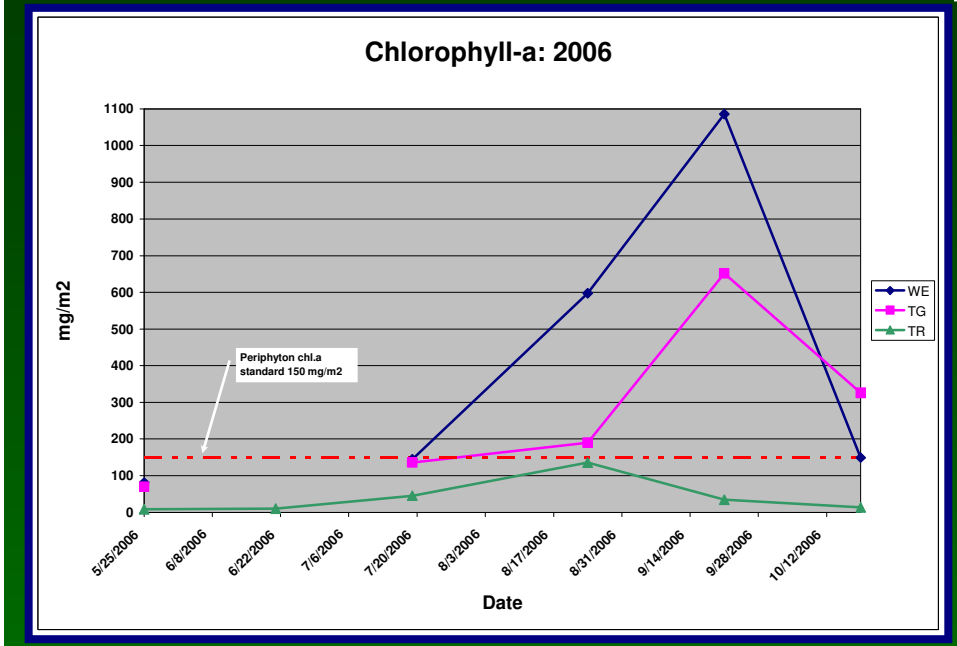
- Motile (sediment tolerant)
- Prefers warm waters
- USGS Classification: eutrophic, alkaliphilic, silt tolerant

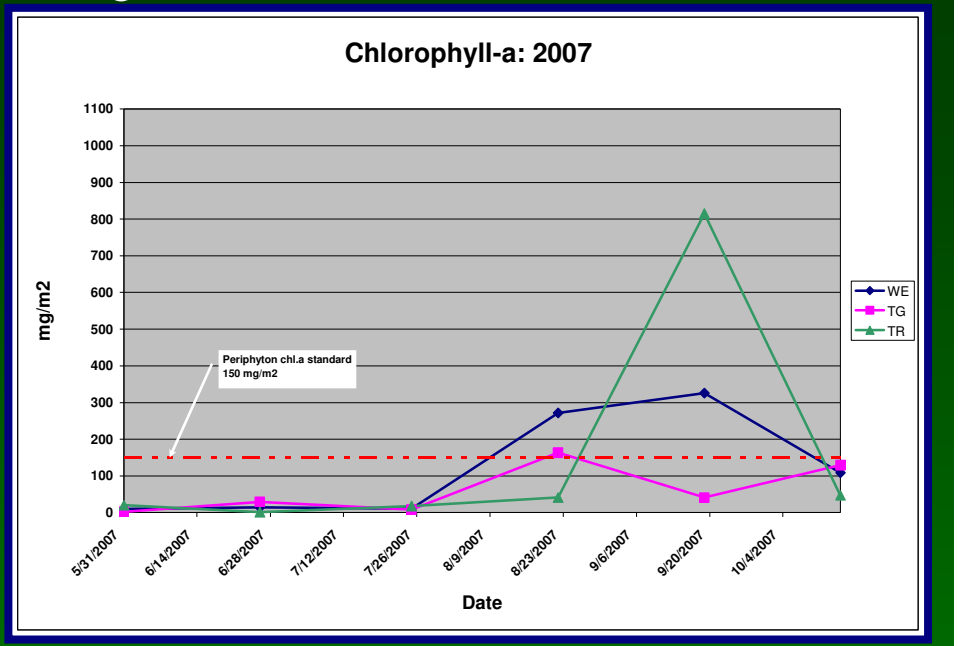


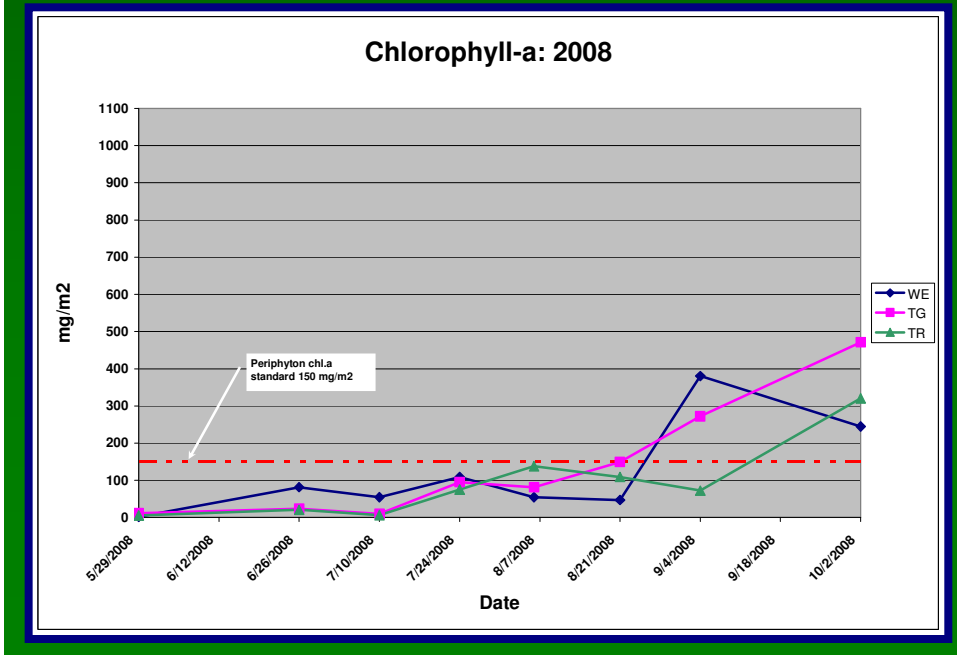

# Motile Species

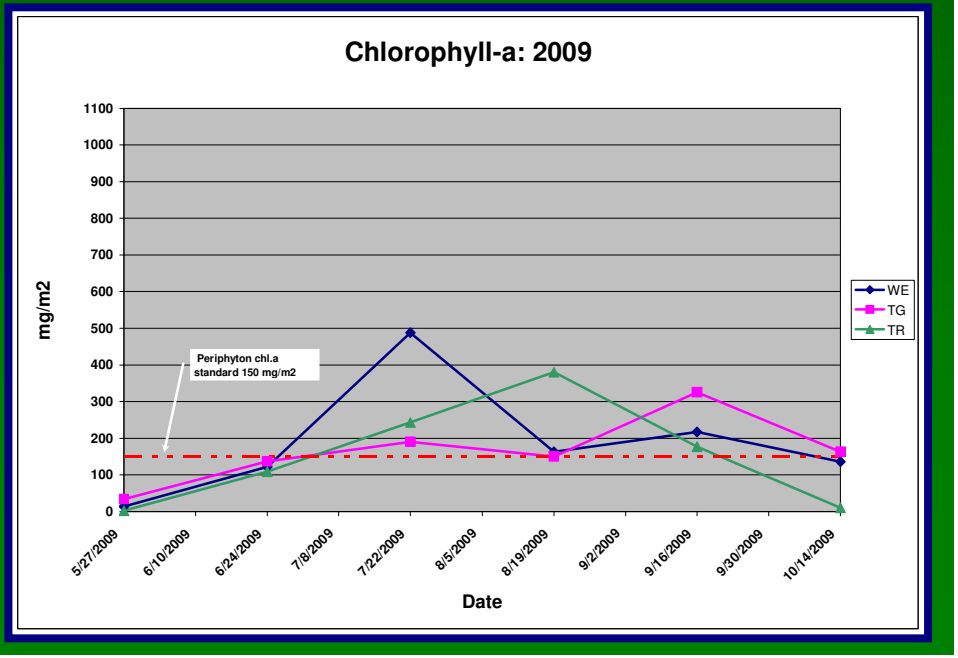


# Chlorophyll-a

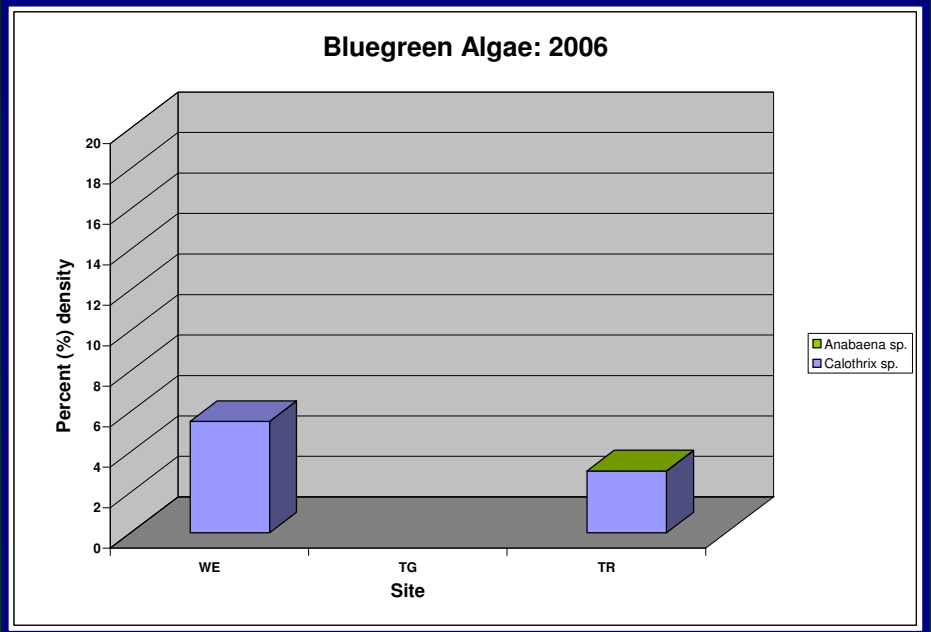


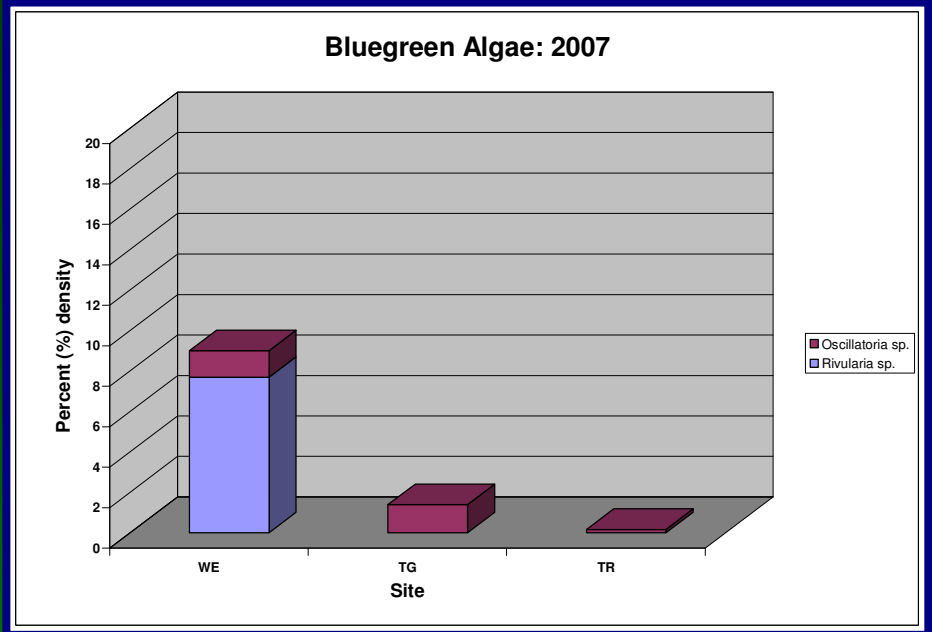



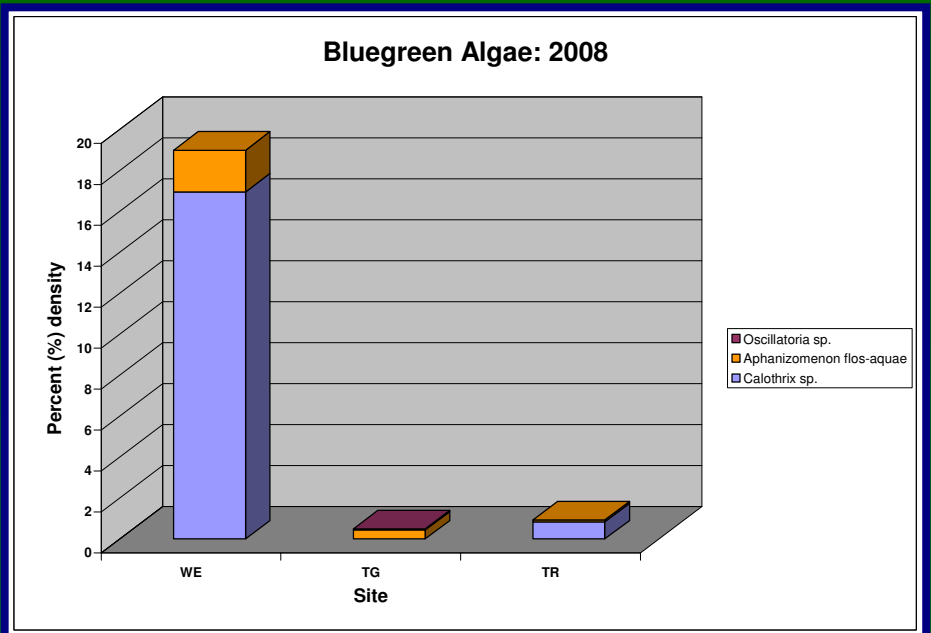



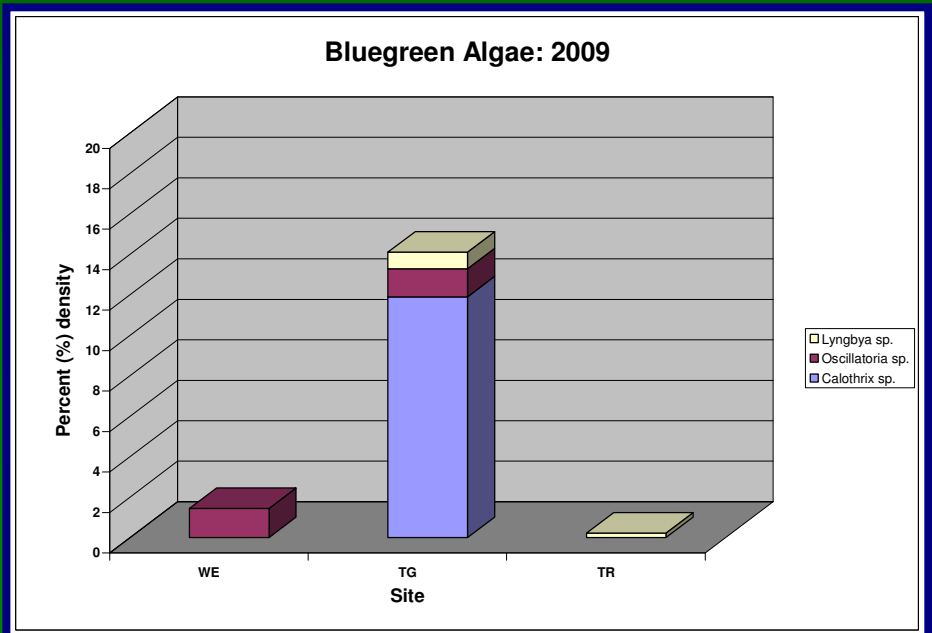



# Bluegreen Algae



# Conclusions

- Periphyton communities are dominated by a few key diatom species, specifically *Epithemia sorex* and *Cymbella affinis*
- Dominant species tend to be prefer eutrophic, alkaliphilic environments
- Motile species were dominant at TG 2006-2009 and at WE in 2006 and 2007
- Periphytic bluegreen algae has been detected at all sites
- The bluegreen algae *Calothrix* was a dominant species (>10% of total density) at WE in 2008 and TG in 2009
- Chlorophyll-a concentrations consistently exceed the water quality standard of 150 mg/m2

# Acknowledgments


- Funding
  -USEPA Clean Water Act Section 106
- Aquatic Analysts for sample analysis
- Sample collection technicians
- Eli Asarian – Riverbend Sciences
- Jacob Kann of Aquatic Ecosystem Sciences


2009 Freshwater Mussel Collection from 2 Sites on the Yurok Indian Reservation

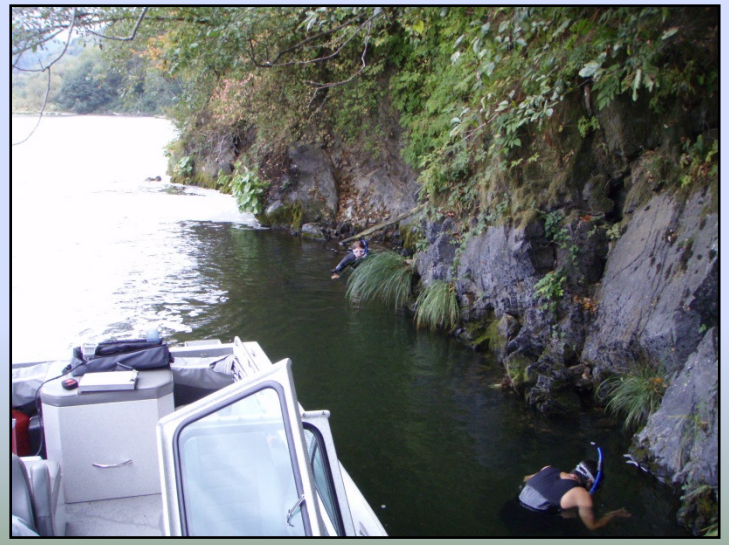
# Basis of Study

- Public Health Study of a traditional food source
- Collected during dry season
  - Same time period in which they would have been collected by indigenous populations
  - Low flows
  - Impaired water quality = presence of *Microcystis aeruginosa*
- Mussel tissue analyzed for microcystin congeners LA, LW, LF, LY, YR, LR, RR and anatoxin A by DFG Water Pollution Control Lab

# Methods

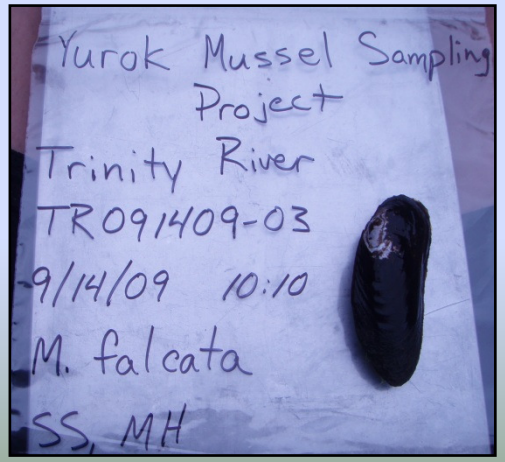
- Collect 5 mussels
  - Attempted to collect largest mussels available to maximize tissue mass
  - Largest mussels would have also been the most likely to be gathered

- Weigh and measure axial length

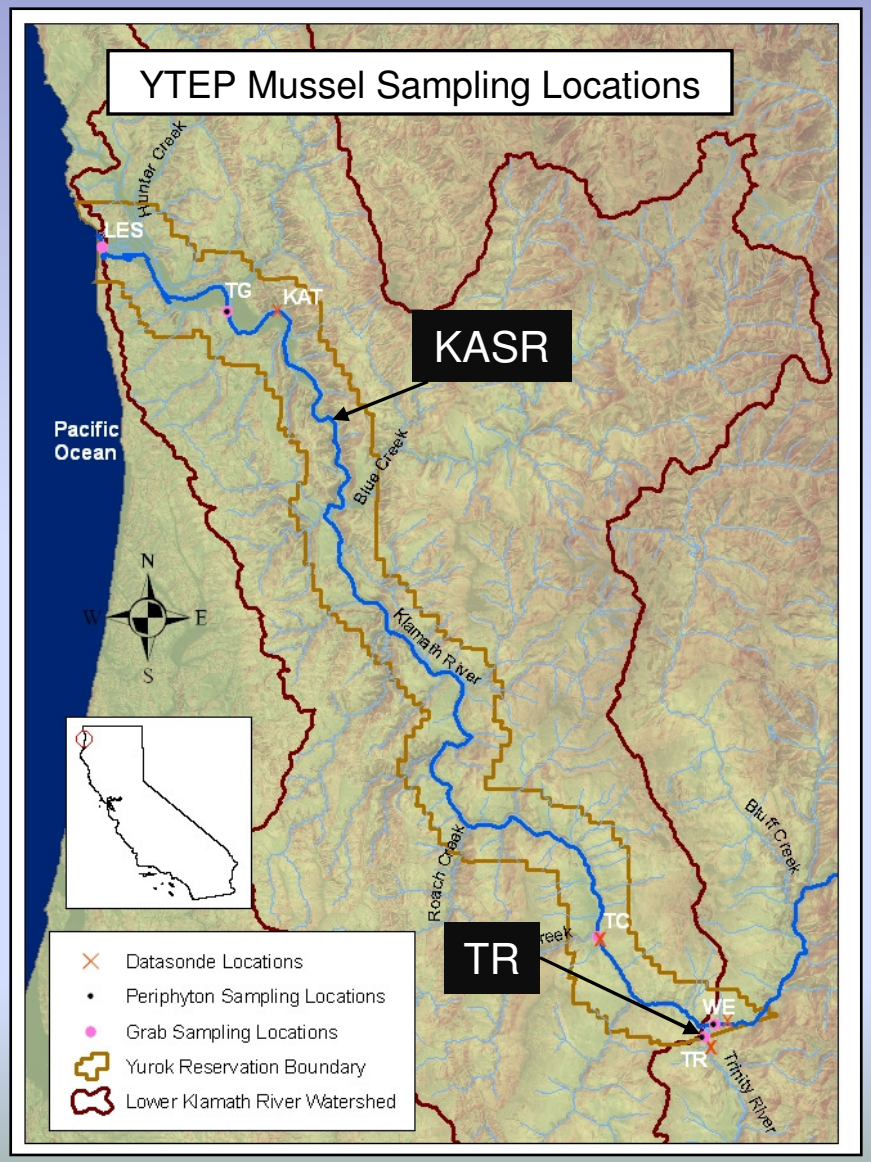


# Methods

- Wrap each mussel individually in aluminum foil
- Place foil wrapped mussel in sealable plastic bag (double bagged) with proper identifying information
- Collect water samples with churn
  - Toxic algae identification
  - Microsystin concentration




# Sampling Locations




KASR- Klamath River above Starwein Riffle

TR- Trinity River near mouth (just upstream of periphyton sampling location)

# *Margaritifera falcata* (Western Pearlshell)

- Inhabits streams with a population of anadromous salmonids
  - Uses salmonids as host species to complete its life cycle
- Life spans can be up to 120 years
- Most common freshwater mussel in the Pacific Northwest with a range from California to southern Alaska
- Prefers cold, clean water
- More prolific downstream of TR confluence

# *Gonidea angulata* (Western Ridged Mussel)

- Uses dace and sculpin as host fish
- Lives 80-100 years
- Habitat range from California to southern British Columbia
- Tolerates warmer water and more unstable sediments than *M. falcata*
- More prolific upstream of Trinity River

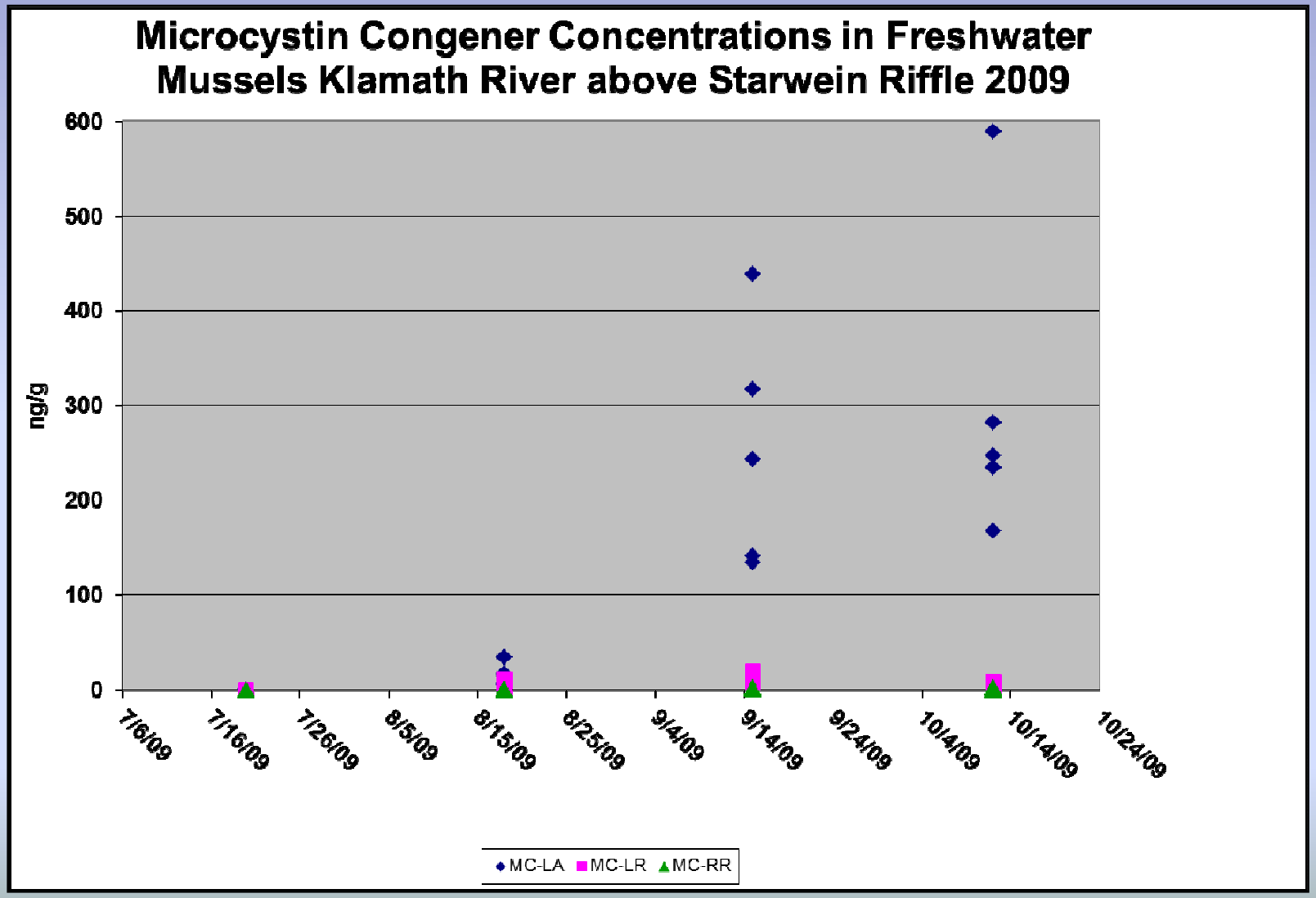
# *Anodonta spp.*
# (The "Floaters")

- Can use many species as host fish
- Lives 5-10 years
- When they die, their shells fill with gas and float to the surface
- More tolerant of slow, warm, turbid water than *M. falcata* or *G. angulata*
- Most likely to be observed upriver of dams on Klamath River

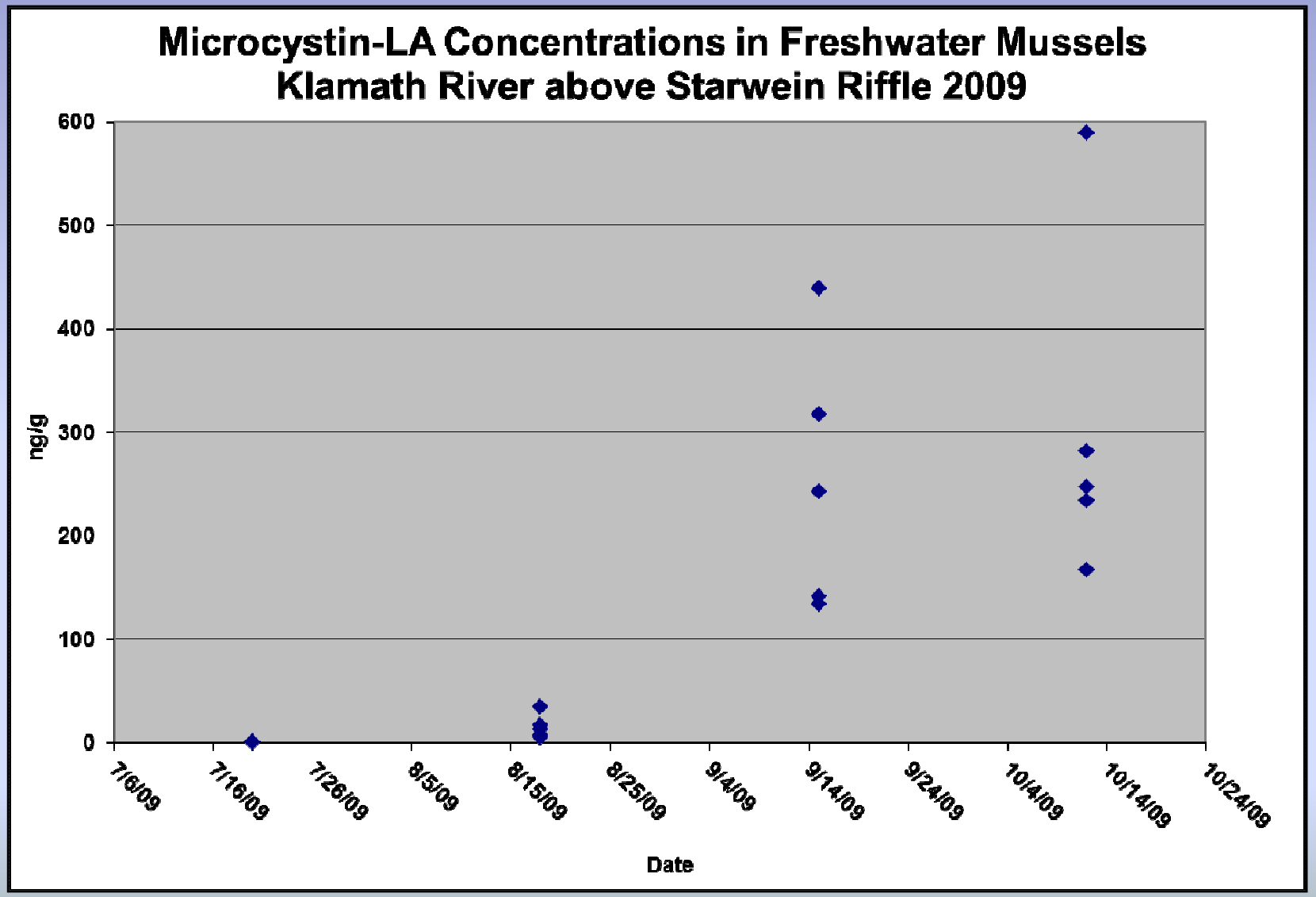
# Results

- All species collected were *M. falcata*
- Toxin results for both mussel tissue and ambient water at TR were below reporting limits

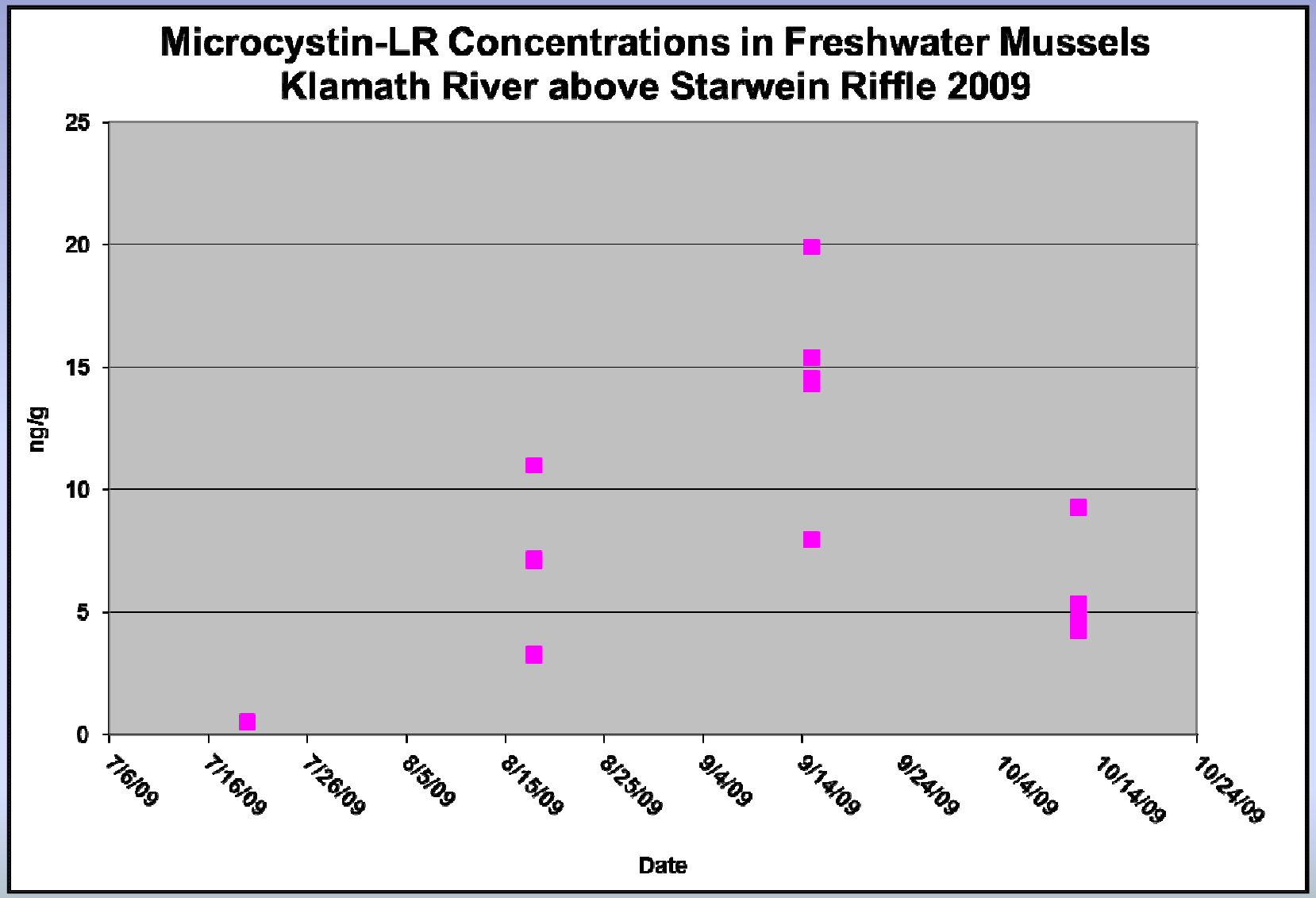
# Results: Mussel Tissue



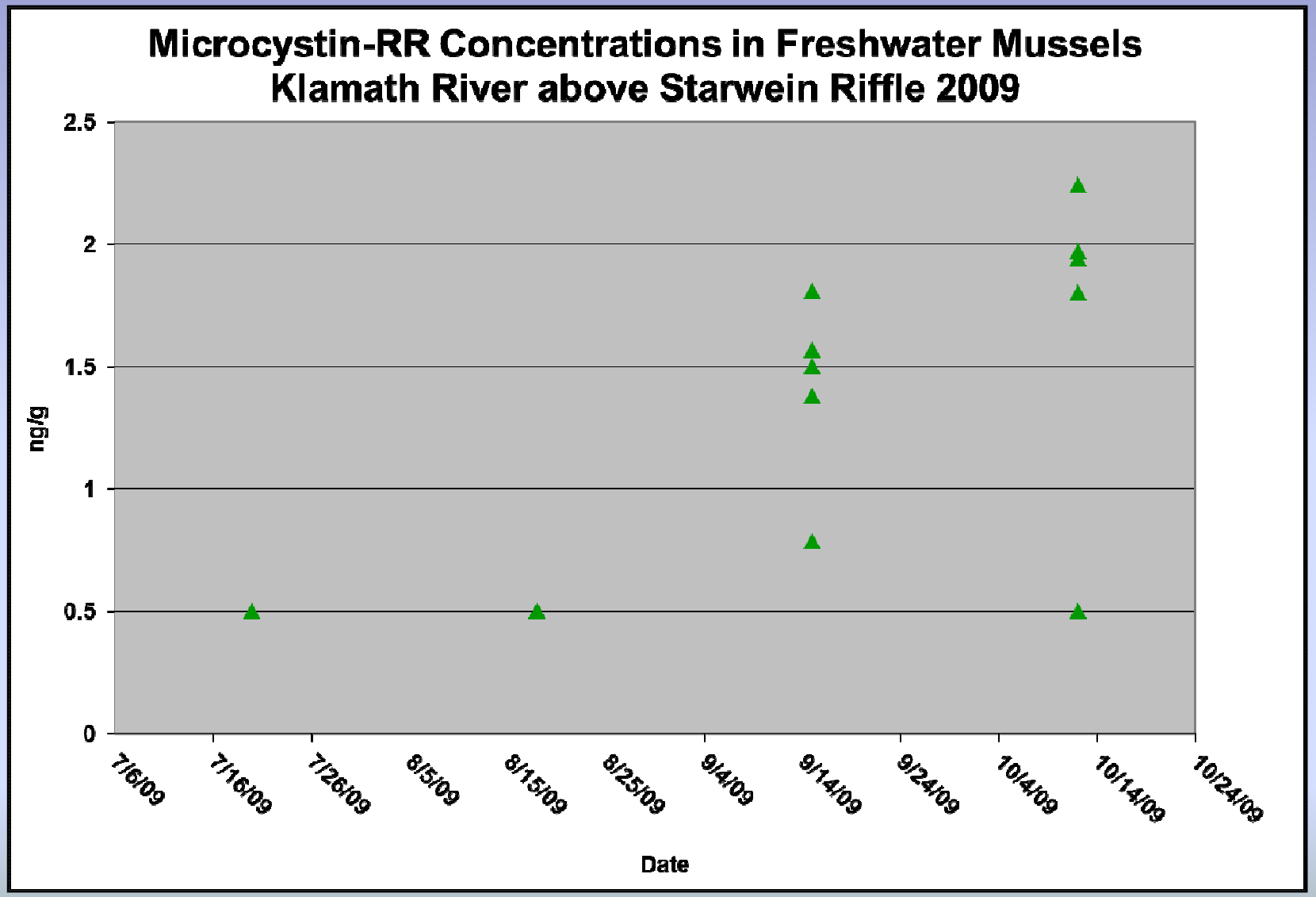
# Results: Mussel Tissue



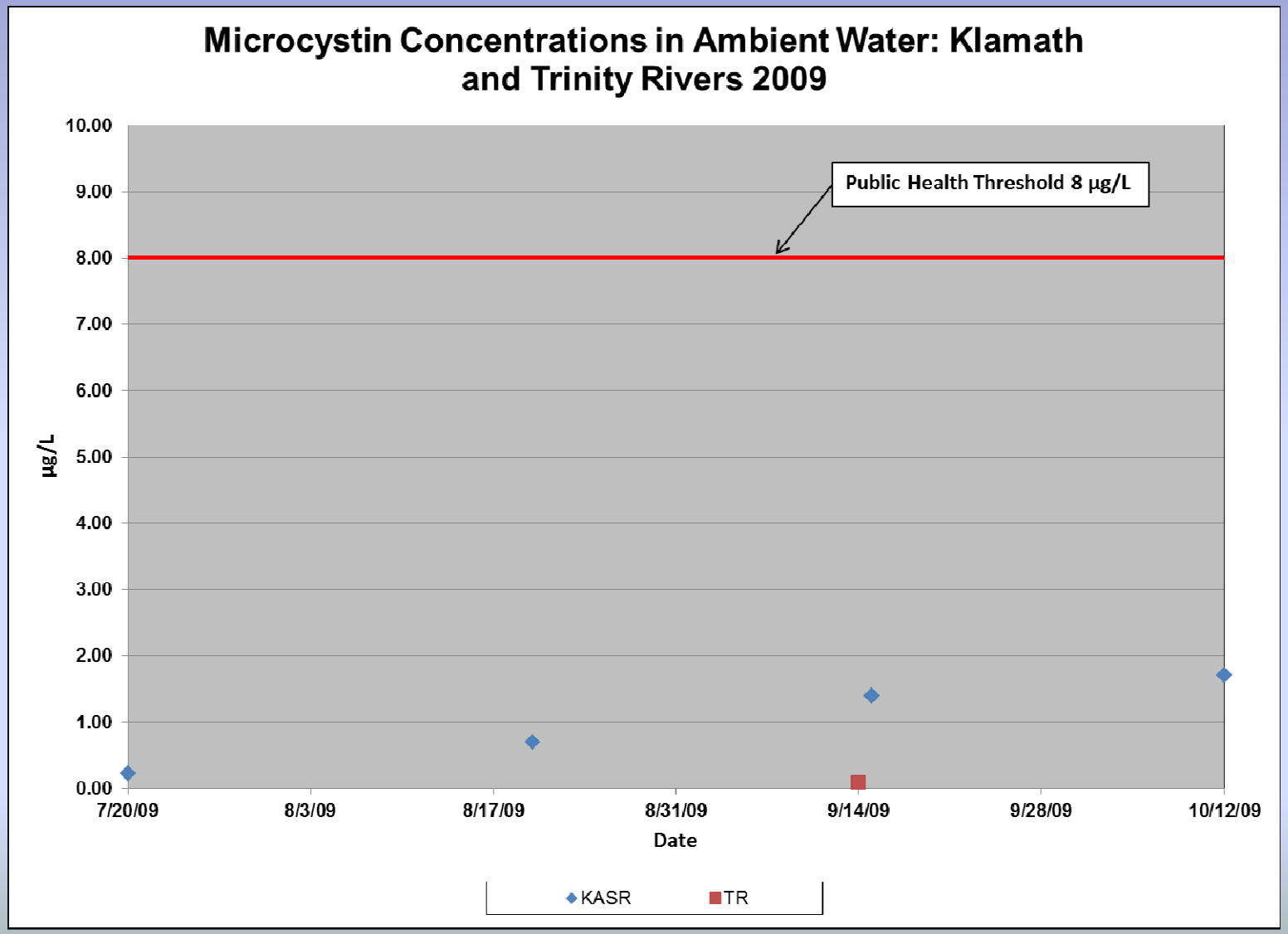
# Results: Mussel Tissue



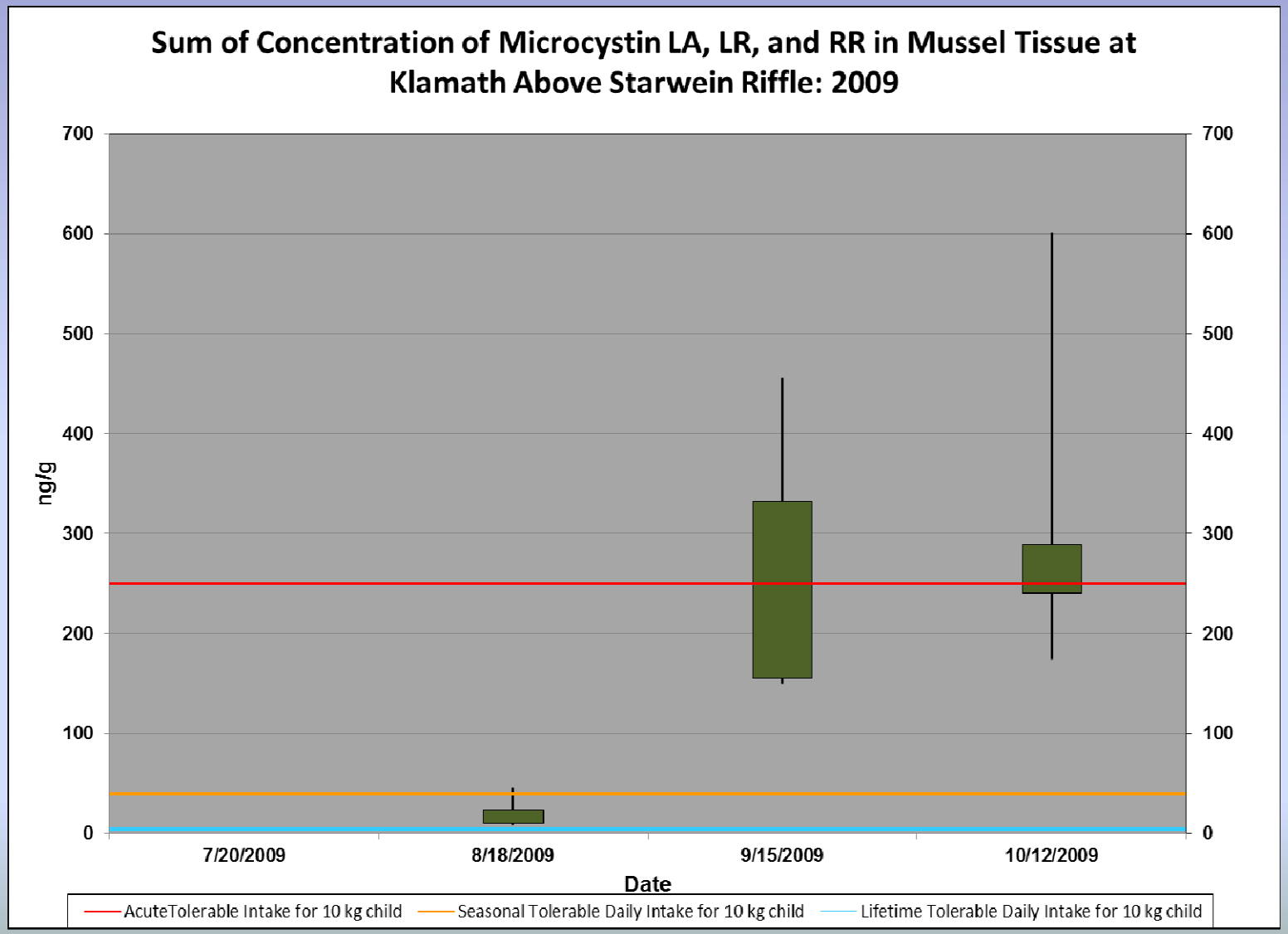
# Results: Mussel Tissue



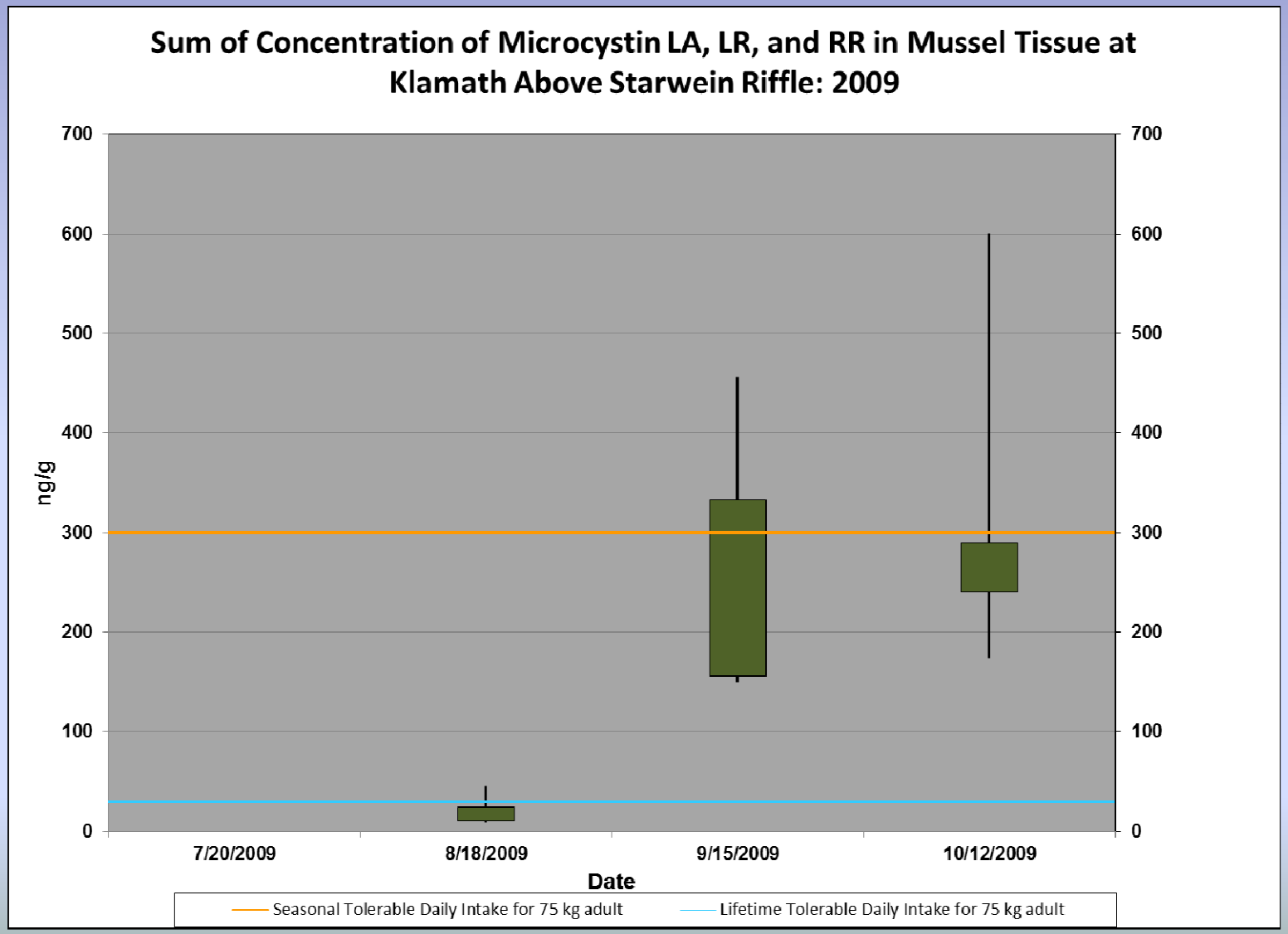
# Results: Water



# Discussion


Sum of Concentration of Microcystin LA, LR, and RR in Mussel Tissue at Klamath Above Starwein Riffle: 2009
700
600
500
400
300
200
100
0
ng/g
7/20/2009
8/18/2009
9/15/2009
10/12/2009
Date
AcuteTolerable Intake for 10 kg child
Seasonal Tolerable Daily Intake for 10 kg child
Lifetime Tolerable Daily Intake for 10 kg child

# Discussion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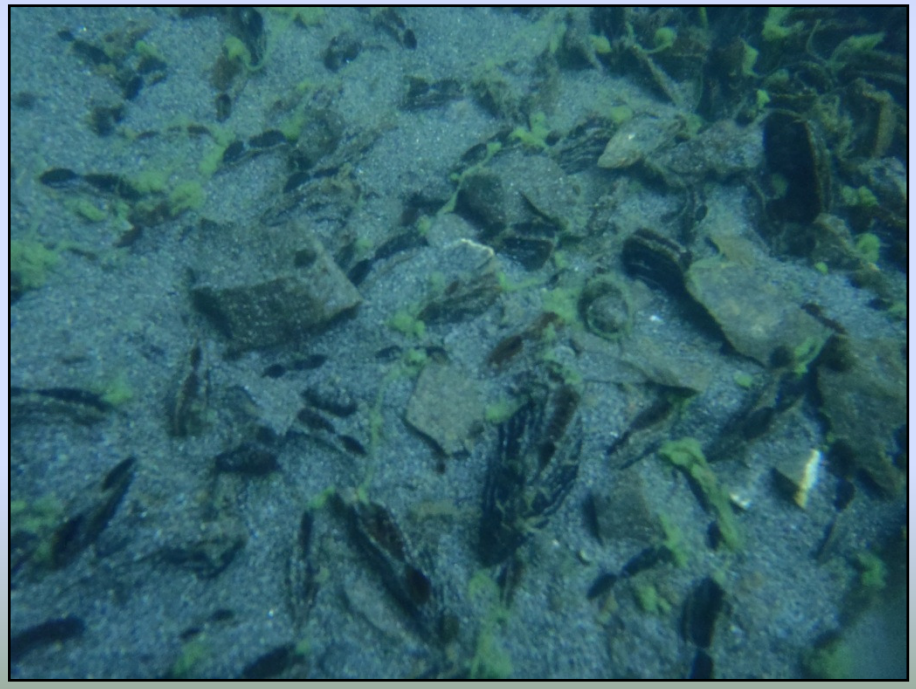
700
600
500
400
300
200
100
0
ng/g
7/20/2009
8/18/2009
9/15/2009
10/12/2009
Date
Seasonal Tolerable Daily Intake for 75 kg adult
Lifetime Tolerable Daily Intake for 75 kg adult

# Conclusions

- Bioaccumulation
  - lack of detection/low frequency of microcystin detection in water throughout sampling period
  - level of microcystin in mussel tissue increasing throughout most of sampling period
  - while microcystin levels may be below detection in water, accumulation in mussel tissue can still occur

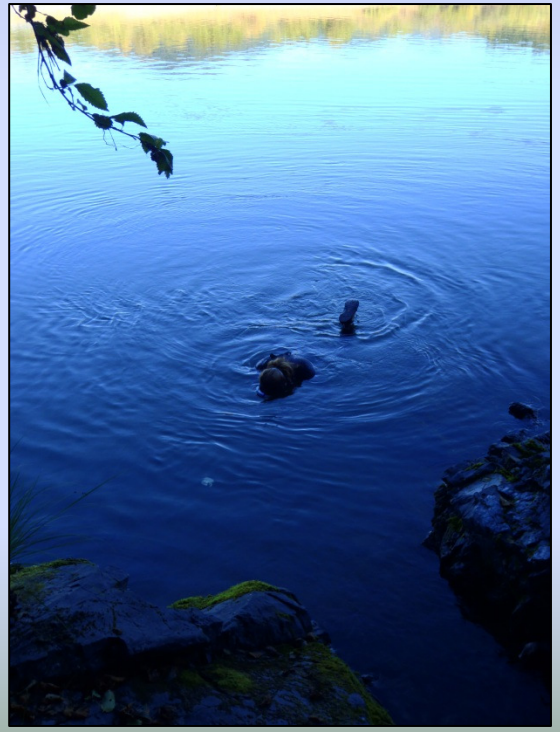
# Conclusions

- Ingestion of freshwater mussels in the Klamath River during summer and fall
  - would result in microcystin doses that exceed various public health thresholds for safe consumption
  - Microcystin exceedances occur during same months as subsistence use by Tribal members
  - even one meal could exceed safe consumption levels
  - if harvesting of mussels was stopped during this period, their use would be eliminated from a dietary and cultural standpoint



# Further Investigations

- Sampling of 3 sites on the Klamath River funded under EPA STAR grant during October 2010
- Mussel tissue analyzed for suite of biological toxins, metals, pesticides, herbicides, and fungicides
- Results expected in spring of 2011



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- Jacob Kann of Aquatic Ecosystem Sciences
- Sample collection technicians
- PacifiCorp funding received under Interim Measure 15 for the Klamath Hydroelectric Settlement Agreement (KHSA)


Questions? Comments?