Water Quality and Habitat Impacts Caused by Common Carp (Cyprinus carpio)

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Thanks To….

- NYSFOLA
- Co-authors for field work and modeling specific to the study of Mill Pond, Southampton, NY
- Mill Pond Association and Deal Lake Commission

Common Carp

- *Cyprinus carpio* non-native, highly invasive fish
- Found in variety of lake and pond ecosystems

Yes…They Can Get Very Large!

How Do Carp Impact Lake Ecosystems?

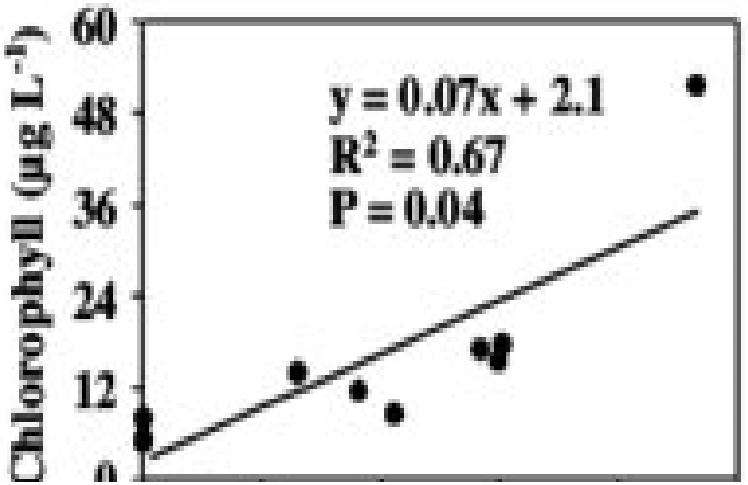
- Uproot and disturb submerged vegetation.
- Suspend sediments reducing water clarity.
- Resuspension of sediment bound phosphorus.
- Resuspension of organic sediments impact dissolved oxygen concentrations.
- Impact and disrupt feeding, spawning and nursery habitat for various game fish.

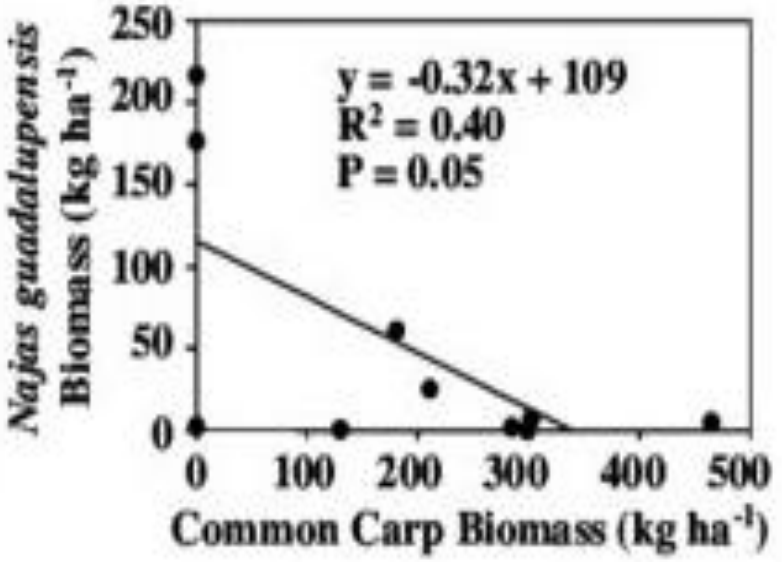
Carp Impacts Increase as Densities Increase

- Biomass significantly positively correlated with increased concentrations of...
  - Chlorophyll a, Total phosphorus, and Total nitrogen
- Biomass negatively correlated with densities of bushy pondweed (Najas guadalupensis) biomass.

M.M. Chumchal, W.H. Nowlin, and R.W. Drenar. 2005. Biomass-dependent effects of common carp on water quality in shallow ponds. Hydrobiologia 545(1):271-277

Impacts of Carp





M.M. Chumchal, W.H. Nowlin, and R.W. Drenar. 2005.

Case Study - Mill Pond, Water Mill (Southampton) NY

- Located in Water Mill, Suffolk County, NY
- 92-acre, kettle hole, freshwater lake
- 850-acre, relatively small watershed, forest (44%), hay and low intensity ag (27%), and low-density development (12%),
- Historically connected to Mecox Bay / Atlantic

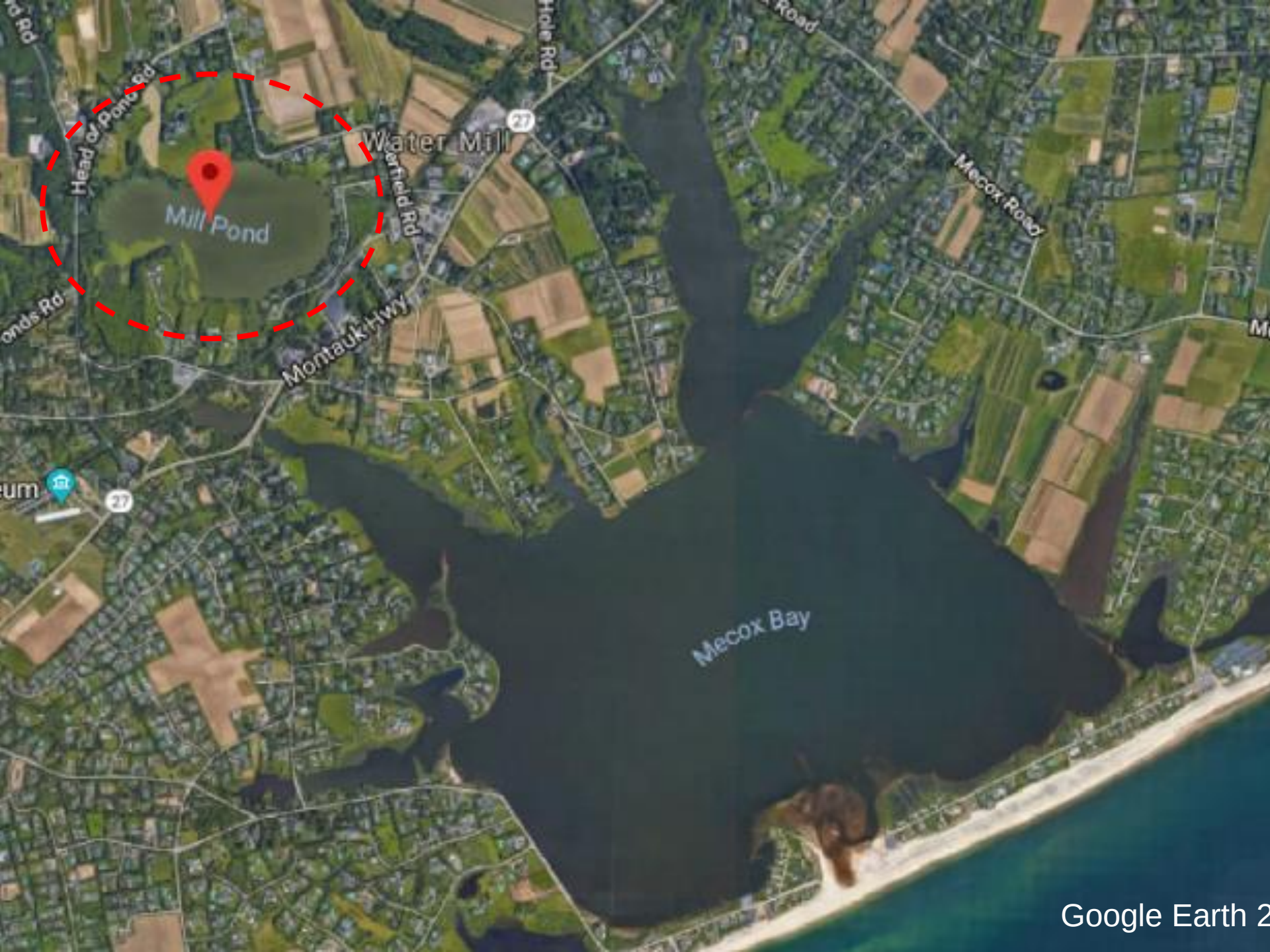

Mill Pond
Water Mill
Head of Pond Rd
Hole Rd
Mecox Road
Waterfield Rd
Montauk Hwy
Mecox Bay
27
Google Earth 2

Photo Source - www.bhsusa.com

Mill Pond

- Categorized by NYSDEC as eutrophic
- Frequently impacted by cyanobacteria blooms…as per NYSDEC data from 2012 – 2018 confirmed blooms with some associated with elevated toxin levels
- Fishery - Largemouth Bass, Chain Pickerel, Bluegill, Pumpkinseed, Yellow Perch, White Perch, Brown Bullhead…large Carp population

Past Management Efforts

- Solar-powered aeration system 2007
- Phoslock application 2013
- Carp removal project 2012
- Improved stormwater management
- Updated septic design ordinance

Neither aeration nor PhosLock yielded any measurable benefits

Documented HABs

Major Fish Kill 2008

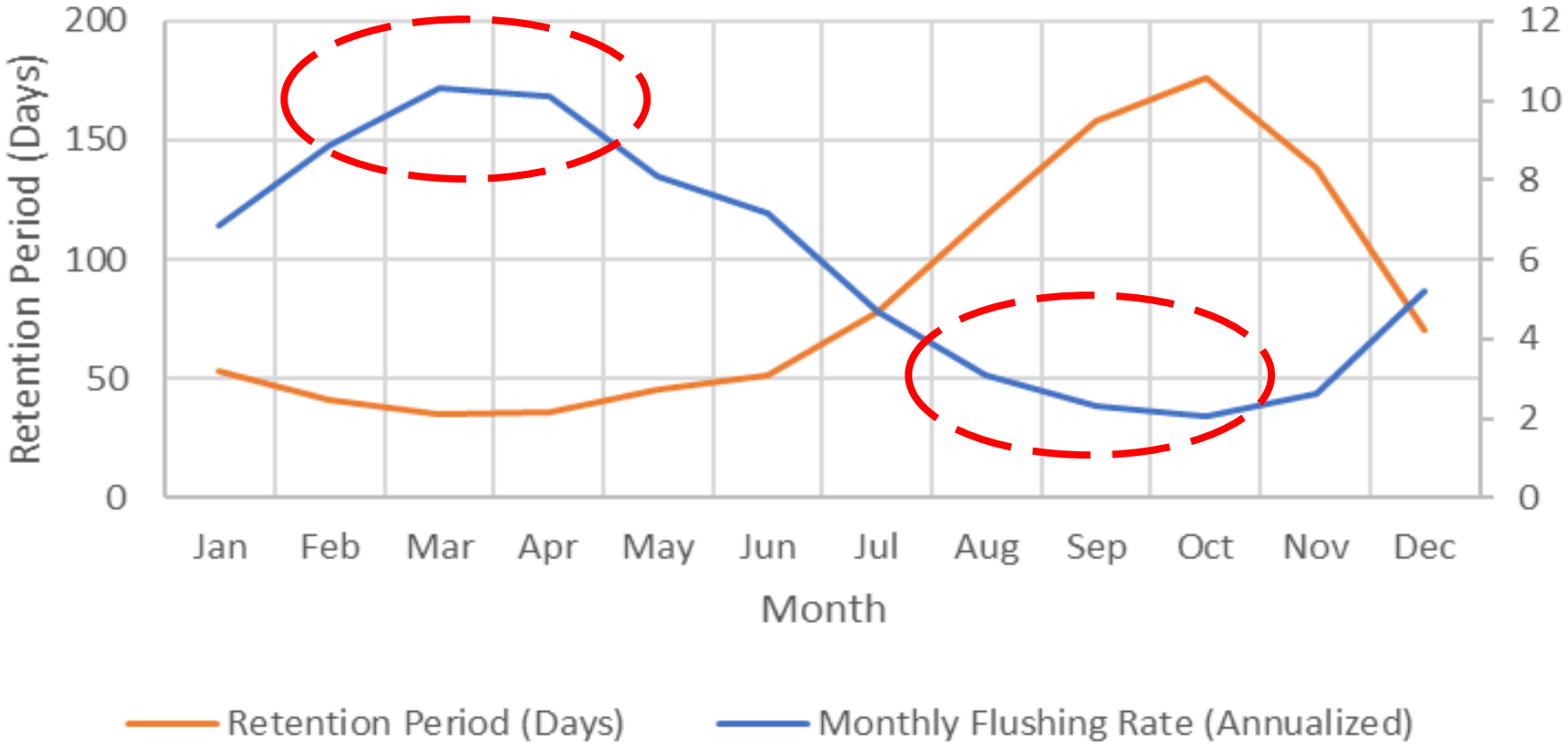
CWC

2018 Princeton Hydro Restoration and Management Project

- Identify, quantify and prioritize factors responsible for eutrophication and cyanobacteria blooms,
- Identify the correct combination of in-pond and watershed management actions,
- Develop cost estimates to implement plan and secure any required NYSDEC permits,
- Generate a schedule for plan implementation, and
- Create sampling plan to objectively and quantitatively track WQ improvements and ecological benefits.

Summary of Princeton Hydro 2018 Data

- Lake : Watershed ratio – 23:1
- Moderately flushed system – 62 days
- GW ~ 50% of monthly inflow
- Secchi low – typically > 0.5 m
  - Water often brownish color
- No evidence of thermal stratification
- No evidence of "deep water" anoxia



Annualized hydraulic retention time = 62 days

Annualized flushing rate ~ 6 times / year

Summary of Princeton Hydro 2018 Data

- TP very high - $Surf_m$ = 0.104 mg/L

  $Deep_m$ = 0.118 mg/L
- SRP low > 0.004 mg/L
- Anoxic sediment P loading not an issue
- Chlorophyll a very high - Usually > 40 mg/m^3
- TSS always elevated, TSS_m > 45 mg/L, surf and deep concentrations similar
- Cyano blooms common but cyanotoxin concentrations low (< 4µg/l)

In-Situ Monitoring for Mill Pond, 4/24/2018

Station	DEPTH (meters)			Temp	Specific Cond.	Dissolved Oxygen		pH
	Total	Secchi	Sample	°C	mS/cm	mg/L	% Sat.	S.U.
WQ1	1.50	0.50	0.0	13.67	0.193	9.86	114.1	7.17
			0.5	12.82	0.190	10.00	93.5	7.30
			1.0	11.99	0.190	8.92	99.4	7.26
			1.4	11.73	0.187	9.68	96.1	7.23
WQ2	2.50	0.50	0.0	13.10	0.192	9.82	112.2	7.43
			0.5	13.03	0.195	9.60	109.5	7.70
			1.0	13.00	0.194	9.48	108.1	7.77
			1.5	12.95	0.194	9.44	107.5	7.80
			2.0	12.60	0.194	8.84	99.8	7.74
			2.4	12.32	0.196	8.85	99.4	7.70
WQ3	2.00	0.50	0.0	12.94	0.192	9.89	112.6	7.33
			0.5	12.78	0.195	9.70	110.1	7.43
			1.0	11.92	0.198	9.18	102.2	7.44
			1.5	11.88	0.197	8.46	94.0	7.39

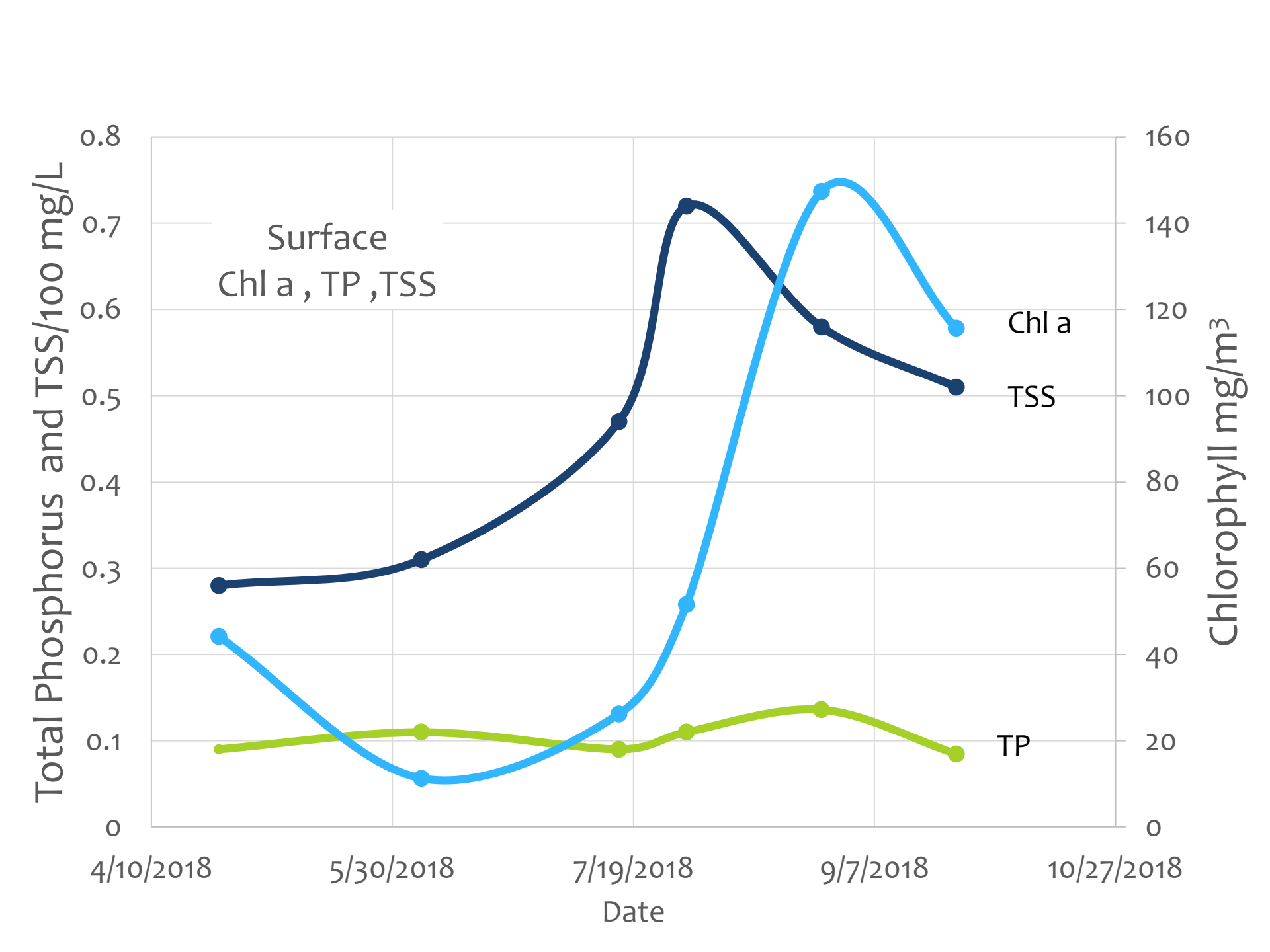
In-Situ Monitoring for Mill Pond, 9/24/18

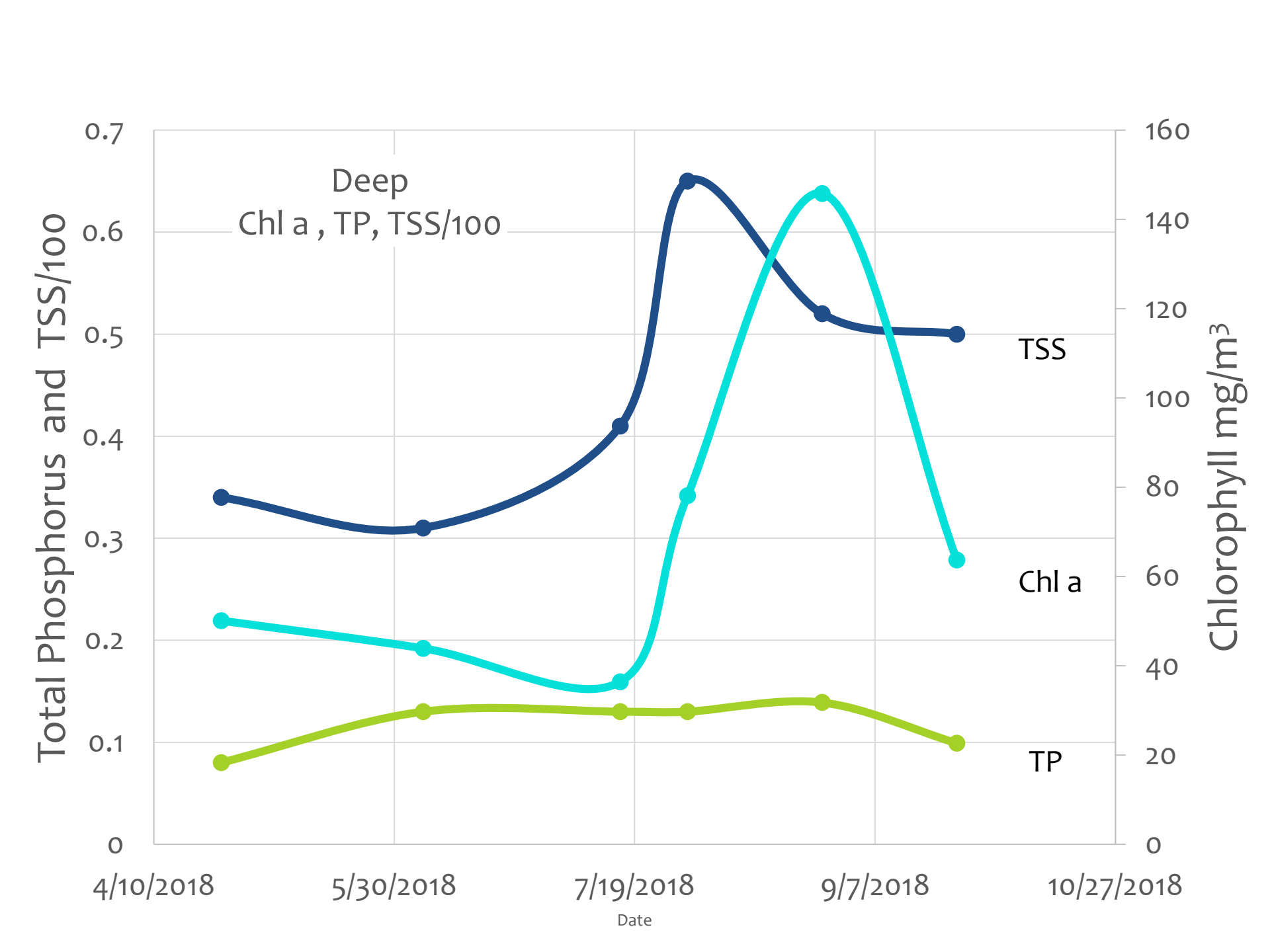
Station	DEPTH (meters)			Temp	Specific Cond.	Dissolved Oxygen		pH
	Total	Secchi	Sample	°C	mS/cm	mg/L	% Sat.	S.U.
WQ1	1.4	0.2	Surface	20.05	0.215	8.44	91.3	6.68
			0.5	19.93	0.213	8.01	86.5	6.81
			1.0	19.92	0.215	6.37	68.7	6.93
WQ2	2.4	0.3	Surface	20.47	0.217	7.55	82.4	6.62
			0.5	20.50	0.215	7.62	83.1	6.72
			1.0	20.49	0.217	7.61	83.0	6.77
			1.5	20.49	0.216	7.66	83.6	6.81
			2.0	20.49	0.216	7.52	82.4	6.88
WQ3	1.8	0.3	Surface	20.02	0.215	8.18	88.5	6.51
			0.5	20.05	0.215	7.84	84.7	6.65
			1.0	20.04	0.216	8.06	87.2	6.74
			1.5	20.01	0.215	7.93	85.8	6.77

Water Quality Data Surface and Deep

Date	Chl a (mg/M³)		SRP (mg/L)		TP (mg/L)		TSS (mg/L)	
	Surface	Deep	Surface	Deep	Surface	Deep	Surface	Deep
4/24/2018	44.2	50.1	0.008	0.004	0.09	0.08	28	34
6/5/2018	11.3	43.9	0.018	0.003	0.11	0.13	31	31
7/16/2018	26.2	36.4	0.003	0.002	0.09	0.13	47	41
7/30/2018	51.6	78.1	0.003	0.001	0.11	0.13	72	65
8/27/2018	147.4	145.8	0.001	0.001	0.136	0.139	58	52
9/24/2018	115.7	63.7	0.0038	0.0021	0.0847	0.0991	51	50

CWC


Surface
Chl a , TP ,TSS
Chl a
TSS
TP
Total Phosphorus and TSS/100 mg/L
Chlorophyll mg/m³
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
160
140
120
100
80
60
40
20
0
4/10/2018
5/30/2018
7/19/2018
9/7/2018
10/27/2018
Date


Deep
Chl a , TP, TSS/100
TSS
Chl a
TP
Total Phosphorus and TSS/100
Chlorophyll mg/m3
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
160
140
120
100
80
60
40
20
0
4/10/2018
5/30/2018
7/19/2018
9/7/2018
10/27/2018
Date

Lake Sediment Analysis

- Collected eight (8) sediment cores
  - Cores hand-driven to point of refusal (~ 0.5 - 1m)
  - Retrieved and examined in field for any evidence of striation, odor, reduced organic content, residual macrophyte/leaf detritus
  - Returned to lab for TP and grain size analysis
- Sediments found to be composed mostly of silts/clays, reduced organic material (Org ~30%)
- Sediment TP concs. - 542-1062 mg/kg

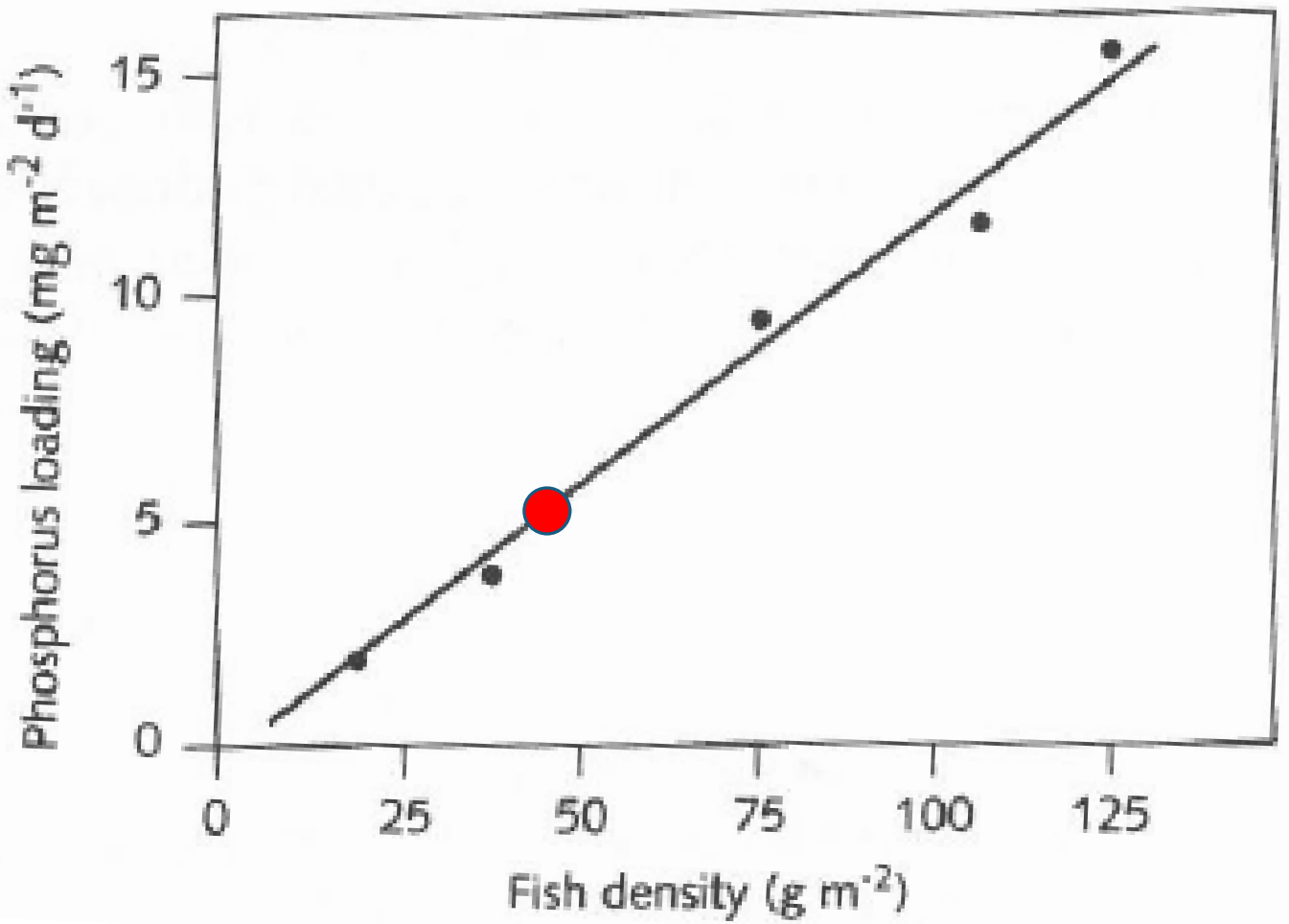
Sediment Core

What's role of sediment resuspension on lake eutrophication?

Role of Carp On P Loading

- Mill Pond has a large common carp population
- 2012 over 6,000 lbs removed via netting
- Carp significantly impact water quality
  - Direct nutrient inputs (defecation)
  - Indirect nutrient inputs (bioturbation) and alteration of littoral plant community)
- Carp responsible for lack of littoral vegetation and persistent turbidity of the lake

Carp Bioturbation Impacts, Lamarra, 1974



Role of Carp On P Loading

- Computed P Load due to carp bioturbation only
  - Loading rate 5 mg/m^2/day
  - Lake bottom area 372,000 m^2
  - Loading period 245 days
  - Computed load 455.7 kg/yr
  - Adjusted by 50% to account for settling
- Total P load = 227.85 kg/yr

Modeled External/Internal TP Load

TP Load Source	Load (kg/yr)	% Load
Land Use (SW Runoff)	200.4	33.75
Animals	8.6	1.44
Stream Bank	2.0	0.33
Groundwater	32.8	5.52
Septic	67.2	11.32
Internal - Oxic	26.8	4.43
Internal – Carp (bioturbation)	227.85	38.39
Internal - Geese	27.99	4.71
Total		100.0%

What The Data Is Telling Us

- Lake well mixed, non-stratified and no evidence of anoxia...aeration not needed
- Lake very turbid; due to TSS and Phytoplankton (as per elevated Chl a concentrations)....clarity < 0.5 m
- Mean TP, Chl a concentrations very high, but SRP concentrations moderate

What The Data Is Telling Us

- External P load high 200.4 kg/yr (33.75% of total)
- Septic P load moderate and manageable 67.2kg/yr (11.3% total load)
- Internal sediment P load under oxic conditions is low (<4.43%)
- Carp related P loading is high 227.85 kg/yr (38.39% of total load)

Management Recommendations

- Focus on manageable sources of P
  - Stormwater runoff
  - Septic
  - Carp
- No need to aerate lake, not stratified and internal sediment load low
- Data do not support need for nutrient inactivation (alum or alum surrogate treatment of lake sediments

Target carp removal as primary restoration effort

Carp Removal

- Conduct detailed fishery survey to quantify the amount of carp in lake
- Proposal to conduct baited box net removal program.
- Advocate active removal effort using recreational anglers/bow anglers.

CWC

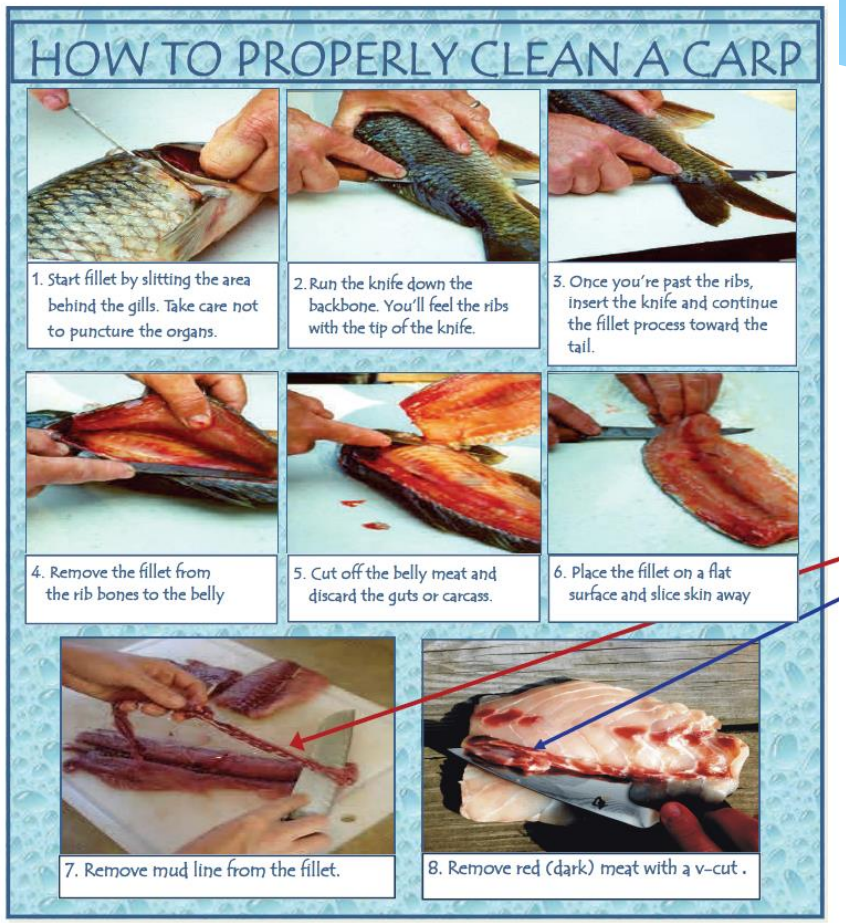
Carp Removal Options

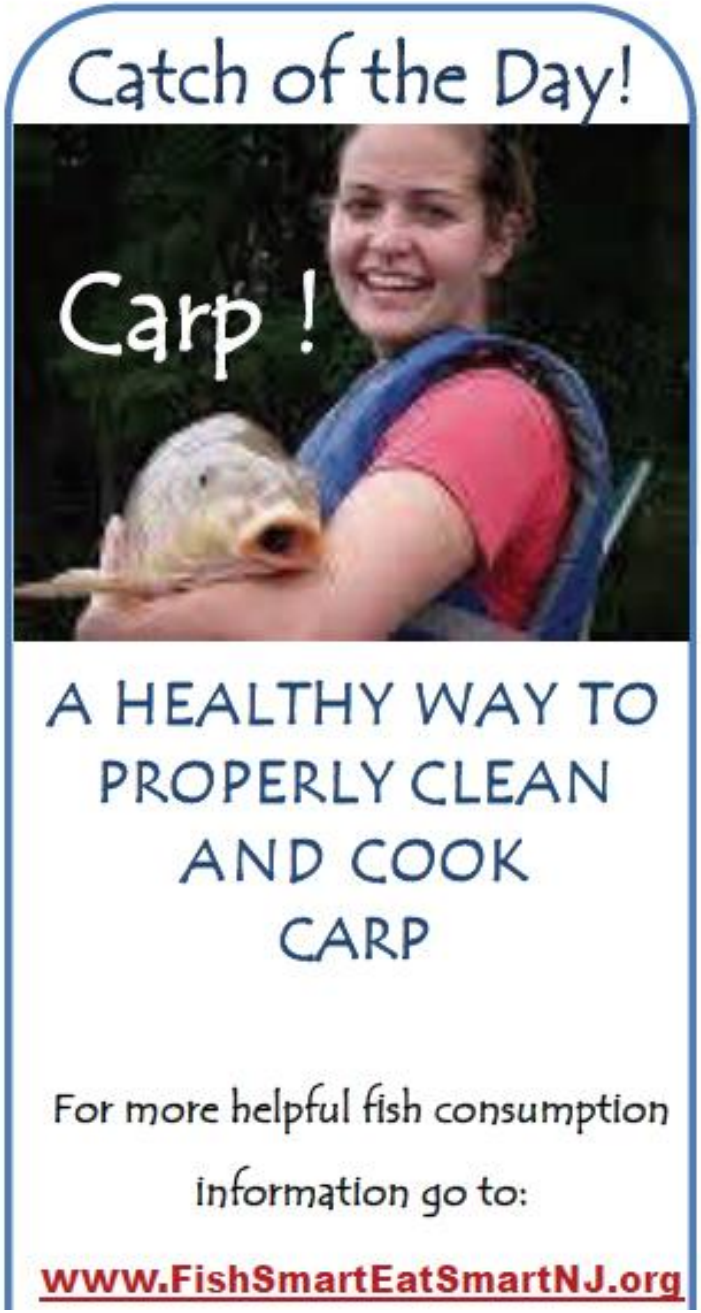
- Gill Nets
- Electroshocking
- Recreational anglers
- Bow anglers
- Baited box nets

Deal Lake Carp Contest

- Held annually
- Cash prizes given for largest and greatest number of carp.
- Fish taken by local commercial fishermen for use as chum and lobster pot bait.

Recreational Fishing





Baited Box Nets

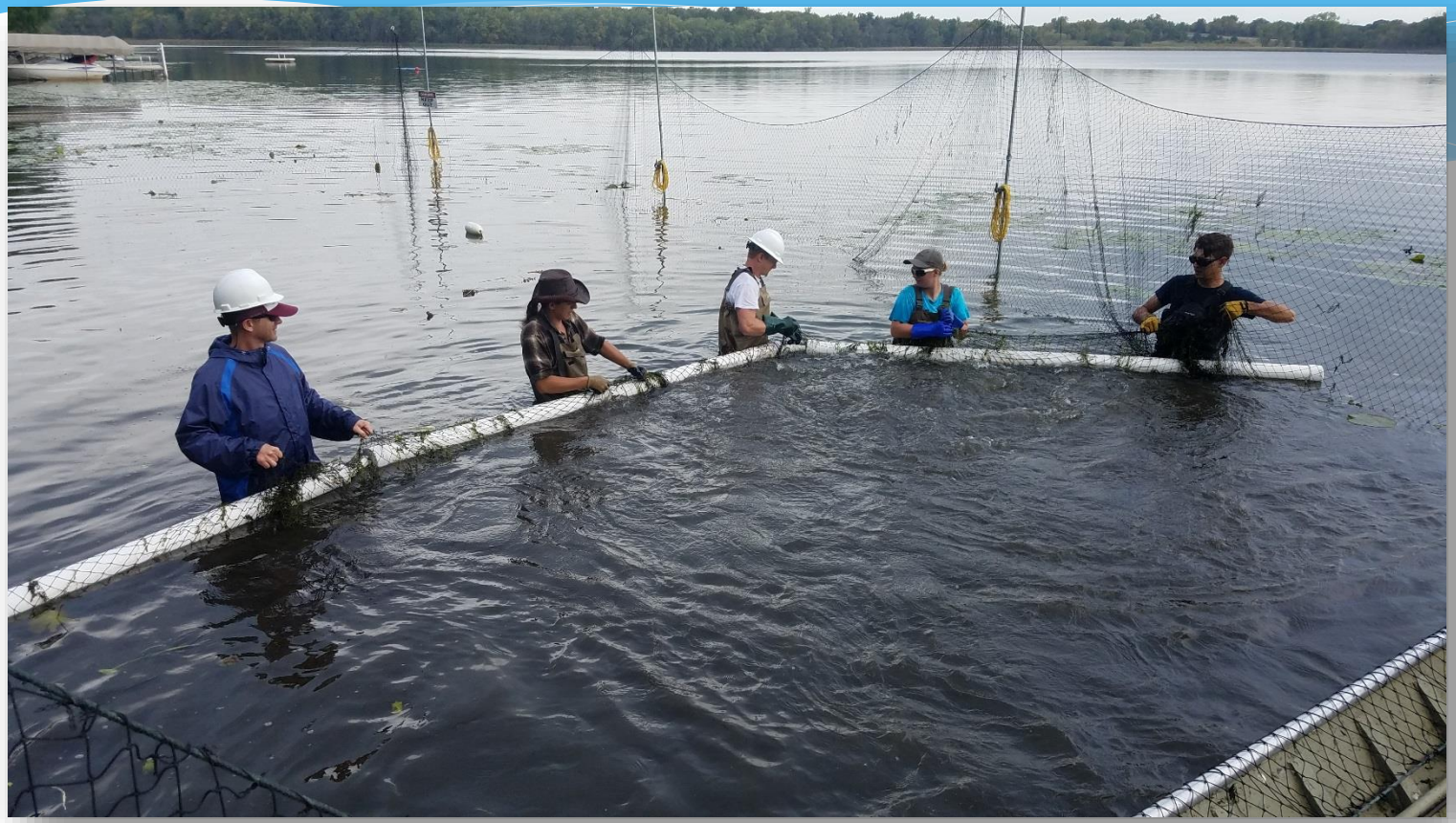


Photo Courtesy of Carp Solutions - http://carpsolutionsmn.com

Advantages of Baited Box Nets

- Fish come to you!
- Highly selective; by-catch minimal.
- Not size selective.
- High catch per unit effort.
- Relatively cost effective.

Mill Pond, NY & Deal Lake, NJ

- Proposals in place to conduct during summer of 2019 intensive carp removal effort using baited box nets.
- Nets deployed and baited with cracked corn 1 week in advance to entice carp to congregate.
- Conduct fish removal over 1 week period and repeat 2-4 weeks later.
- Collected fish go to commercial fishermen (bait) or organic farmers (fertilizer).

Summary

- Common carp invasive fish species.
- Proven ability to disrupt fishery and create water quality problems.....perhaps even HABs.
- Negative aspects of control programs
  - Prolific
  - Difficult to catch
  - Public perception
- Baited box nets promising option

Thank You….

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