



**CAPE COASTAL
CONFERENCE**

*Linking Science with Local
Solutions and Decision-Making*

River Herring Spawning and Nursery Habitat Assessment

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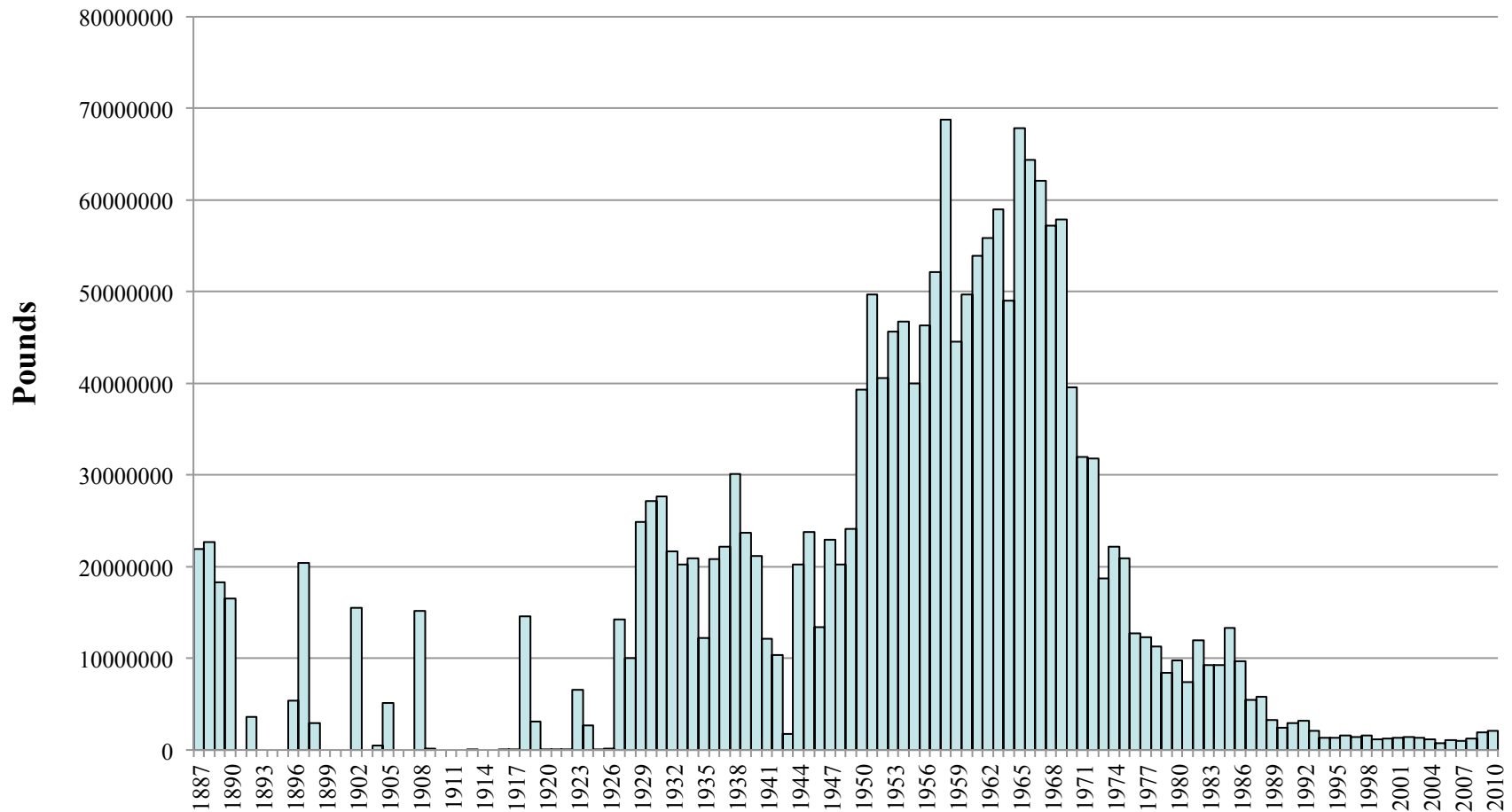
Why Migrate?

- For diadromy to evolve there must be a gain in fitness (**lifetime reproductive success**) over a life history that does not migrate
- This adaptation likely occurred either from competition within a gene pool or in response to environmental selection
- **Advantage ?** Improved survival from higher growth in the ocean or a safer place for juveniles above the tide



Herring Packers
North Harwich, Mass

US Commercial Landings of River Herring, 1887 – 2010 (millions of pounds)



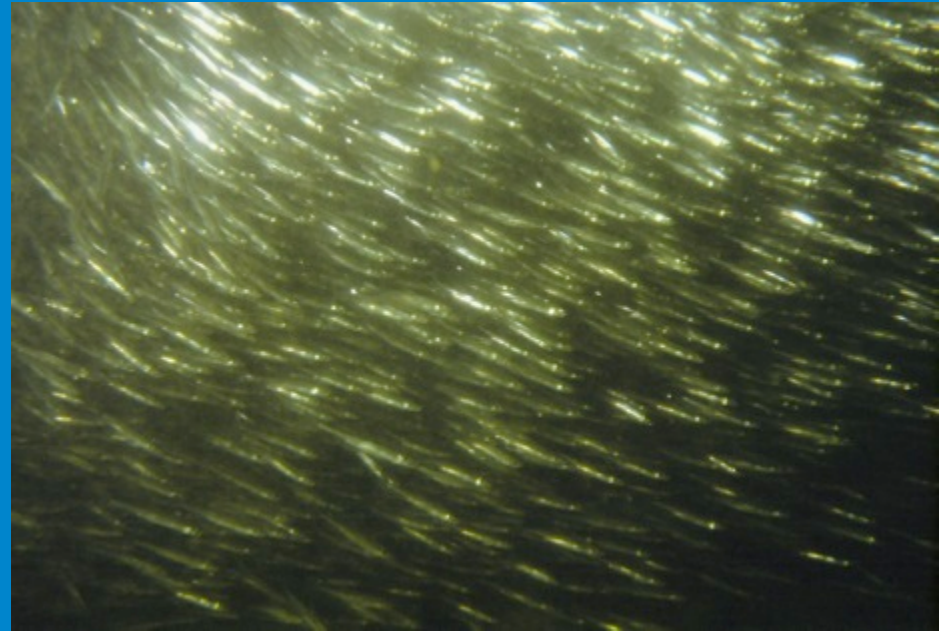
Status of River Herring

- MA harvest ban, 2006
- *ESA Species of Concern*, 2006
- ASMFC coast-wide stock assessment, 2012
- ESA Petition as Threatened Species under review, 2012



Declining Populations

- Fishing mortality
- Natural mortality
- Habitat alteration
- Climate change



Habitat Alterations

- Passage barriers
- Watershed development
- Water management
- Eutrophication



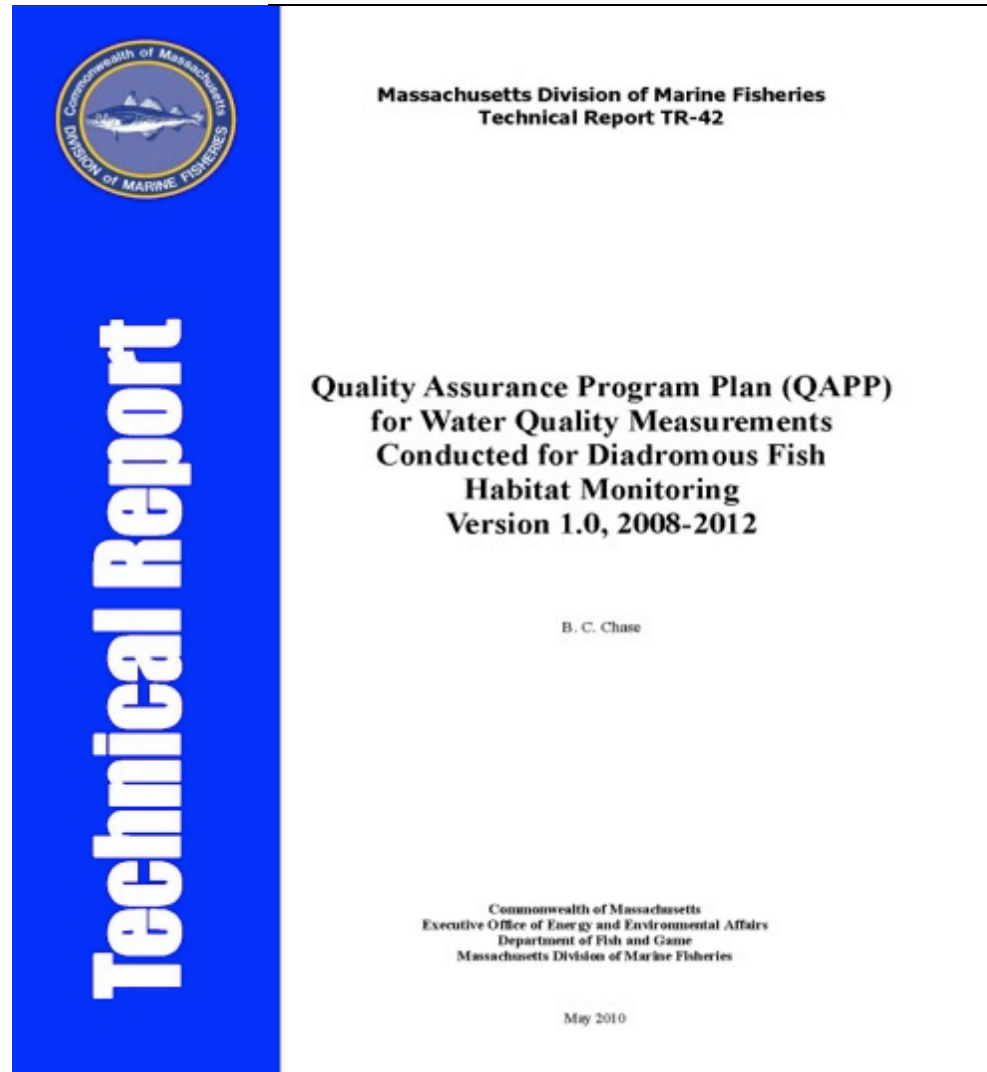


Harwich

Grassy Pond

Harwich Port

<http://www.mass.gov/dfwele/dmf/publications/technical.htm>



QAPP

Standard Operating Procedures

- 1.0 Water temperature loggers.
- 2.0 Water chemistry multi-probe sondes.
- 3.0 Rainbow smelt spawning habitat.
- 4.0 River herring spawning and nursery habitat.

QAPP Objectives

1. Provide standardized sampling protocols
2. Guidance for diadromous fish habitat restoration
3. Produce data that is acceptable to *MassDEP* waterbody assessments
4. Develop criteria for classifying and protecting diadromous fish habitat

Habitat Criteria and Classification

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graph TD; A[Habitat Criteria and Classification] --- B[Life History]; A --- C[MassDEP SWQC]; A --- D[US EPA Nutrient Criteria]
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Life History

MassDEP SWQC

US EPA Nutrient Criteria

Table 4.1 Physical, Chemical and Biotic Criteria used for River Herring Spawning and Nursery Habitat.

Variables	Suitable (SWQC or BPJ)	Minimally Impacted (25 th percentile)	Notes/Source
REFERENCE			
Temperature (°C) (July-Oct.- nursery)	≤ 28.3		Maximum limit (<i>MassDEP 2007</i>)
Temperature (°C) (May/June spawning)	≤ 26.0		Scientific literature and BPJ
Temperature (°C) (May/June spawning)	≤ 20.0 (7-day mean)		7-day mean of daily max. from logger data (<i>MassDEP 2007</i>)
pH	≥ 6.5 to ≤ 8.3		(<i>MassDEP 2007</i>)
DO (mg/L)	≥ 5.0		(<i>MassDEP 2007</i>)
Secchi disc (m)		≤ 2.0	75 th percentile; EPA Ecoregion 14, sub-84 (US EPA 2000c)
Turbidity (NTU)		≤ 1.7 (rivers only)	EPA Ecoregion 14, sub-59 (US EPA 2000b)
TN (mg/L)		≤ 0.32	EPA Ecoregion 14, sub-59 (US EPA 2000c)
TP (ug/L)		≤ 8.0	EPA Ecoregion 14, sub-59 (US EPA 2000c)
Chlorophyll <i>a</i> (ug/L)		≤ 4.2	EPA Ecoregion 14, sub-59 (US EPA 2000c)
QUALITATIVE			
Fish Passage	BPJ		SOP Section 4.0
Stream Flow	BPJ		SOP Section 4.0
Eutrophication	BPJ		SOP Section 4.0

Other Assessment Data

- conductivity and turbidity
- substrate composition (%)
- Carlson Trophic State Index
- presence of invasive plant
- presence of other diadromous fish

Complete or Ongoing Assessments

Large Reservoirs

Great Pond Reservoir, Braintree
First Herring Brook, Scituate
Whitman's Pond, Weymouth
Silver Lake, Kingston

Shallow – Natural

Cedar Lake, Falmouth
Bourne Pond, Falmouth
Blackwater Pond, Kingston
Chebacco Lake, Essex

Large Impoundments

Lake Sabbatia, Taunton
Pentucket Pond, Newbury
Sunset Lake, Braintree
Upper Mystic Lake, Medford

Shallow- Artificial

5 Cape Cod Ponds
Hathaway Pond, Rochester
Leonard's Pond, Rochester
Tashmoo Pond, MV
Old Oaken Bucket Pond, Scituate

Upper Mystic Lake, Medford, MA



Figure 1. River herring habitat assessment stations in the Upper Mystic Lake.



Figure 2. Water temperature measurements taken at Upper Mystic Lake. Station averages are presented (\pm 2 SE) for 2007 (blank bars) and 2008 (striped bars). The sample size range for each bar is 3-5.

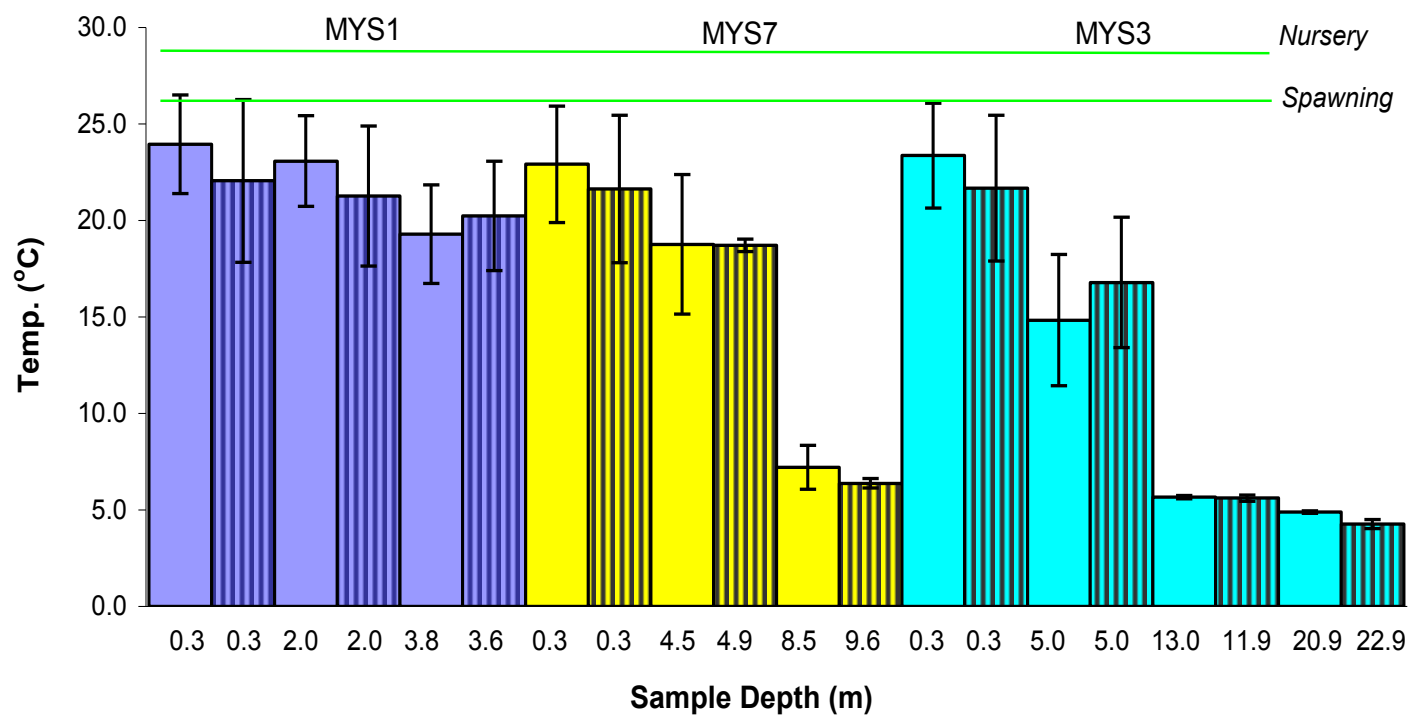
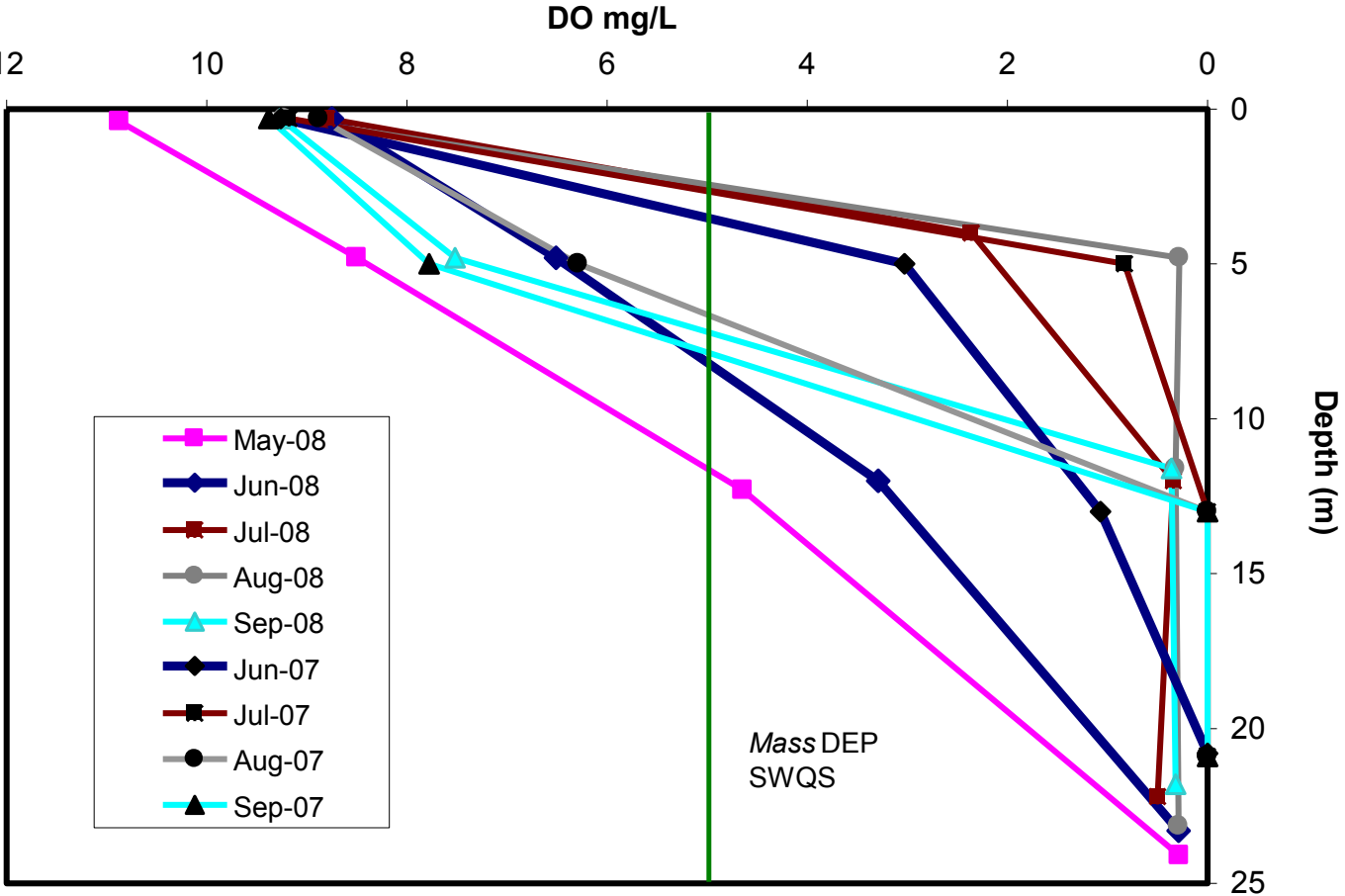
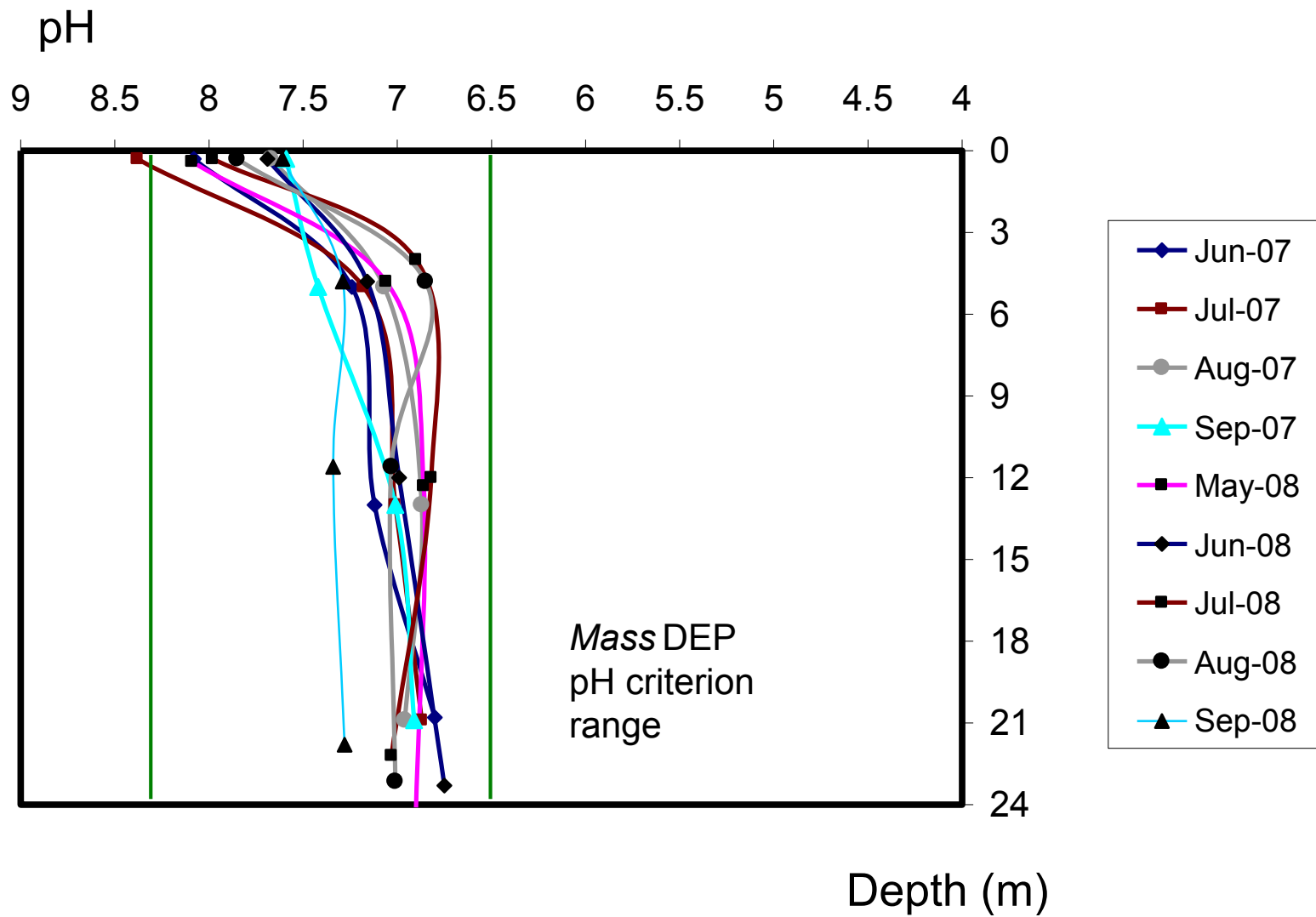


Figure xx. Water column profiles for dissolved oxygen at station MYS3 in the Mystic Upper Lake, 2007-2008. The measurements made in 2007 are marked with black symbols.





Summary of river herring habitat assessment at the Upper Mystic Lake, 2007-2008.

Parameter	Units	Sample Size (No.)	Acceptable Criteria	Exceedance (%)	Classification
Temp. (nursery)	°C	50	<28.3	0	<i>Suitable</i>
Temp. (spawning)	°C	27	<26.0	1	<i>Suitable</i>
DO	mg/L	70	>5.0	26	<i>Impaired</i>
pH	SU	87	6.5 to <8.3	3	<i>Suitable</i>
Secchi	m	26	>2.0	35	<i>Impaired</i>
N+N	mg/L	10	<0.32	100	<i>Impaired</i>
TP	ug/L	10	<8.0	100	<i>Impaired</i>
Fish Passage	NA	9	BPJ	100	<i>Impaired</i>
Stream Flow	NA	9	BPJ	100	<i>Impaired</i>

Notes:

1. Bottom measurements were excluded from DO classification due to QAPP exemption.
2. *Impaired* classifications result from exceedances >10% at transect stations during two seasons.
3. The US EPA TN criterion was adopted for N+N measurements.

Upper Mystic Lake Summary

- Upper Mystic Lake was classified as **Impaired** for all parameters except temperature and pH
- However, spawning and nursery functions were supported in parts of the Lake
- Enlarged hypolimnion likely due to eutrophication, damming and historic pollution sources

Great Pond Reservoir, Braintree



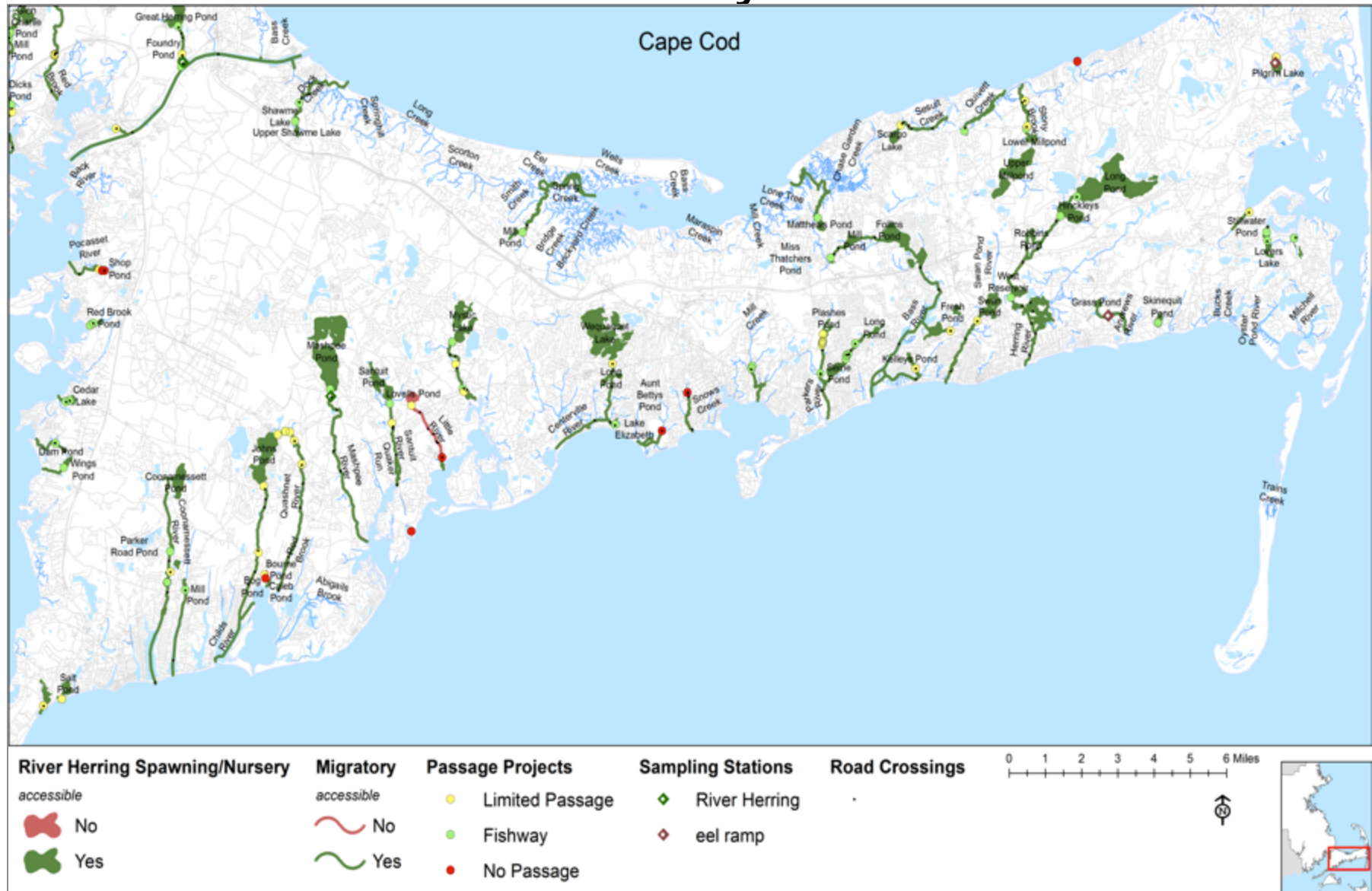
Summary of river herring habitat assessment criteria for Great Pond Reservoir, Braintree, 2008/2010.

Parameter	Units	Sample Size (No.)	Acceptable Criteria	Exceedance (%)	Classification
Temp. (nursery)	°C	31	≤28.3	0	<i>Suitable</i>
Temp. (spawning)	°C	41	≤26.0	0	<i>Suitable</i>
DO	mg/L	64	≥5.0	2	<i>Suitable</i>
pH	SU	74	6.5 to ≤8.3	1	<i>Suitable</i>
Secchi	m	18	≥2.0	0	<i>Suitable</i>
TN	mg/L	5	≤0.32	40	<i>Impaired</i>
TP	ug/L	5	≤8.0	20	<i>Impaired</i>
Eutrophication	NA	10	BPJ	0	<i>Suitable</i>
Fish Passage	NA	10	BPJ	100	<i>Impaired</i>
Stream Flow	NA	10	BPJ	100	<i>Impaired</i>

Notes:

Bottom DO measurements at deep stations in stratified lakes are excluded due to QAPP exemption.
Impaired classifications result from exceedancesf >10% for transect stations during two seasons.

Diadromous Fish – GIS Transportation Datalayer



Cedar Lake, Falmouth



Red Brook, Bourne



-- NRCS Cape Cod Water Resources Restoration Projects

Summary of river herring habitat assessment criteria for Cedar Lake, Falmouth, 2011-2012.

Parameter	Units	Sample Size (No.)	Acceptable Criteria	Exceedance (%)	Classification
Temp. (nursery)	°C	24	≤28.3	0	<i>Suitable</i>
Temp. (spawning)	°C	36	≤26.0	0	<i>Suitable</i>
DO	mg/L	60	≥5.0	5%	<i>Suitable</i>
pH	SU	60	6.5 to ≤8.3	42%	<i>Impaired</i>
Secchi	m	13	≥2.0	100%	<i>Impaired</i>
TN	mg/L	10	≤0.32	80%	<i>Impaired</i>
TP	ug/L	10	≤8.0	100%	<i>Impaired</i>
Fish Passage	NA	10	BPJ	70%	<i>Impaired</i>
Stream Flow	NA	10	BPJ	0	<i>Suitable</i>

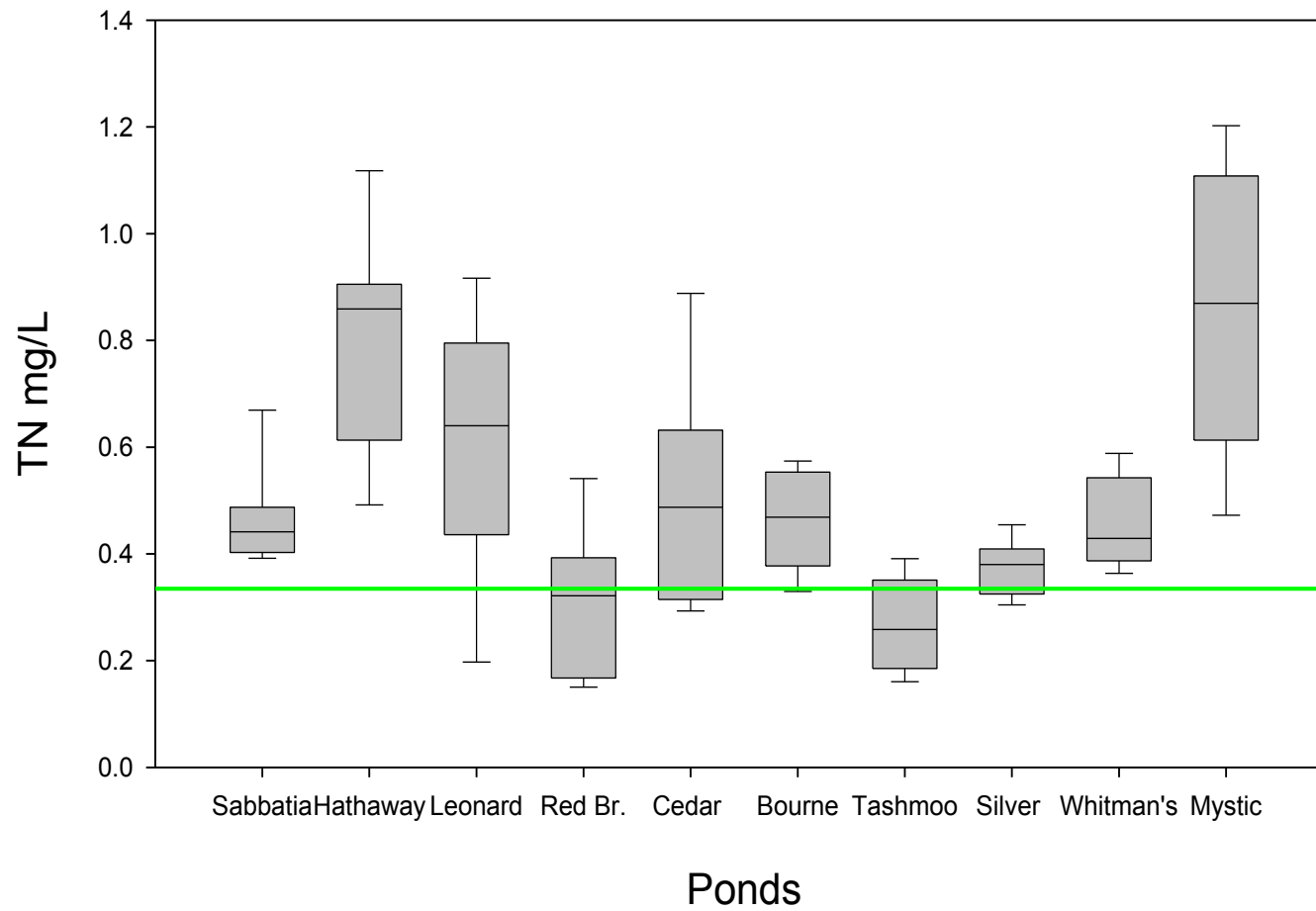
Classification Rules (QAPP page 57). All transect station samples for May-September during both seasons are pooled. Criteria exceedances for temperature, pH, DO and secchi disc ≤10% of the sample size for each parameter result in a *Support* classification.

Summary of river herring habitat assessment criteria for Red Brook, Bourne, 2010-2011.

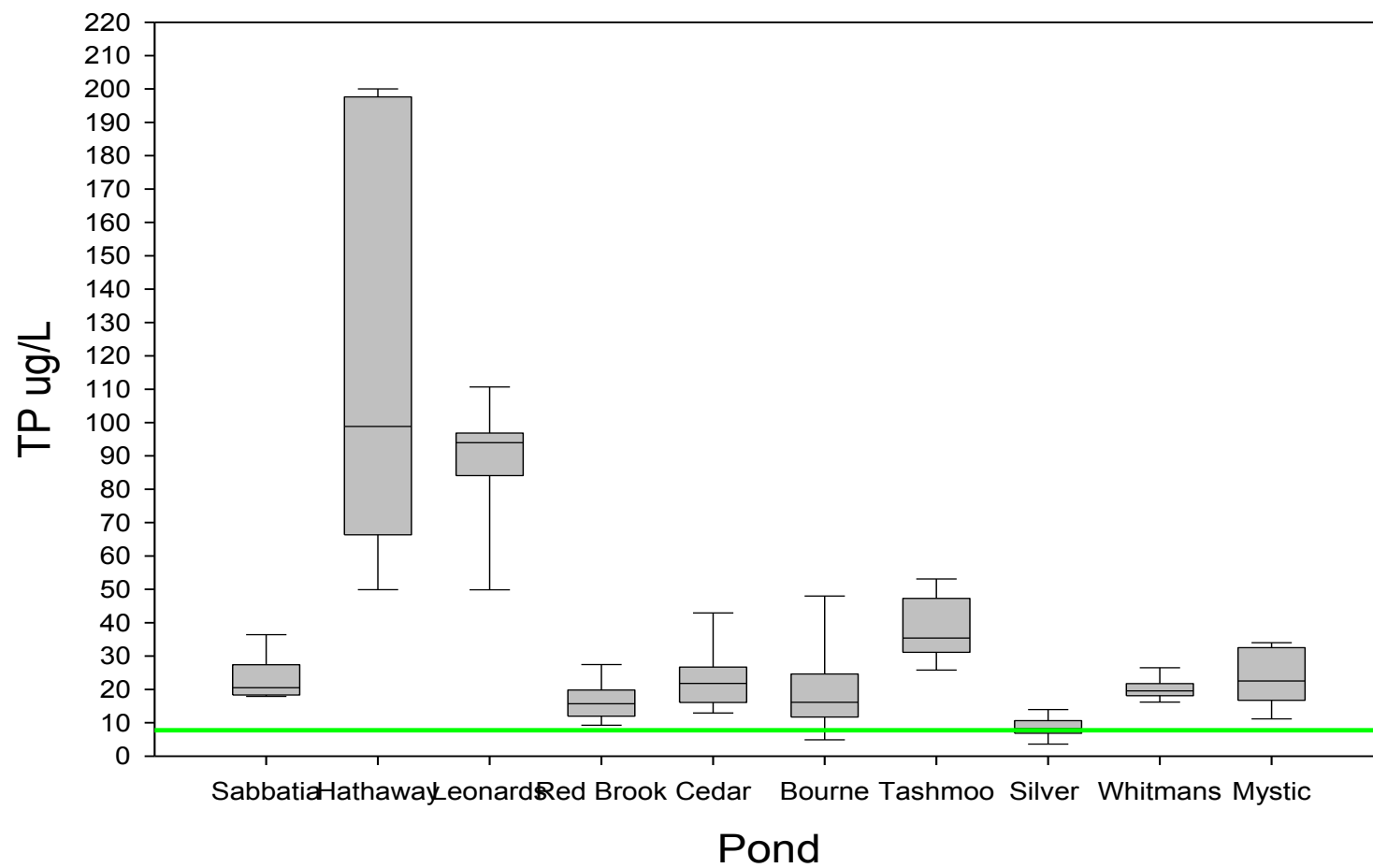
Parameter	Units	Sample Size (No.)	Acceptable Criteria	Exceedance (%)	Classification
Temp. (nursery)	°C	41	≤28.3	0	<i>Suitable</i>
Temp. (spawning)	°C	26	≤26.0	0	<i>Suitable</i>
DO	mg/L	67	≥5.0	10.4%	<i>Impaired</i>
pH	SU	67	6.5 to ≤8.3	42%	<i>Impaired</i>
Secchi	m	10	≥2.0	30%	<i>Impaired</i>
TN	mg/L	10	≤0.32	50%	<i>Impaired</i>
TP	ug/L	10	≤8.0	93%	<i>Impaired</i>
Fish Passage	NA	10	BPJ	30%	<i>Impaired</i>
Stream Flow	NA	10	BPJ	0	<i>Suitable</i>

Classification Rules (QAPP page 57). All transect station samples for May-September during both seasons are pooled. Criteria exceedances for temperature, pH, DO and secchi disc ≤10% of the sample size for each parameter result in a *Support* classification.

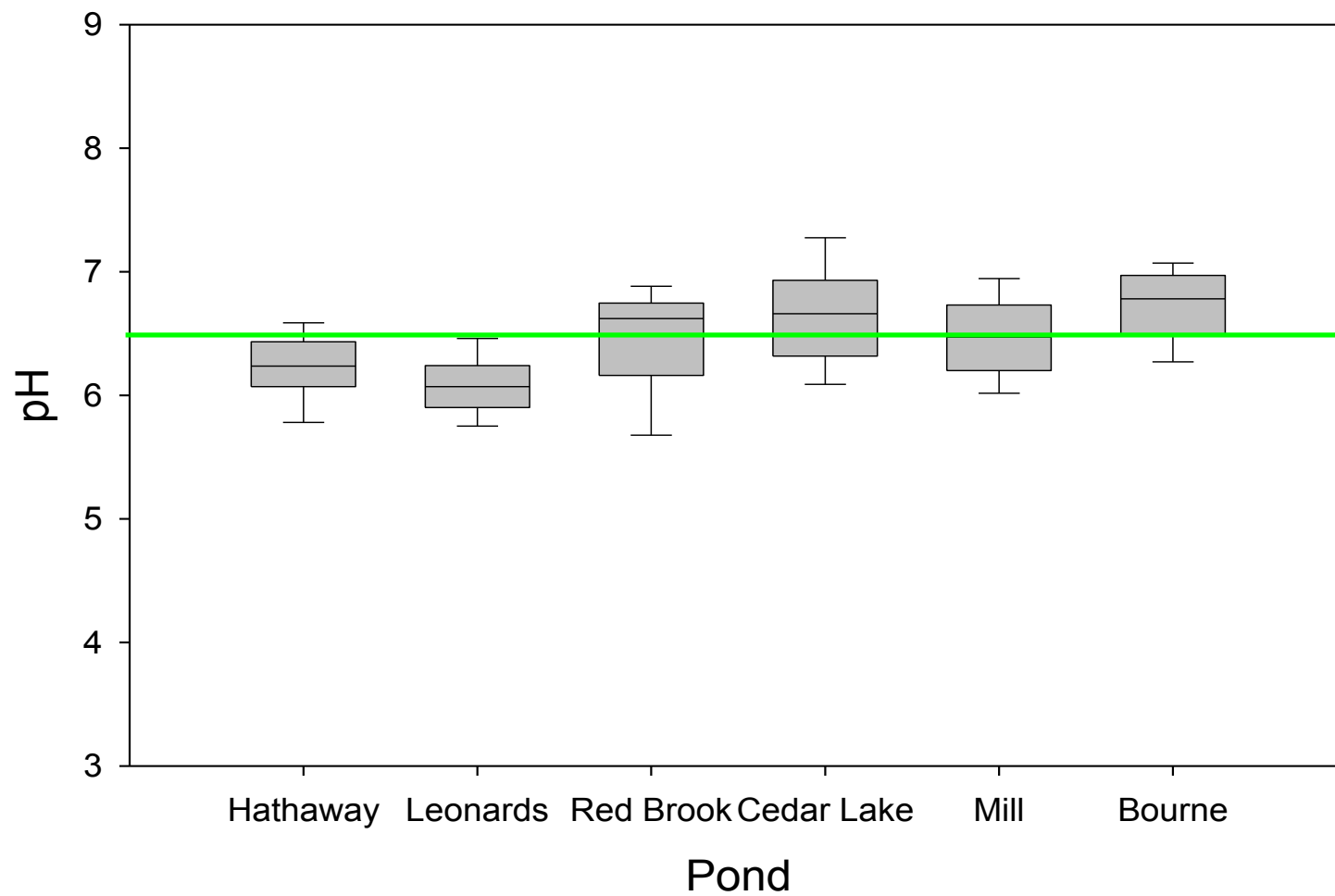
Total Nitrogen



Total Phosphorus



Mill Pond pH



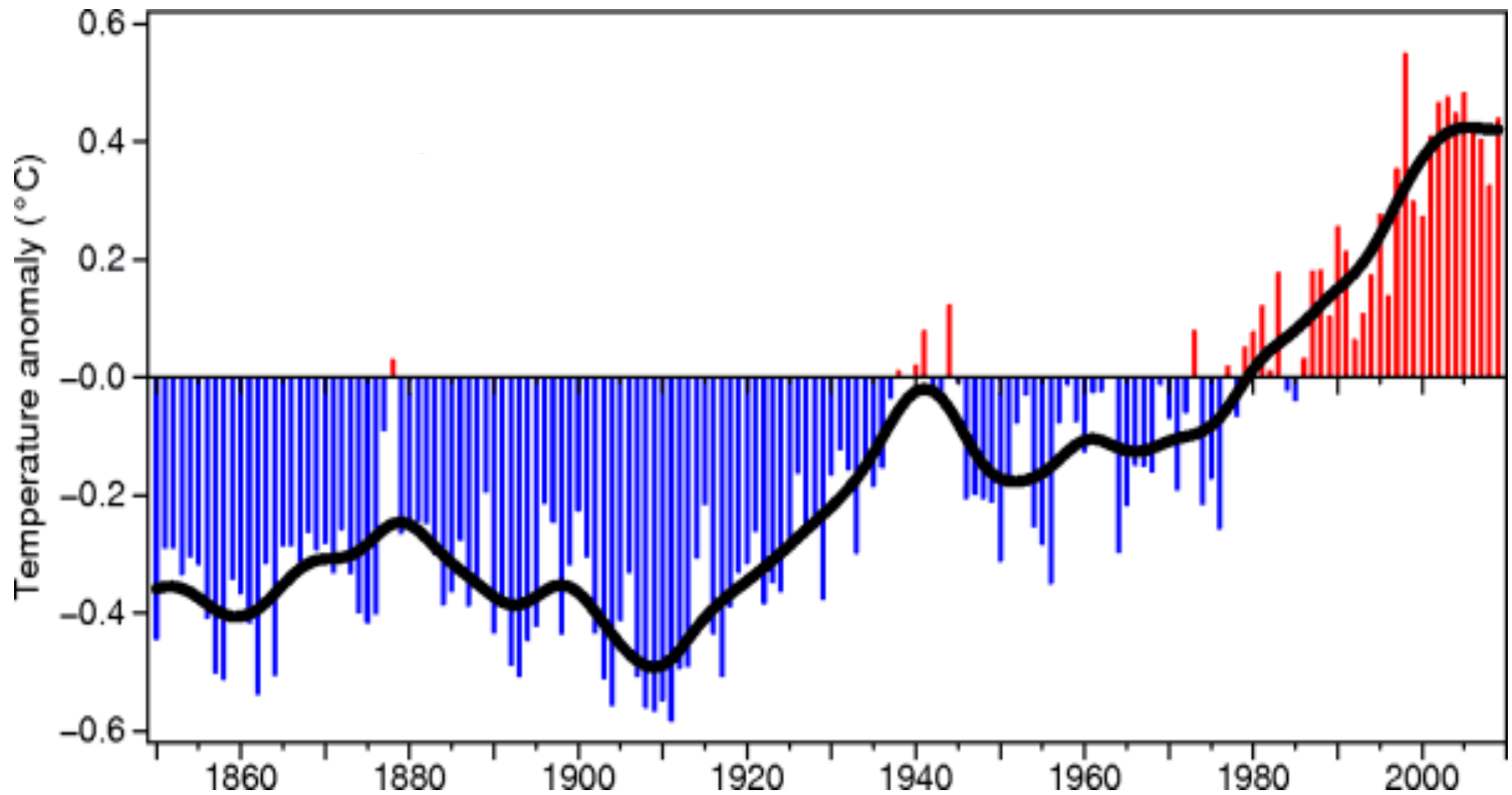
Observations to Date

1. Common impairment for DO, pH, TN and TP
2. Portions of each assessed water body has suitable habitat for river herring early life stages
3. Concerns raised over impact of hypolimnion in stressed lakes and ponds on recruitment
4. Common stream flow limitations

Next Steps

- Include assessments in management process
- Begin evaluating regional data distributions; including correlations to waterbody type, landscape features and spawning run counts
- Review literature for advances in data on biological thresholds for water chemistry
- Update QAPP (5-year version)

Global Mean Air Temperature



Source: NCDC/NESDIS/
NOAA