

**MONITORING OF A NORTHEASTERN LAKE FISHERY  
FOLLOWING THE REMOVAL OF SEDIMENTS CONTAINING  
LEAD CHROMATE**

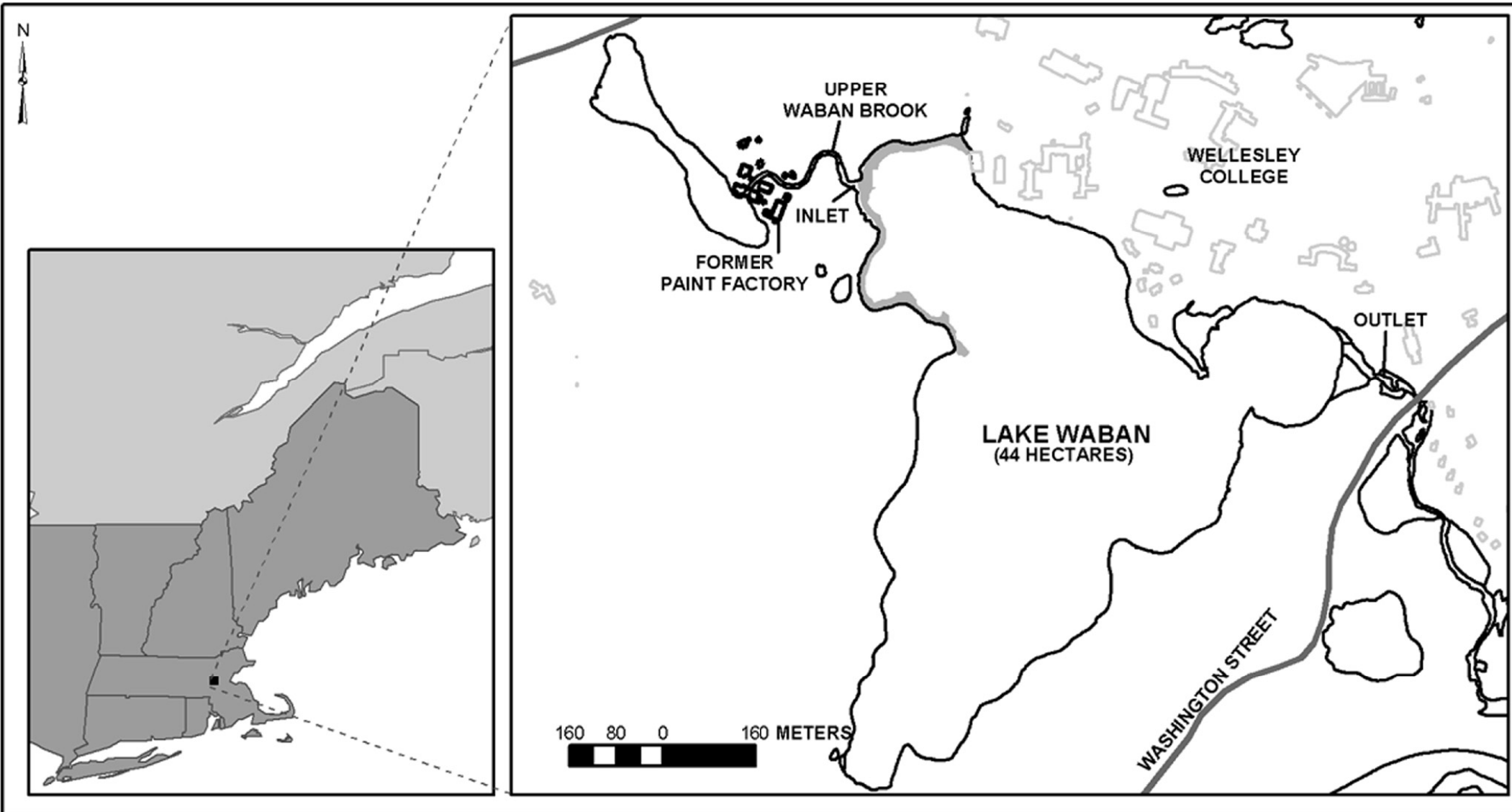
- **Stephen Clough, PhD. and Russell Schuck, P.G.  
Haley & Aldrich Inc. Boston, MA, USA,**

# Presentation Overview

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- Site Setting
- Site History
- Upland Remediation
- Sediment Remediation
- 1999 Pre-Dredging Fishery Assessment
- 2008 Post-Dredging Fishery Assessment
- Conclusions

# Site Location



# Lake Waban

- 44 hectares
- Maximum depth = 13m
- Mean depth = 3m
- Stratified
- Slightly eutrophic
- Retention time  $\pm$  100 days





**SITE HISTORY: c. 1937**

**← “Paint Shop Pond”**

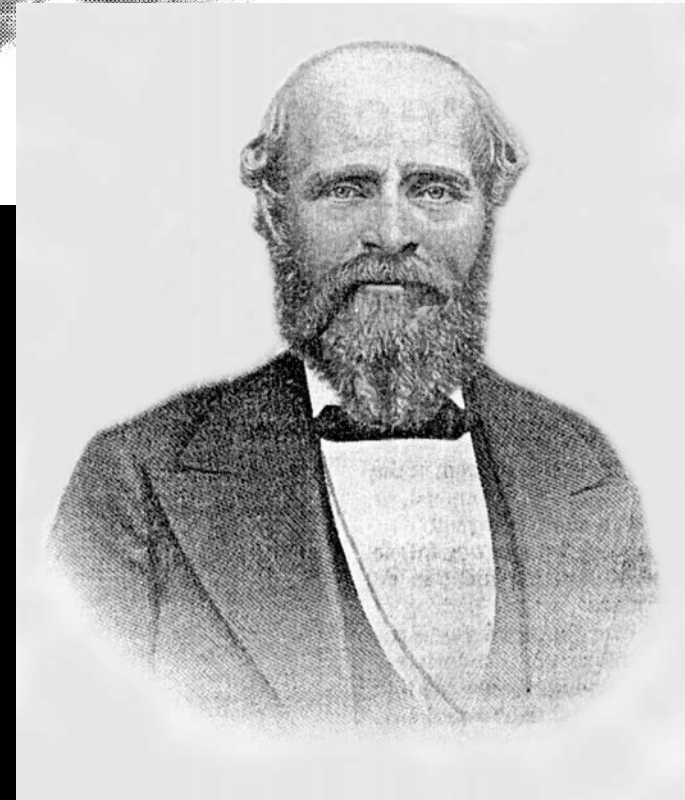
# SITE HISTORY

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- **Factory operated from 1848-1928**
- **Produced 6 tons of lead-based pigment per day at peak operation**
- **Wet process discharged waste effluent directly into upstream tributary feeding into Lake Waban**
- **Wellesley College purchased the property in 1932**

Henry Wood's Sons Co.  
 Makers of  
**Fine Colors.**  
 Established 1837  
 HENRY WOOD  
*Wellesley near Boston,*

**MARSEILLES OCHRE**  
 UNEQUALED FOR  
**PURITY, STRENGTH & BRILLIANCY**  
 MANUFACTURED BY **HENRY WOOD'S SONS CO.** WELLESLEY NEAR BOSTON  
© 2001 REMEDIATED BY HALEY & ALDRICH, INC.



Morses Pond

# SITE HISTORY: c. 2000

Wellesley College

Paint Shop Pond

Approximate limits of Wood's Property

Former Paint Factory Buildings

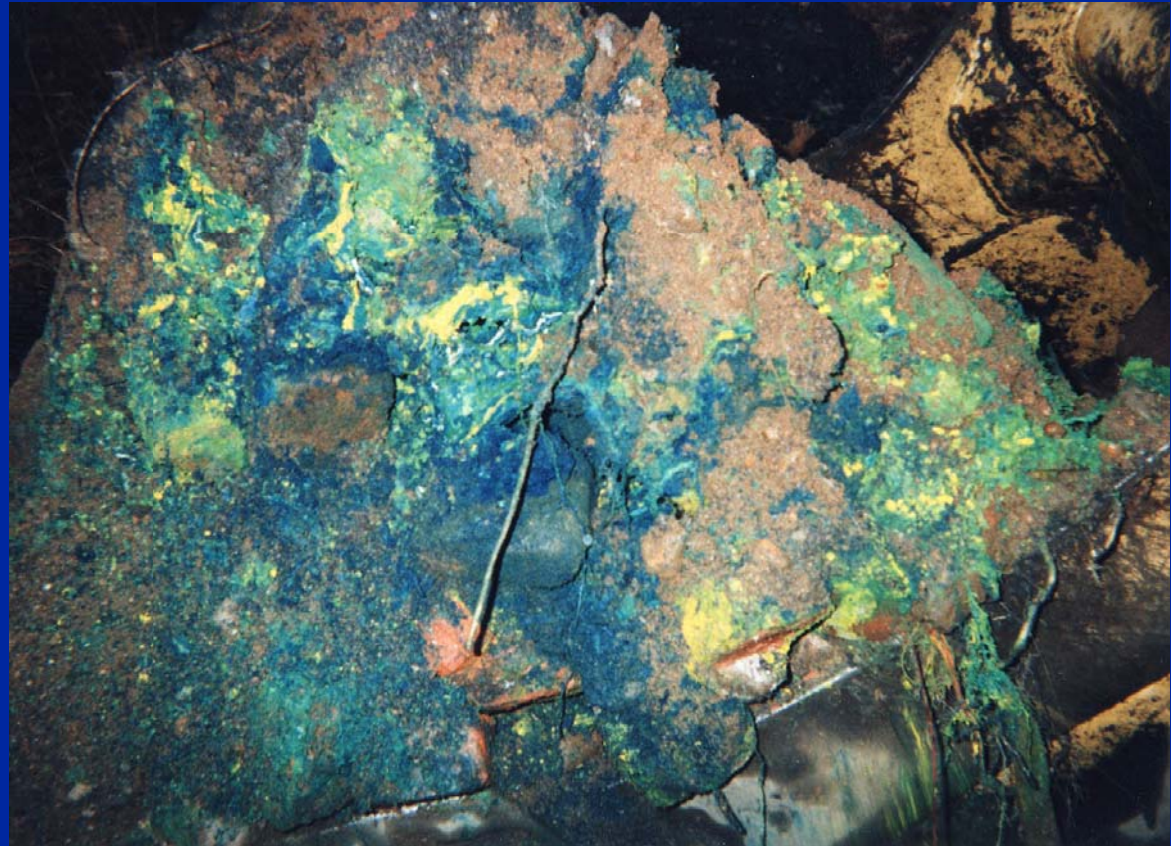
Lake Waban





# Primary Contaminants of Concern

- Soil/Sediment
  - Lead (Pb)
  - Chromium
    - Trivalent: Cr(III)
    - Hexavalent: Cr(VI)
  - Cyanide
- Groundwater
  - Hexavalent Chromium
  - Lead
- Surface Water
  - Lead



# Former Henry Wood's Sons Paint Factory Site

- Paint Factory site investigations began in the early 1980's
- Site includes the Uplands/Paint Shop Pond (where operations were conducted) Lake Waban and Lower Waban Brook (where waste residuals ended up)
- In 2001 Remediation of the Uplands/Paint Shop Pond Portion was initiated; completed in 2002
- Remedy consisted of placement of ~200,000 cu.yds. of soil and sediment beneath an engineered barrier on the site

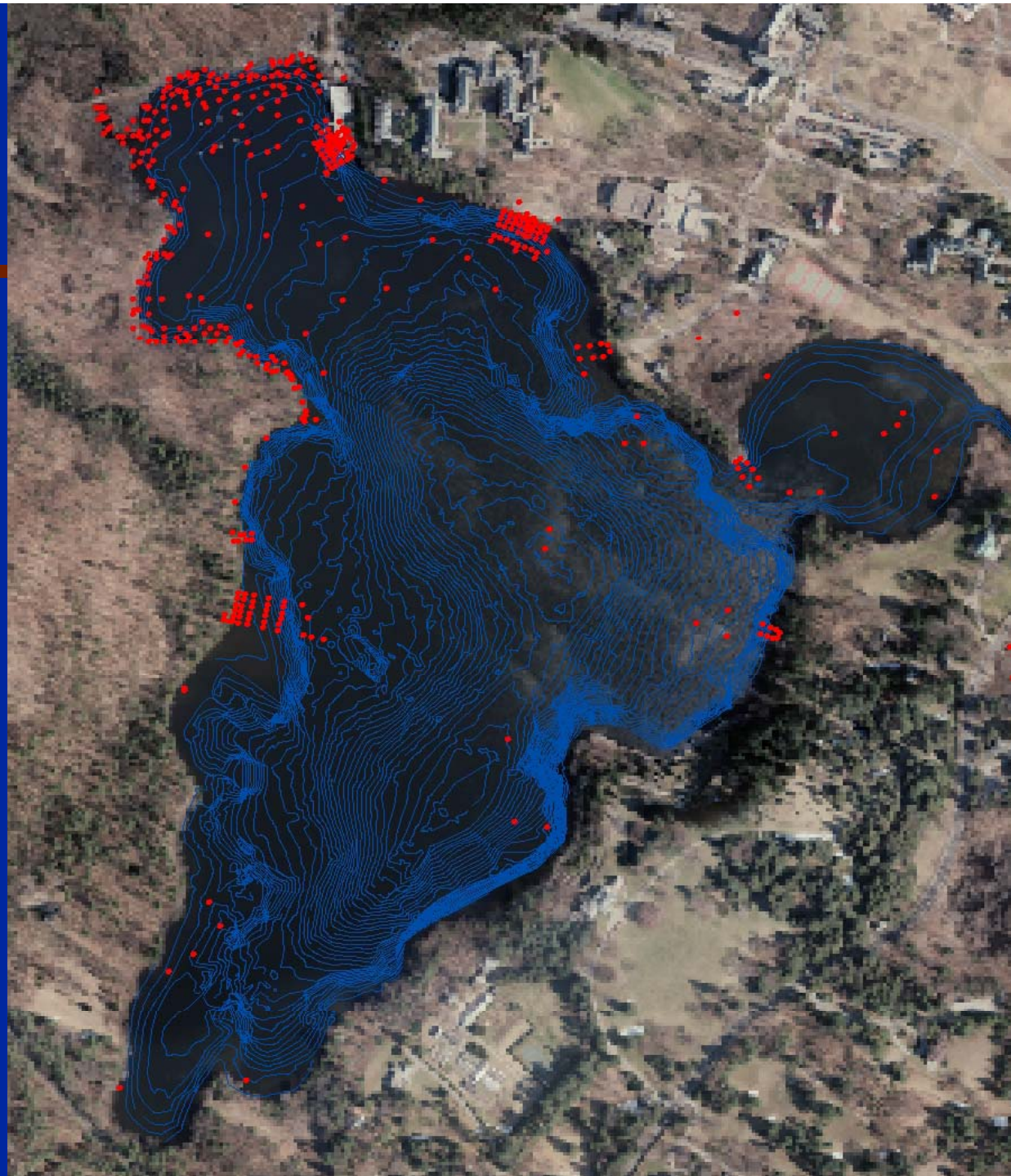






# Lake Waban Site Characterization

- >400 sediment samples
- Lead and Chromium are the primary COCs
  - Max Pb conc. 94,000 mg/kg
  - Max Cr conc. 15,000 mg/kg



# Ecological Risk Characterization

- Benthic invertebrate surveys at 20 locations
- Aquatic Plant tissue sampling & analysis
  - 16 water lily locations
- Fishery assessment
- Fish tissue sampling & analysis
- Invertebrate tissue analysis
- In situ & Laboratory Toxicity testing
- Similar studies conducted in 3 reference Lakes



# Results of the Risk Characterization

- Human Health Risk was identified in the Northern Shoreline/Western Cove portion of Lake Waban
  - Risk was to a child wader/swimmer
  - Risk caused by ingestion of sediment
  - Limited to 1 meter of water depth
- Potential Ecological Risk throughout Lake Waban
  - Modeled potential risk to waterfowl that consume lily roots and sediment
  - Limited to 1 meter in water depth





## Results of the Risk Characterization (cont.)

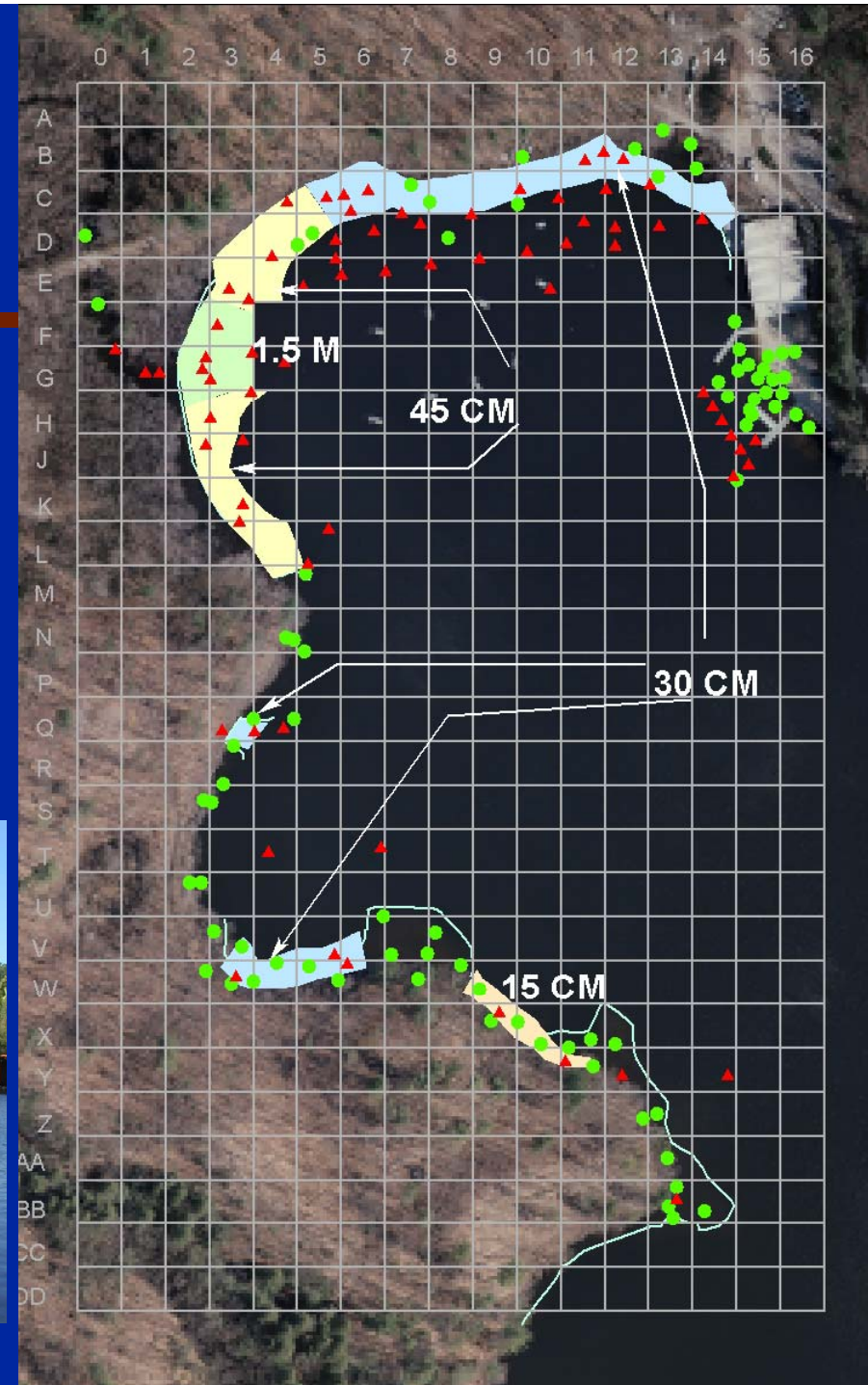
- Lead was often observed in surface water (pre-remediation) at concentrations above the USEPA Ambient Water Quality Criteria (AWQC)
  - Only 1 exceedance in the last 2 years of quarterly monitoring
- **Fish growth rates apparently reduced** in Lake Waban as compared to reference lakes
  - Unclear if this was contaminant related or due to other factors such as competition/overcrowding

# Dredging Plan

- Divided Site into 15 m<sup>2</sup> grid
- Defined areas that exceeded Remedial Goals
- Defined Depth of dredge in each cell based on sediment cores (GPS guided)



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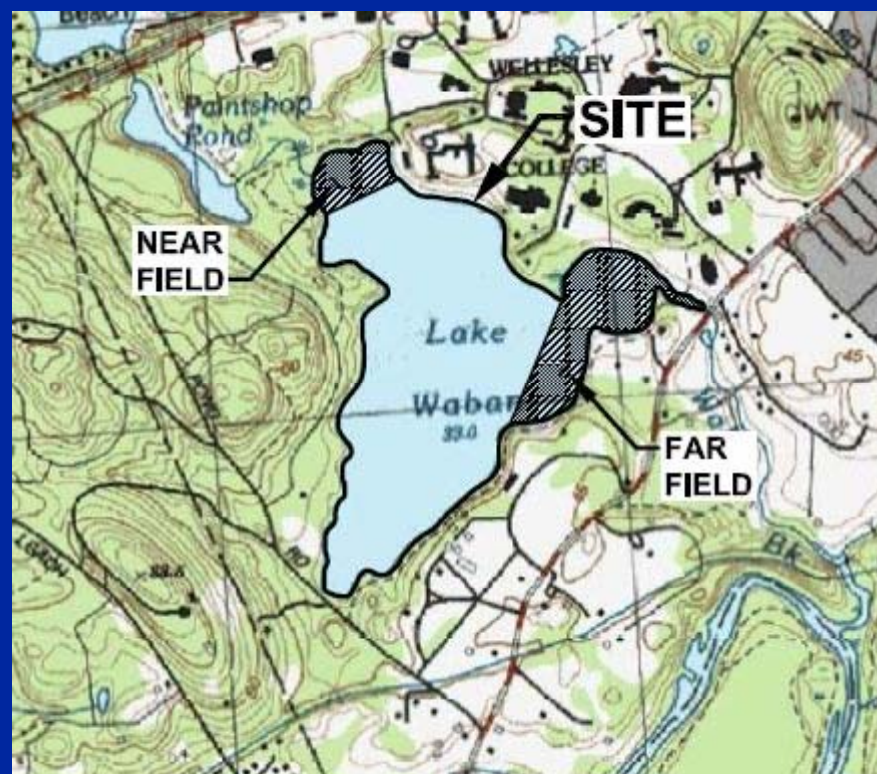
# Not just sediment being dredged!



# 1999 and 2008 Fish Community Assessments: Methodology

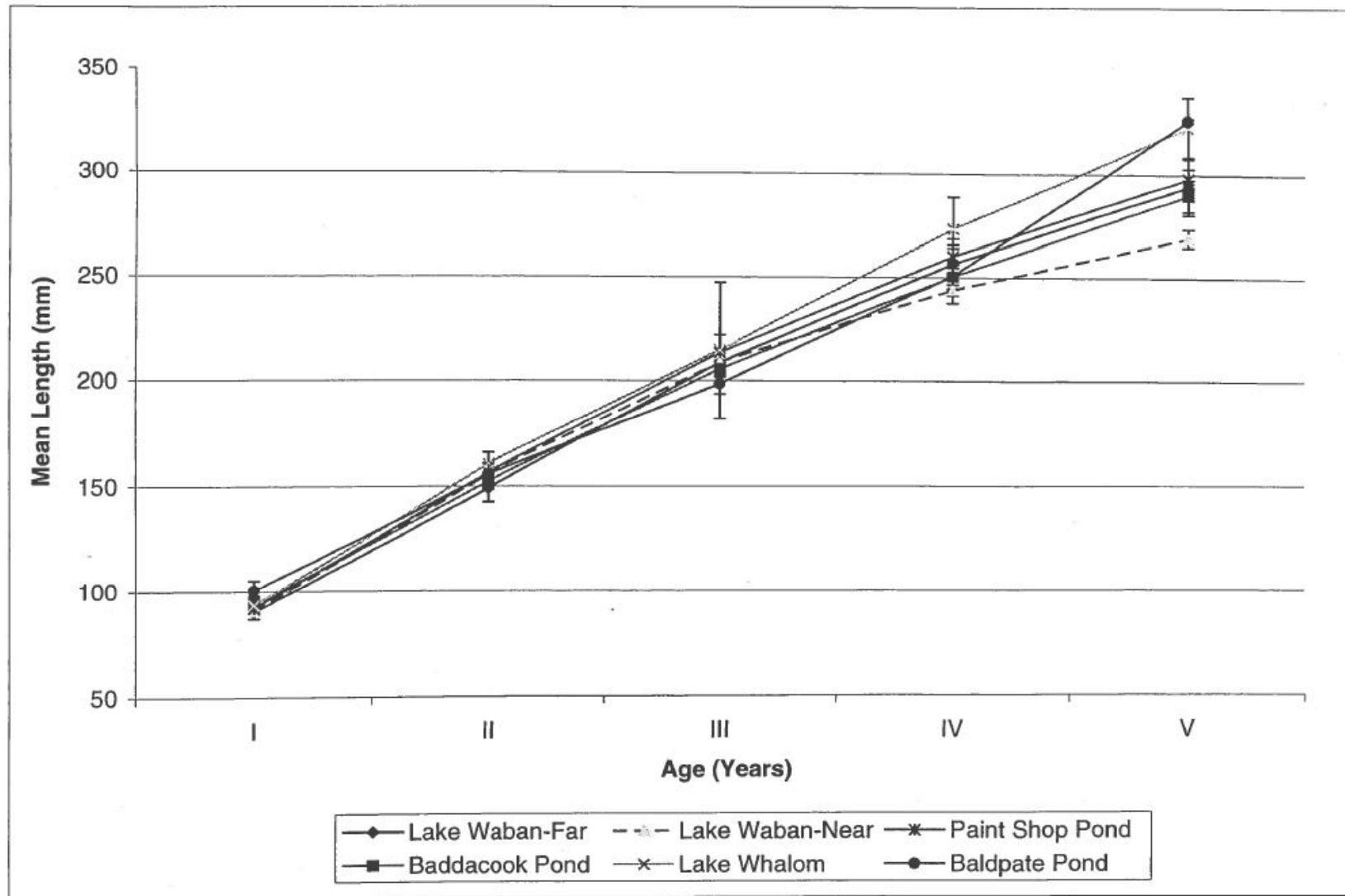
Study Objective: Compare pre-remedial (1999) fish community to post-remedial (2008) “impacts”

- Dredged Area: “Near Field”
- Reference Area: “Far Field”
- Electrofishing
- Gill Netting
- Angling (Rod n’ Reel)
- Water Quality (limnology)



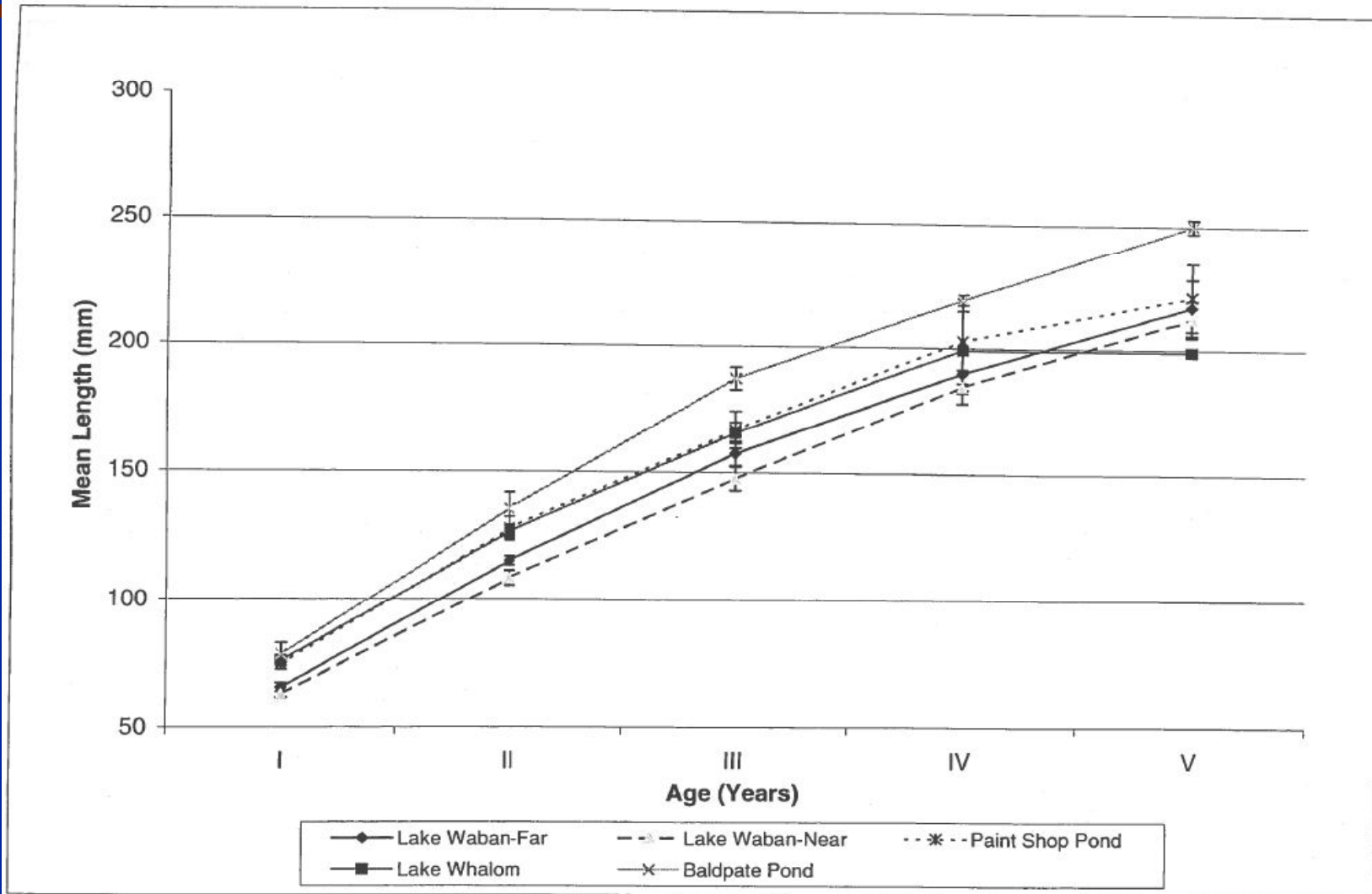
# Pre-Remedial Fish Community Study (1999)

Back Calculated Mean Length at Age for Largemouth Bass Captured at Six Locations



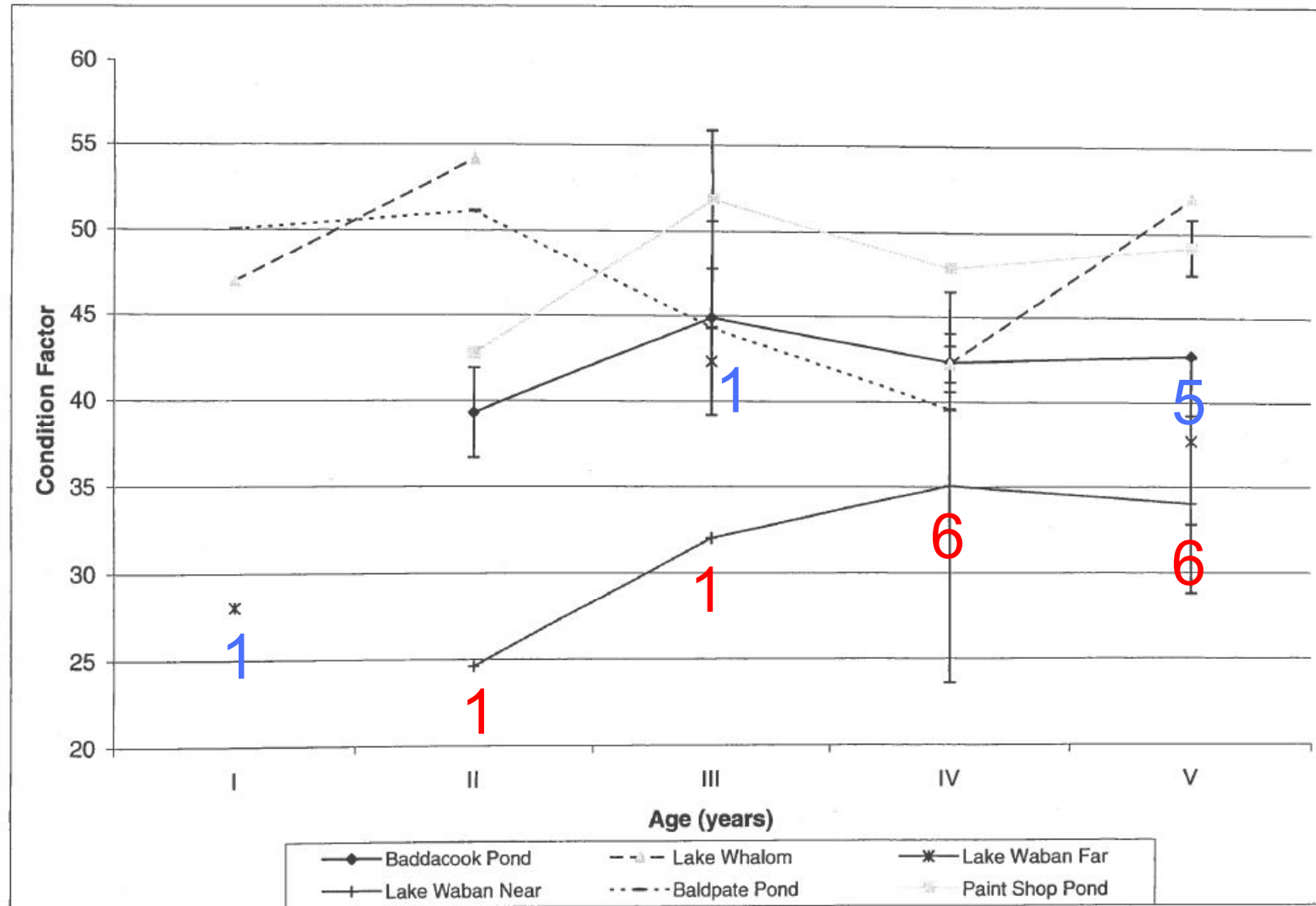
# Pre-Remedial Fish Community Study (1999)

Back Calculated Mean Length at Age for Yellow Perch Captured at Six Locations



# Pre-Remedial Fish Community Study (1999)

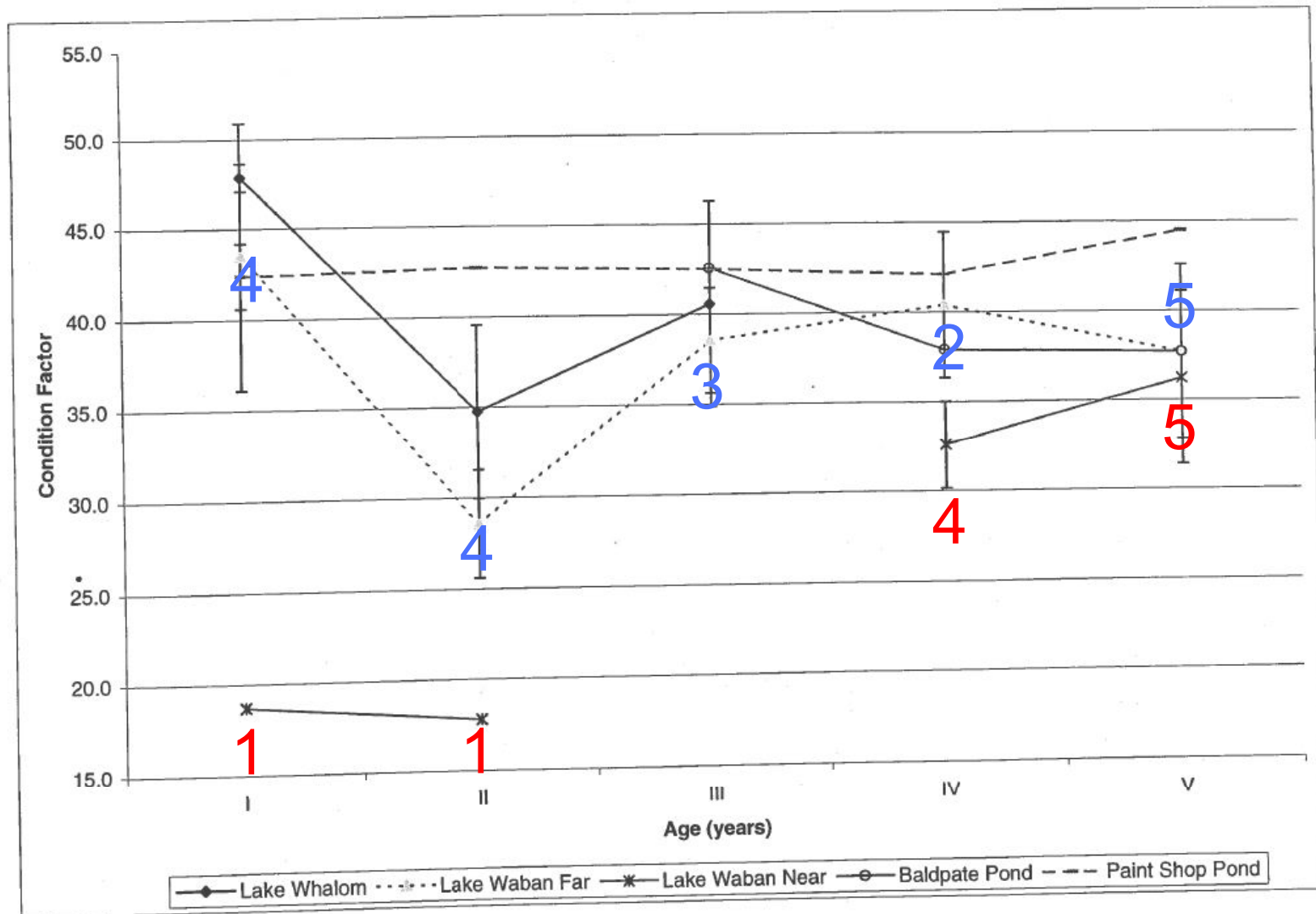
Average Condition Factors for Largemouth Bass Captured at Six Locations



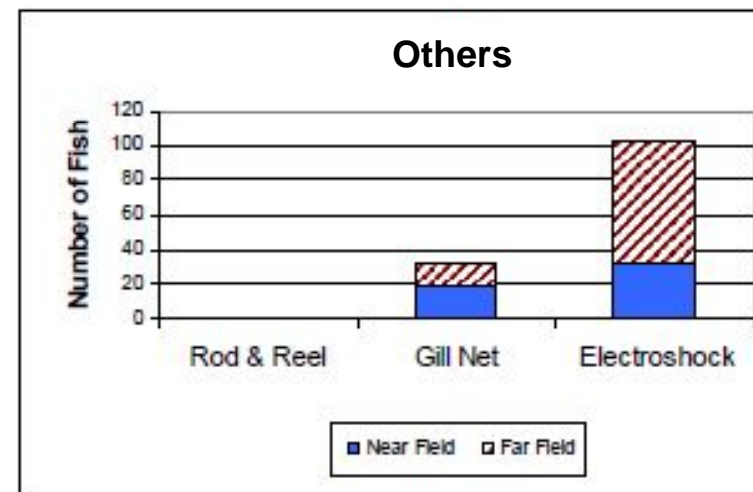
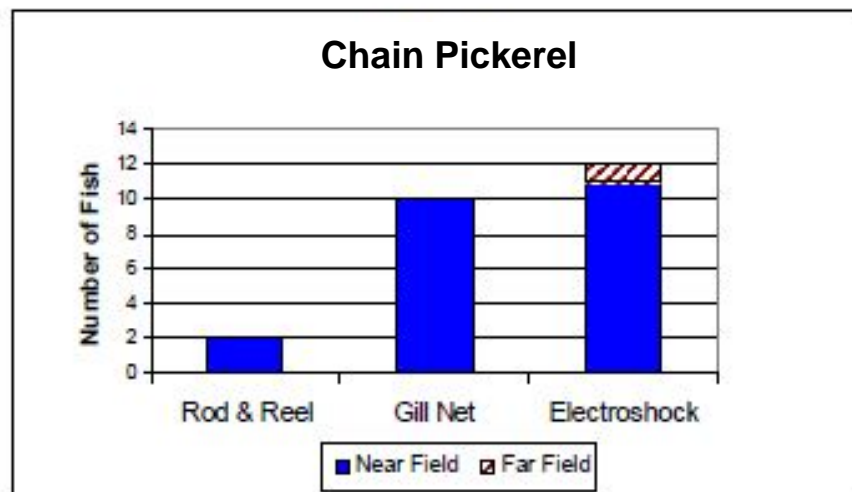
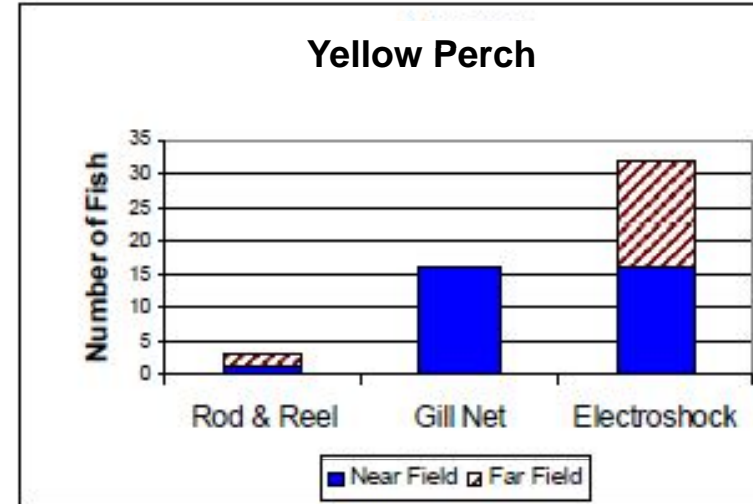
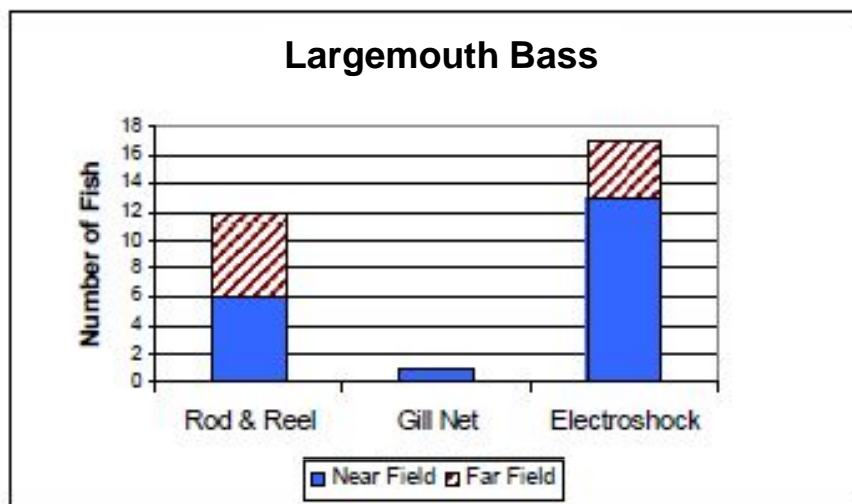


# Pre-Remedial Fish Community Study (1999)

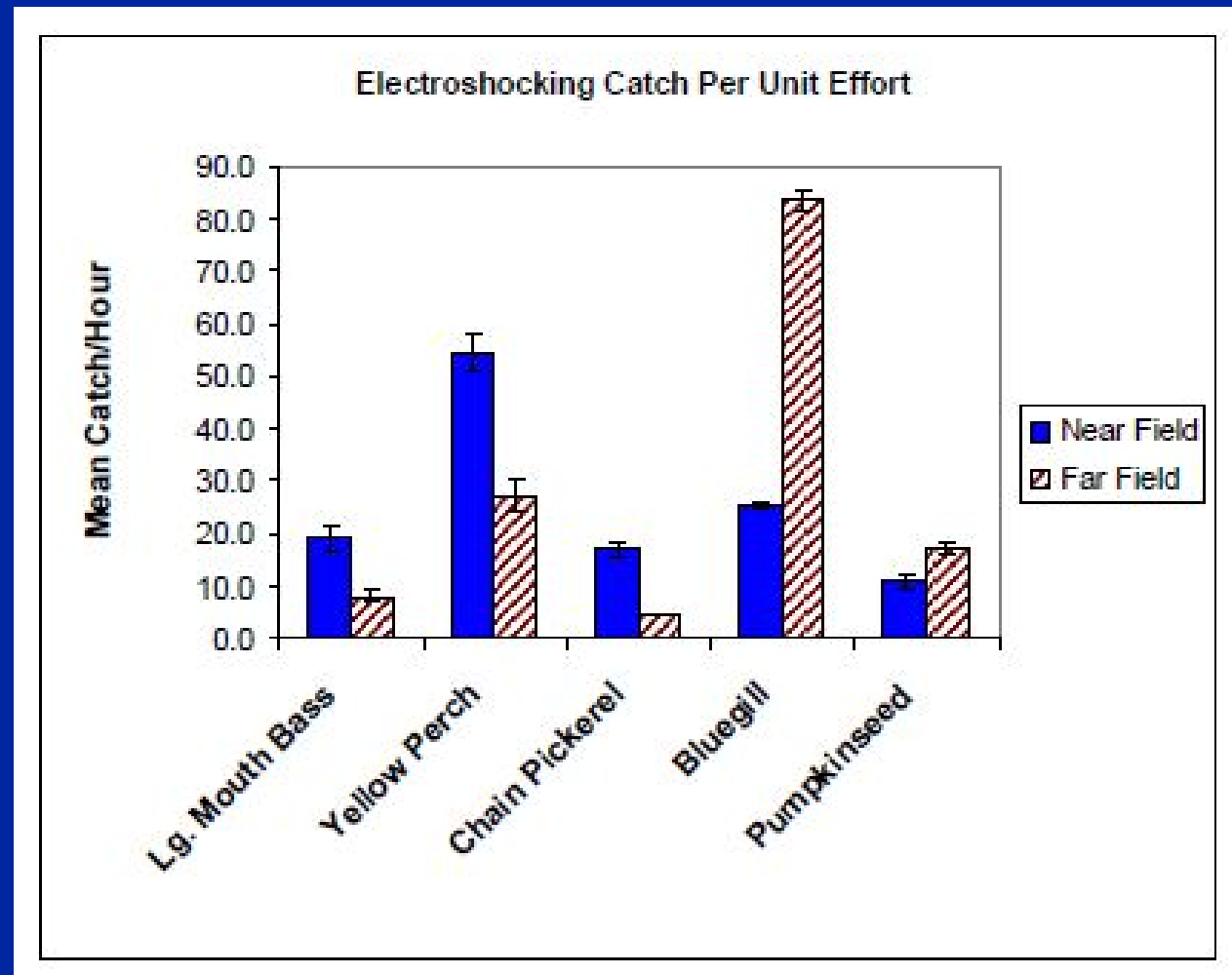
Average Condition Factors for Yellow Perch Captured at Six Locations



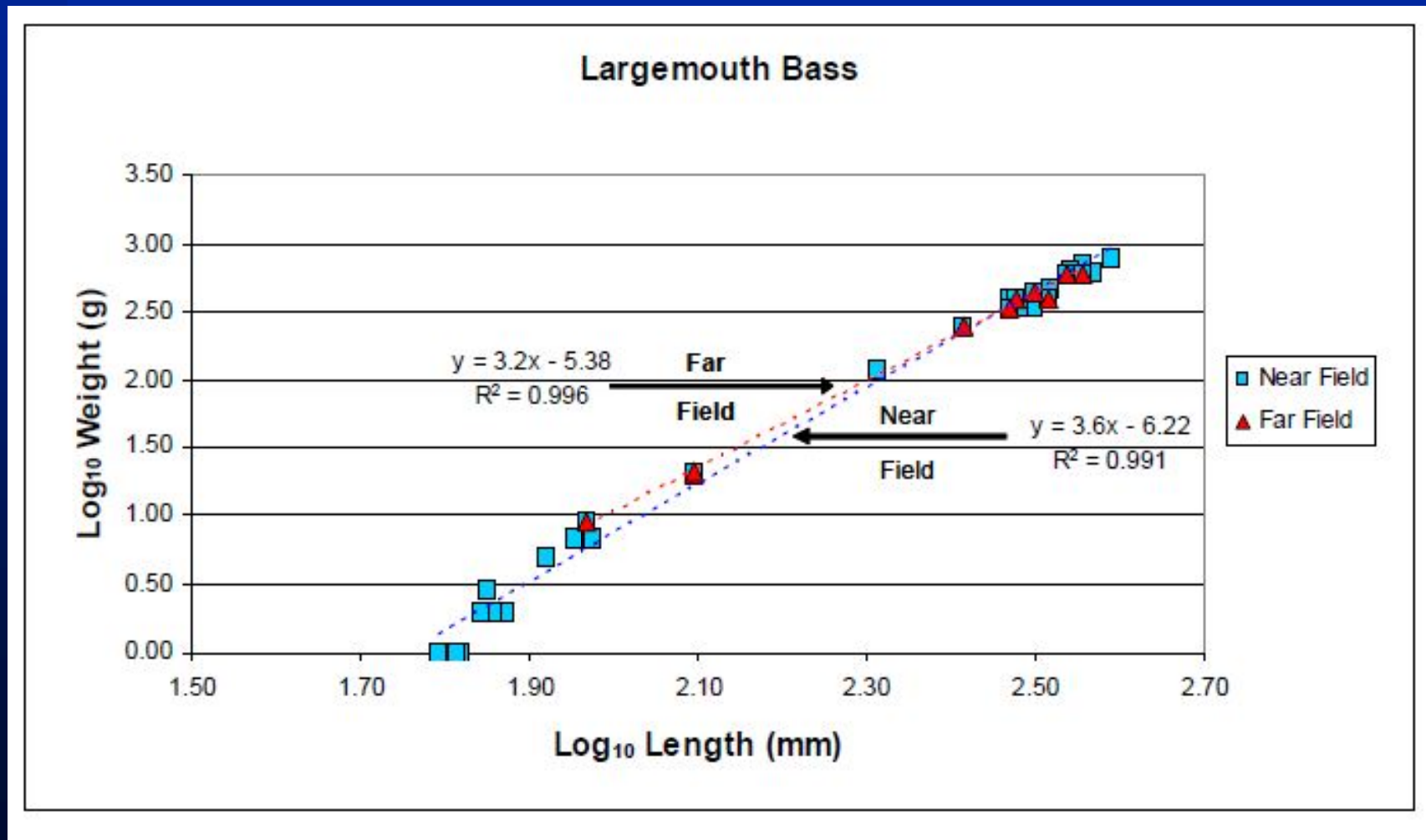
# 2008 Assessment of Fish Community: Yield by Capture Method



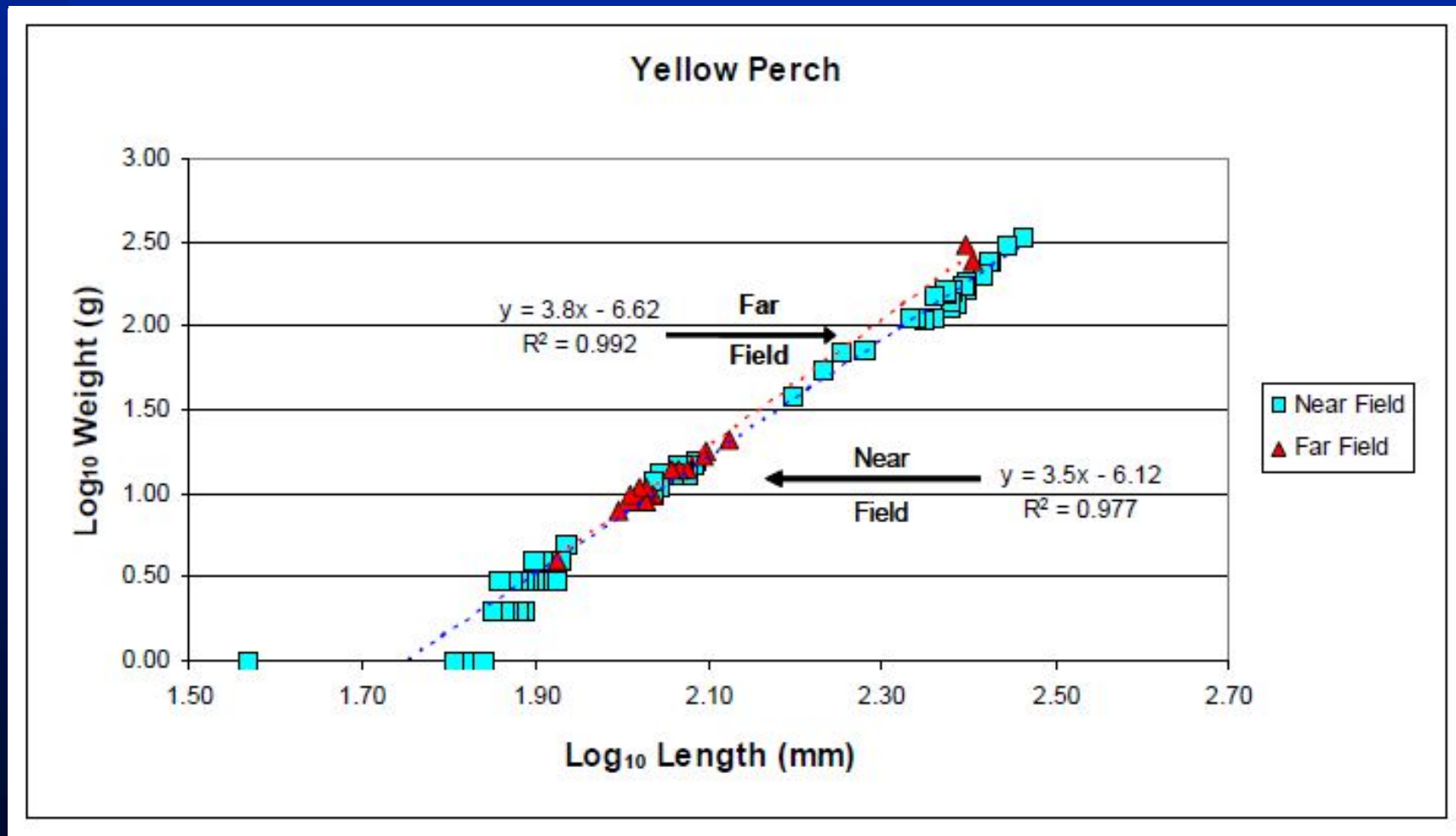
# Assessment of Fish Community: Catch Per Unit Effort for Electrofishing



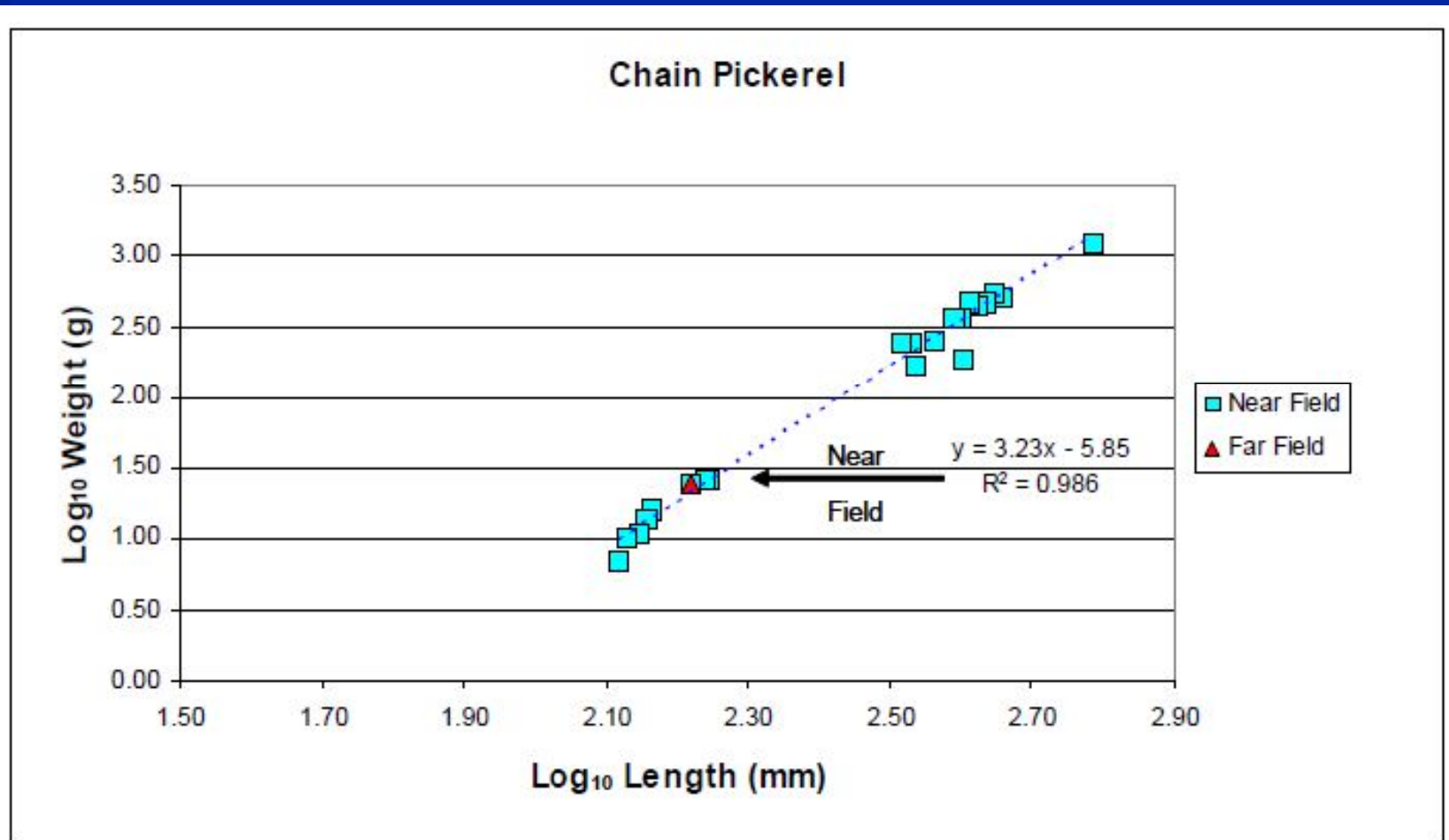
# Largemouth Bass: No Difference in Length vs. Weight



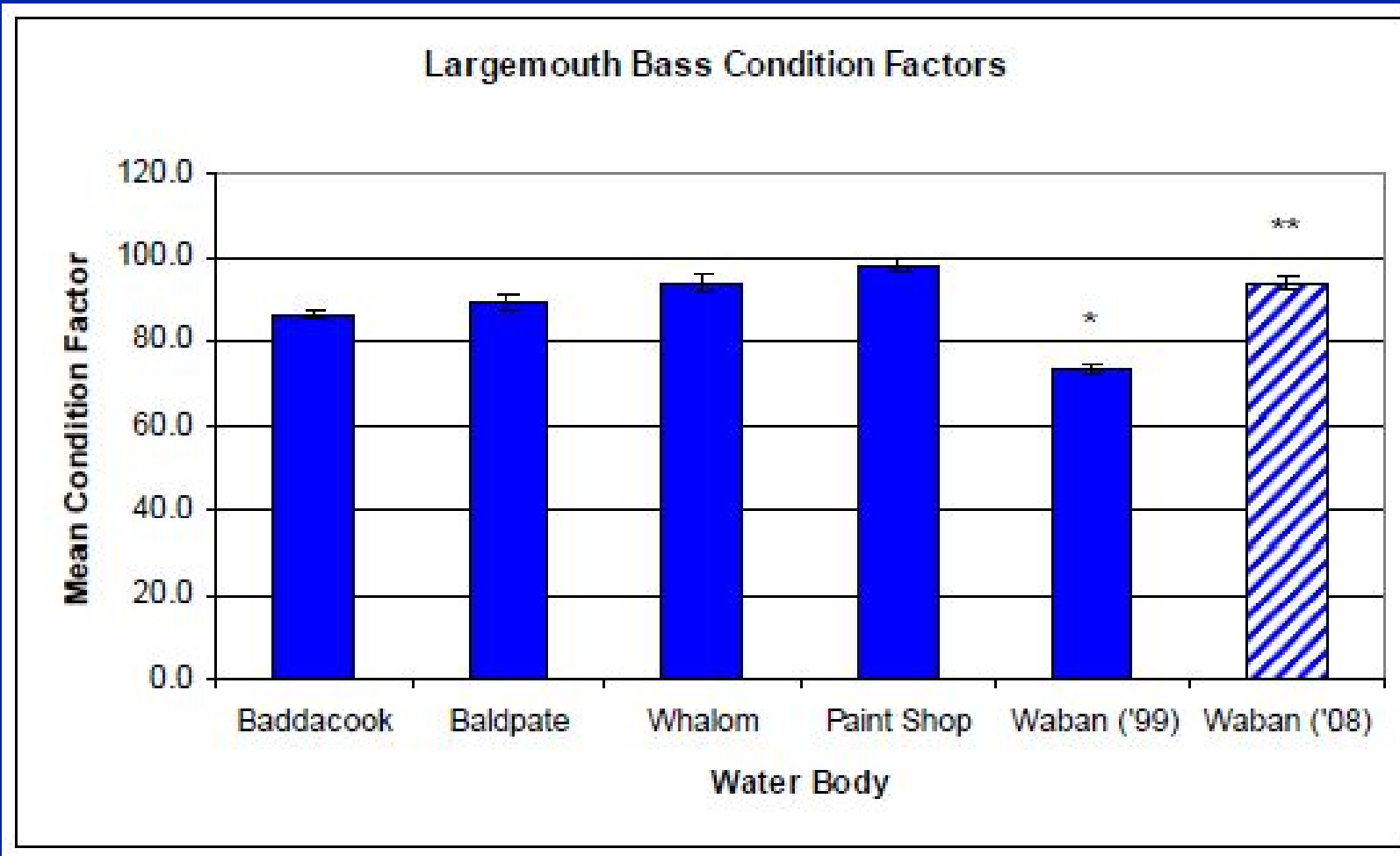
# Yellow Perch: No Difference in Length vs. Weight



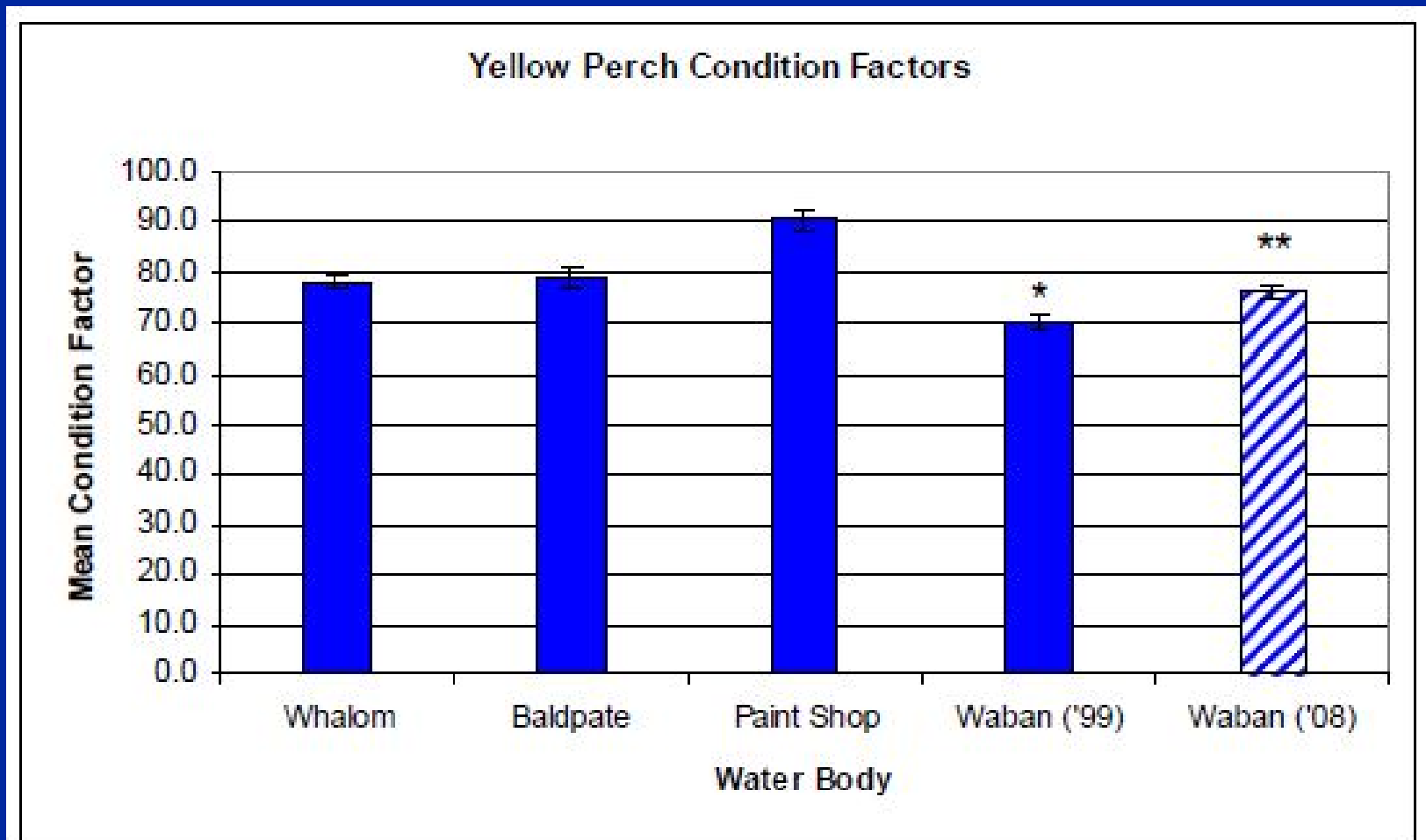
# Chain Pickerel: Clear Habitat Differences Between Near and Far Field



# Comparison of Condition Factors: 1999 vs. 2008



# Comparison of Condition Factors: 1999 vs. 2008





# Comparison of Condition Factors: MA DEP Reference Ponds vs. Lake Waban

Water Body	Town (MA)	Year(s) Sampled	Largemouth Bass		Yellow Perch	
			N	Average Condition Factor	N	Average Condition Factor
Baldpate Pond	Boxford	1999, 2004, 2006	35	95.8	16	76.2
Haggetts Pond	Andover	1999, 2003 - 2005	39	98.3	99	69.1
Johnsons Pond	Groveland	1999, 2004, 2006	23	96.2	59	87.0
Kenoza Lake	Haverhill	2001, 2002, 2006	69	103.3	222	82.7
Lake Attitash	Amesbury	1999, 2004, 2006	34	88.5	69	86.9
Lake Cochichewick	North Andover	1999, 2001, 2004, 2006	62	97.7	156	81.1
Lake Lashaway	East/North Brookfield	2003, 2005	27	95.2	45	83.0
Lake Saltonstall	Haverhill	1999, 2003	21	97.7	--	--
Lake Waban	Wellesley	2008	40	93.9	85	76.2
Lowe Pond	Boxford	1999, 2004, 2006	14	93.8	43	89.7
Pomps Pond	Andover	1999, 2001, 2004	14	98.8	16	95.3
Rock Pond	Georgetown	1999, 2004, 2005	35	89.5	69	86.6
Stevens Pond	Saugus	1999, 2001, 2004	23	97.7	11	86.0
			Minimum:	88.5		69.1
			Maximum:	103.3		95.3
			Mean:	95.9		83.3

# Conclusions

- No difference between Near and Far Field for:
  - LMB and YP length vs. weight data
  - LMB and YP condition factors
- Clear difference in yield for pickerel (Near >> Far)
- Significant “recovery” comparing CF’s from 1999 to 2008
- LMB and YP condition factors fall within the normal ranges for MA DEP clean “reference” lakes
- No contaminant related effects due to remedial activity, which is anticipated given the low bioavailability of lead chromate (particularly in a reducing benthic environs)