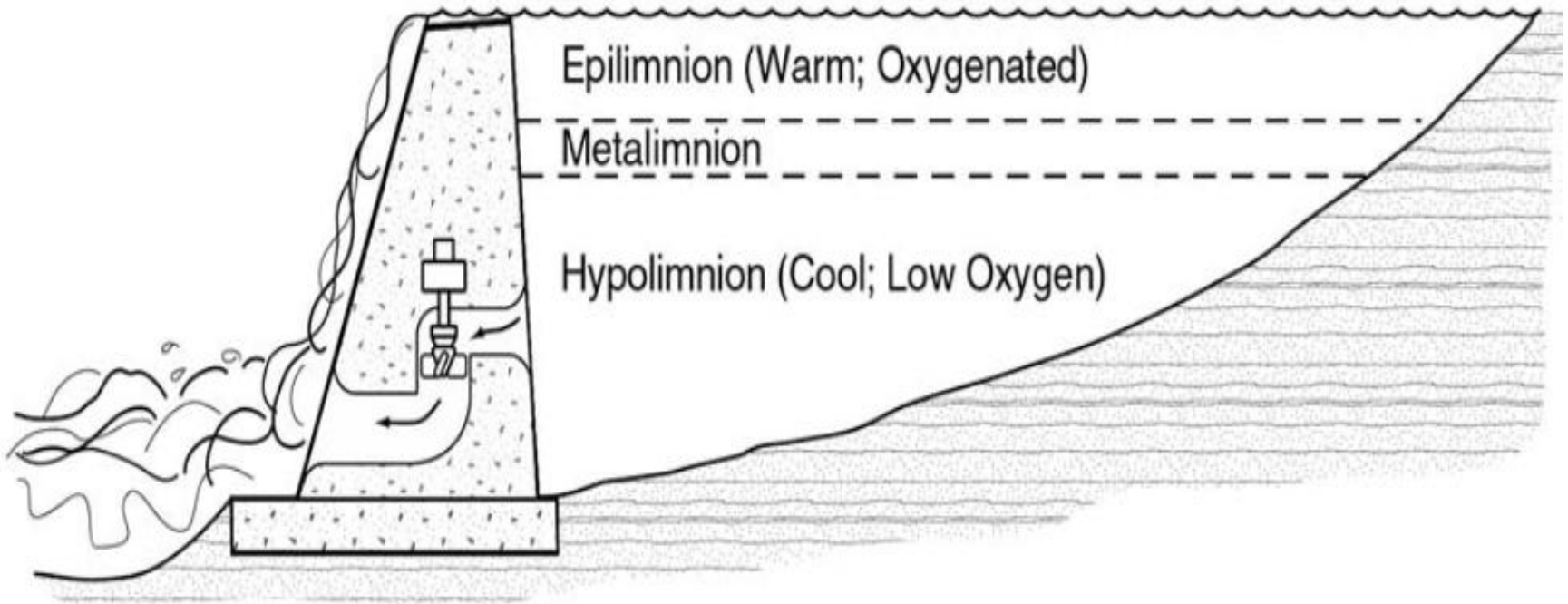


A Summary of the Use of
Hypolimnetic Discharge Systems
at Sport Fishing Waters
in North Dakota



Schematic of a HDS



Background and Rationale for the Use of HDS

- The majority of sport fishing waters in ND have water quality problems, as evidenced by excessive nutrient concentrations, algal blooms & aquatic vegetation, low dissolved oxygen concentrations, and frequent fish kills.
- Reducing sediment and nutrient inputs is critically important at virtually all sport fishing waters in ND.
- Good water quality is beneficial to the sport fishery, and thus to anglers and other recreational users.
- Timely operation of HDS can, in some instances, help to alleviate some of these problems.



9/12/2008



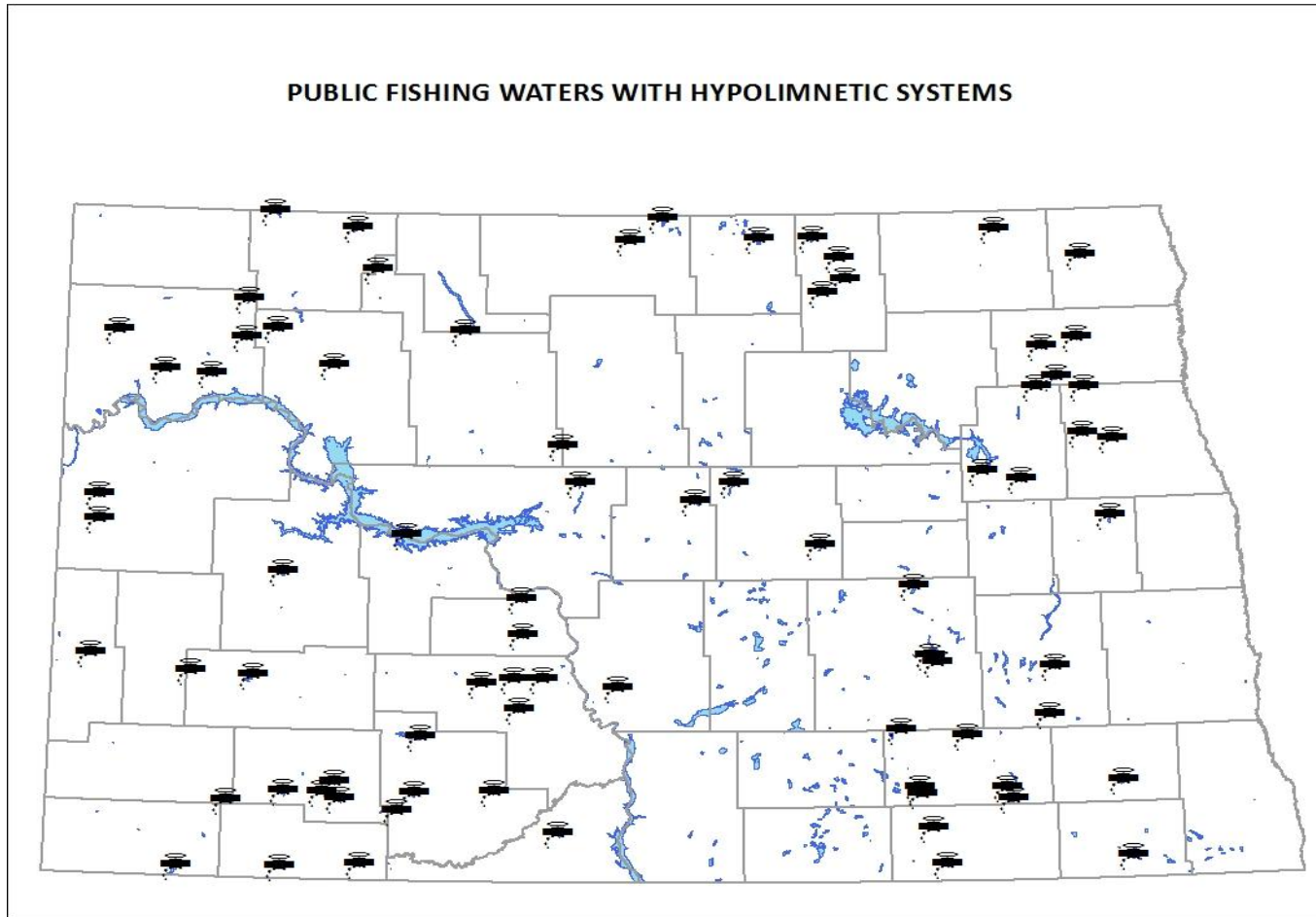
9/02/2009



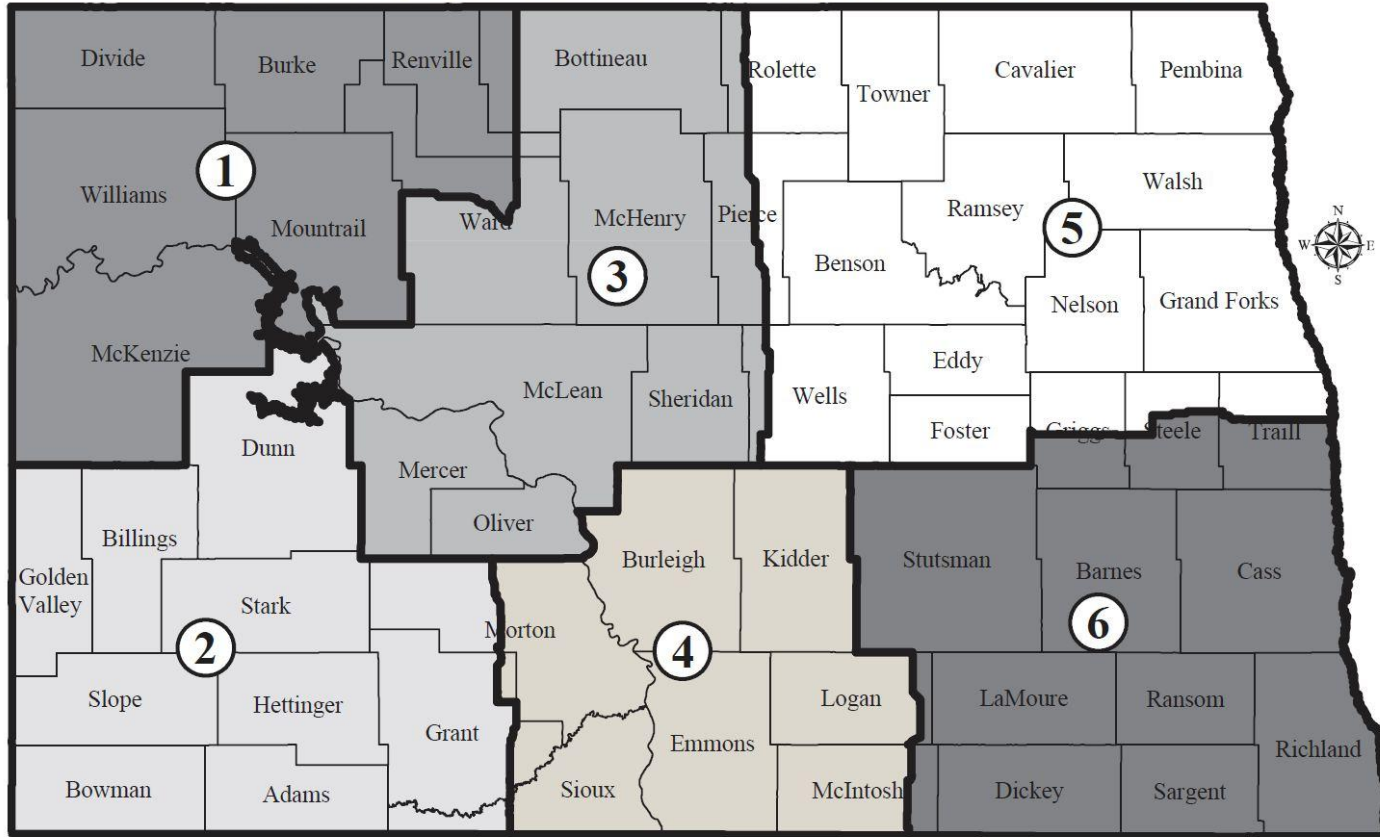




Most mid-sized and larger reservoirs in ND have HDS:
i.e. Sakakawea, Darling, Pipestem, Jamestown Res, Heart Butte, Dickinson Res.
each of which is operated federally (CE, BoR, F&WS) for multiple purposes.



NORTH DAKOTA GAME & FISH FISHERIES DISTRICTS



HDS by
Fisheries
Management
District

Total = 60

DISTRICT 1: Fred Ryckman (Williston)

DISTRICT 2: Jeff Hendrickson (Dickinson)

DISTRICT 3: Jason Lee (Riverdale)

DISTRICT 4: Paul Bailey (Bismarck)

DISTRICT 5: Randy Hiltner (Devils Lake)

DISTRICT 6: Gene Van Eeckhout (Jamestown)

1 = 11

3 = 6

5 = 14

2 = 13

4 = 4

6 = 12

The largest HDS in ND is incorporated into Garrison Dam; discharge $>100,000$ cfs
Several of the smallest HDS in ND discharge less than 1 cfs.



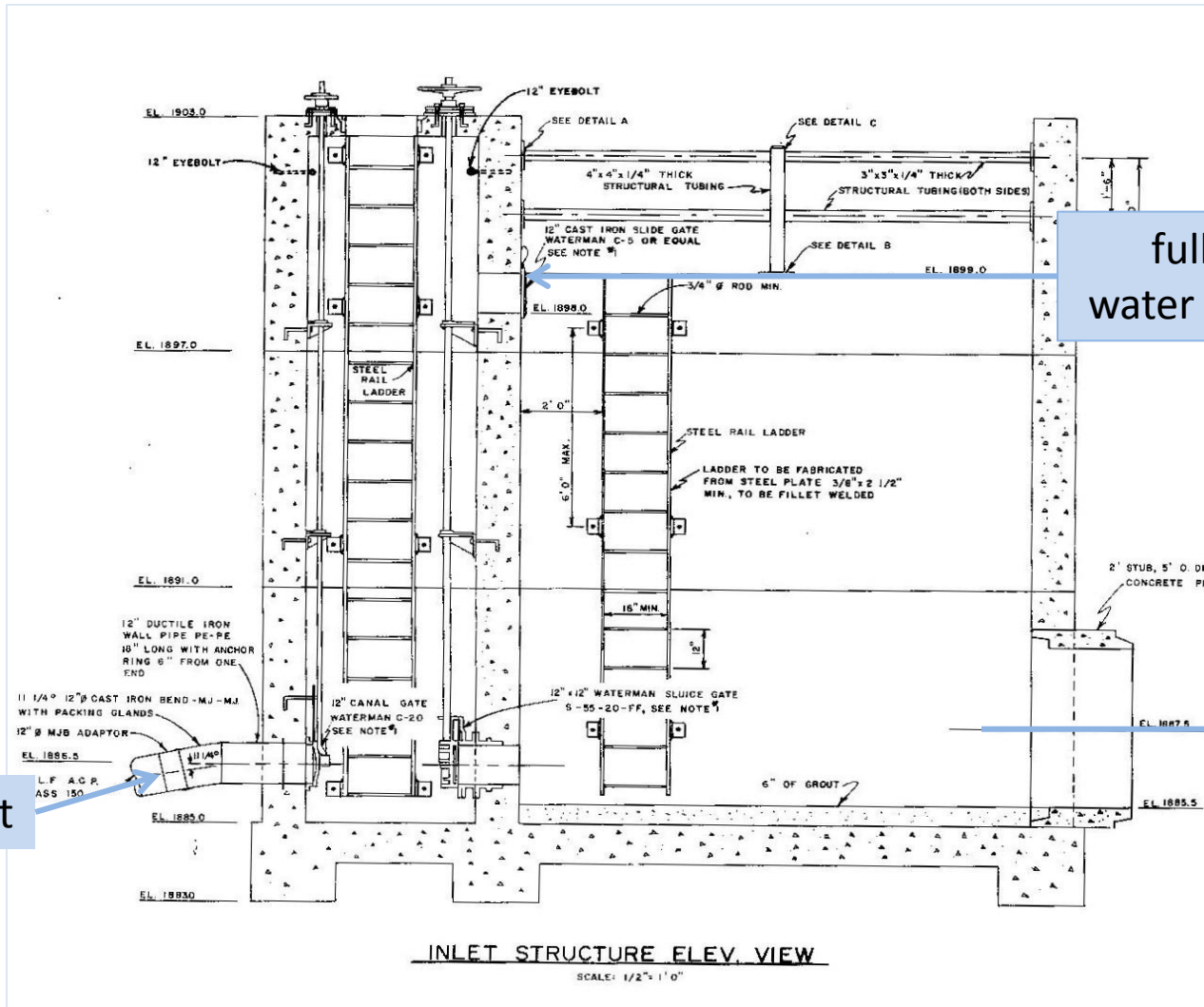
Protocol & Operational Guidelines

Timely operations of HDS may be beneficial when:

- Sediment and nutrient inputs from the watershed are limited (or at least don't overwhelm the system!).
- An appreciable volume of anoxic and nutrient rich water seasonally develops in the hypolimnion.
- “Surplus” water is available to be discharged.
- Discharged water will not unduly impact downstream biota or water uses, and
- The HDS is adequately sized in terms of discharge:
(should have *the capability to discharge 10% of the lake's volume in a 14-day period.*)



Northgate Dam



full pool water elevation

spillway outlet

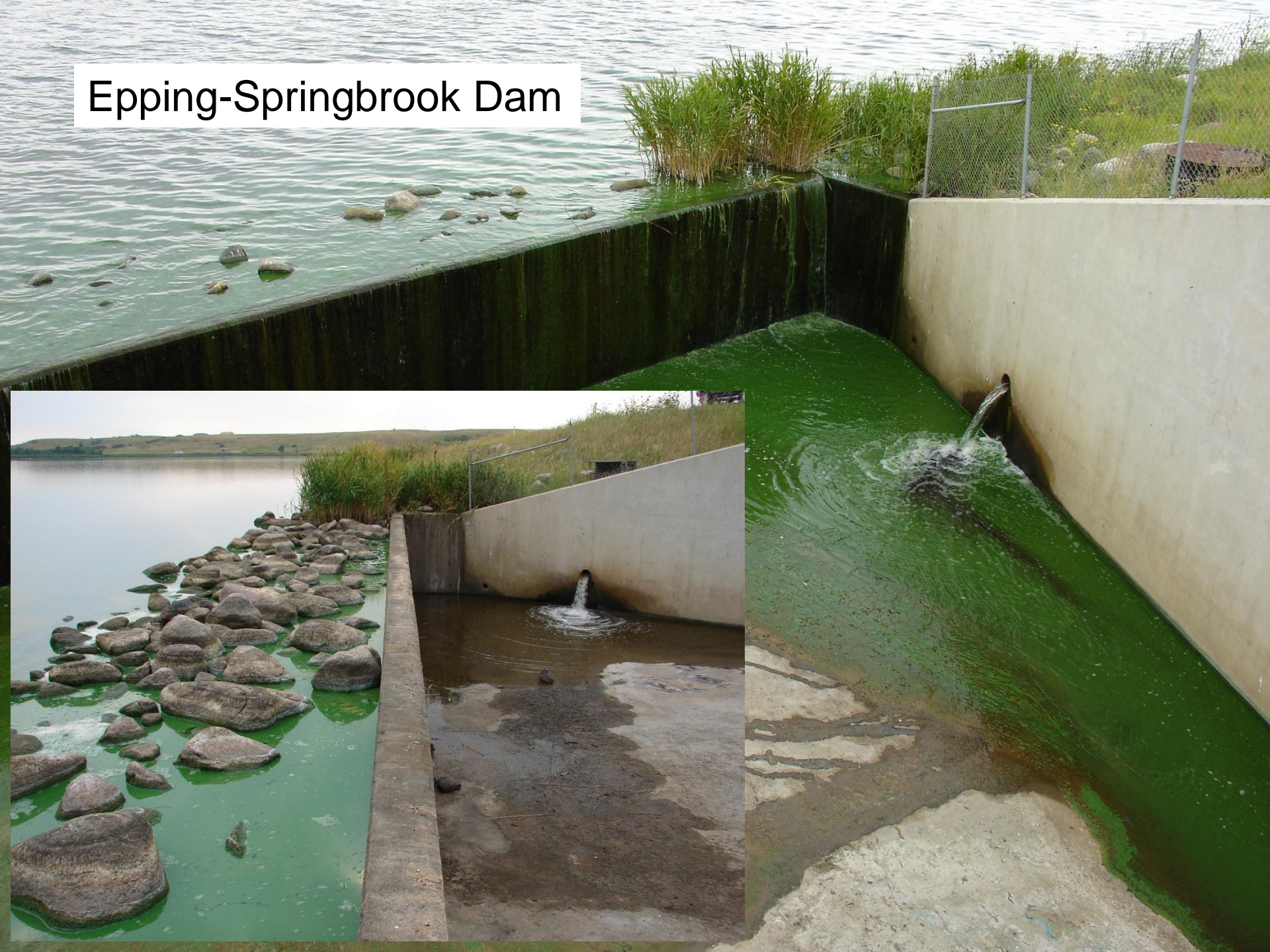
HDS inlet

Sweetbriar Dam





Epping-Springbrook Dam



Final Report

THE BREWER LAKE STUDY
1974 - 1979

Erie, North Dakota 58029

A six-year study of primary productivity and the associated chemical and physical cycles in Brewer Lake (Erie Dam)

Gabriel W. Comita
Department of Zoology
North Dakota State University
Fargo, North Dakota 58105

Submitted
August 31, 1981

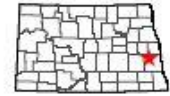
Brewer Lake

Cass County

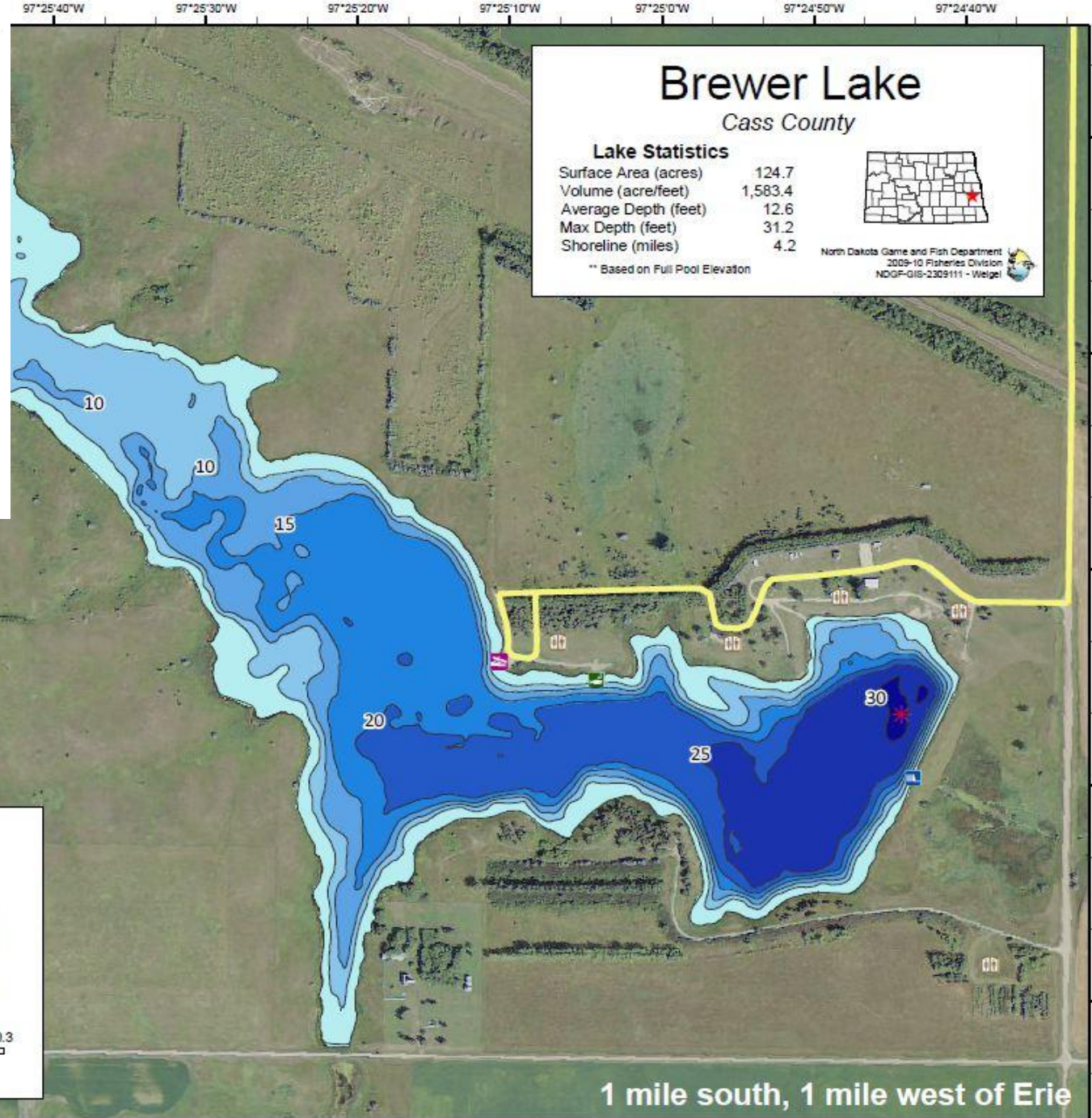
Lake Statistics

Surface Area (acres)	124.7
Volume (acre/feet)	1,583.4
Average Depth (feet)	12.6
Max Depth (feet)	31.2
Shoreline (miles)	4.2

** Based on Full Pool Elevation



North Dakota Game and Fish Department
2009-10 Fisheries Division
NDGF-GIS-2309111 - Weigel

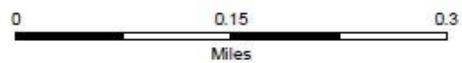


Map Features

- Boat Ramp
- Fishing Pier
- Vault Toilet
- Water Control Structure
- Max. Depth
- 5 ft contours

Depth (feet)

- 0-5
- 5-10
- 10-15
- 15-20
- 20-25
- 25-30
- >30



1 mile south, 1 mile west of Erie

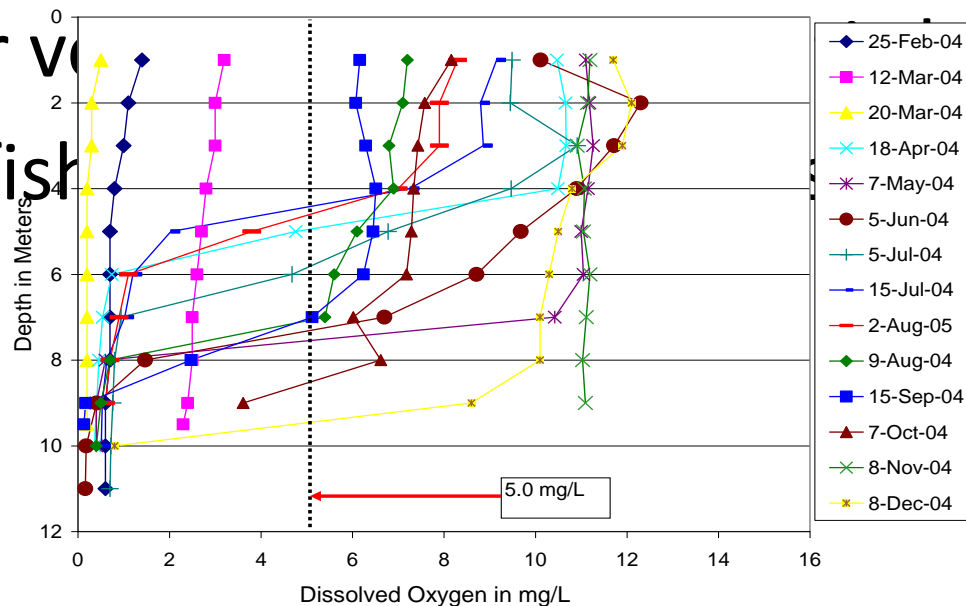
Results of Brewer Lake Study

- The lake exhibited two strong cycles of primary productivity (excessive algal blooms) every year.
- The strongest stratification developed by mid-July in most years. Rapid destabilization of the water column resulted in a significant fish kill in July 1974.
- HDS operations helped to destabilize the water column, resulting in increased circulation of nutrients (due primarily to wind action, which averaged 12.5 mph).
- HDS releases progressively reduced the pool of anoxic water; after the first three years only a limited volume was detected and then for only a short period of time.

Benefits of HDS Operations:

- Reduced nutrient concentrations, which result in less algal growth & aquatic vegetation.
- Improved dissolved oxygen concentrations, thus

- A larger volume of water is available as habitat, thus
- Better fish habitat.



103°37'30"W

103°37'20"W

48°36'30"N

48°36'30"N

103°37'30"W

103°37'20"W

KETTLE LAKE

Williams County



HDS outlet

HDS inlet

Lake Statistics	
Surface Area (acres)	7.3
Volume (acre/feet)	109
Average Depth (feet)	14.9
Max Depth (feet)	34.3
Shoreline (miles)	0.4

Depth (feet)

- 0-5
- 5-10
- 10-15
- 15-20
- 20-25
- 25-30
- >30

— 5 ft contours

* Based on Full Pool Elevation

Map Features

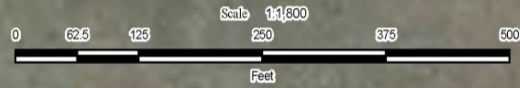
- Boat Ramp
- Fishing Pier
- Vault Toilet
- Bottom Water Pump System

Roads

- Trail
- State Hwy



3 MI E, 2 1/2 MI N OF ZAHL



North Dakota Game and Fish Department
2004-05 Fisheries Division
NDGF-GIS-2304061.067.1-Krapp

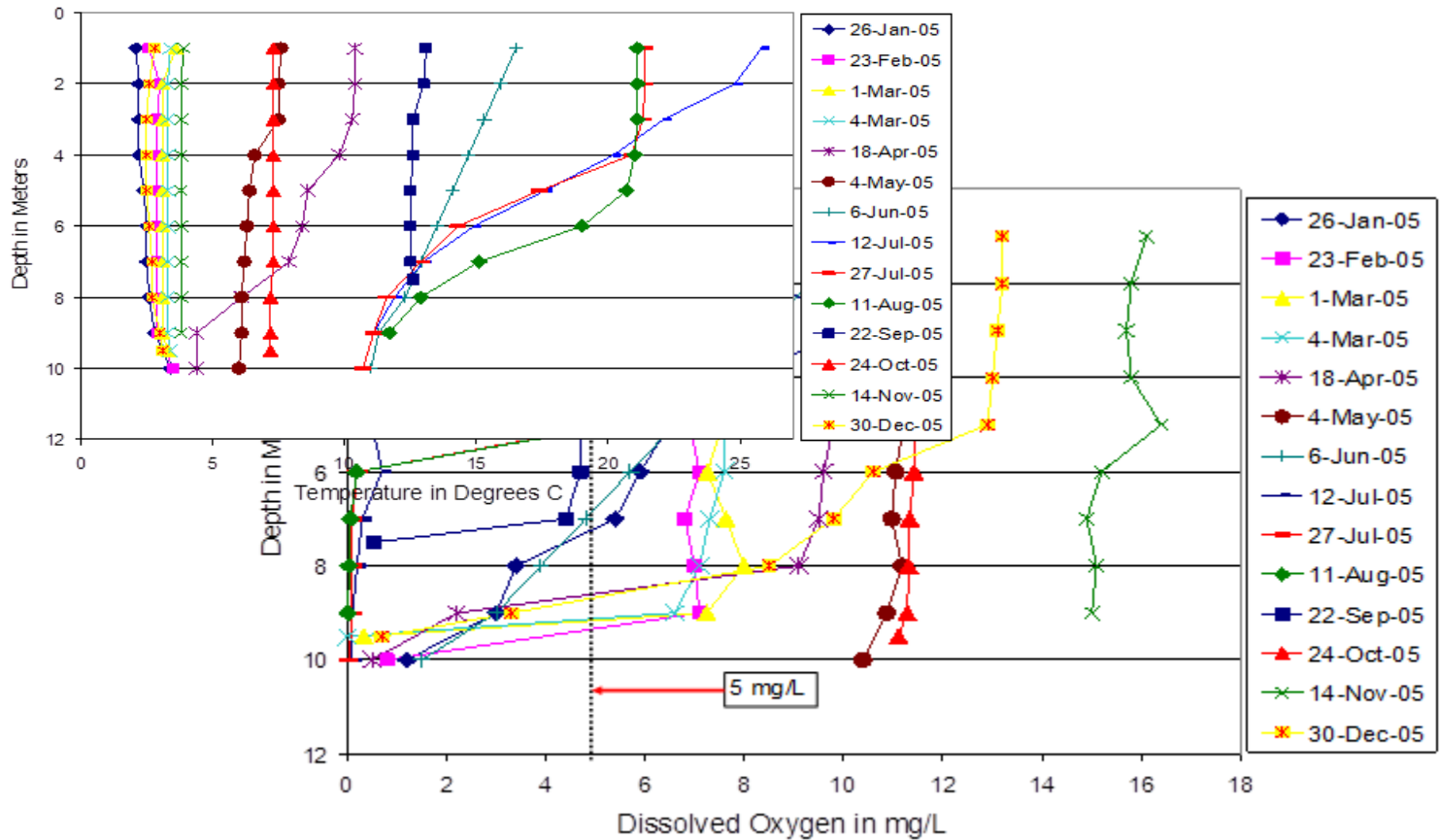
5/11/2009



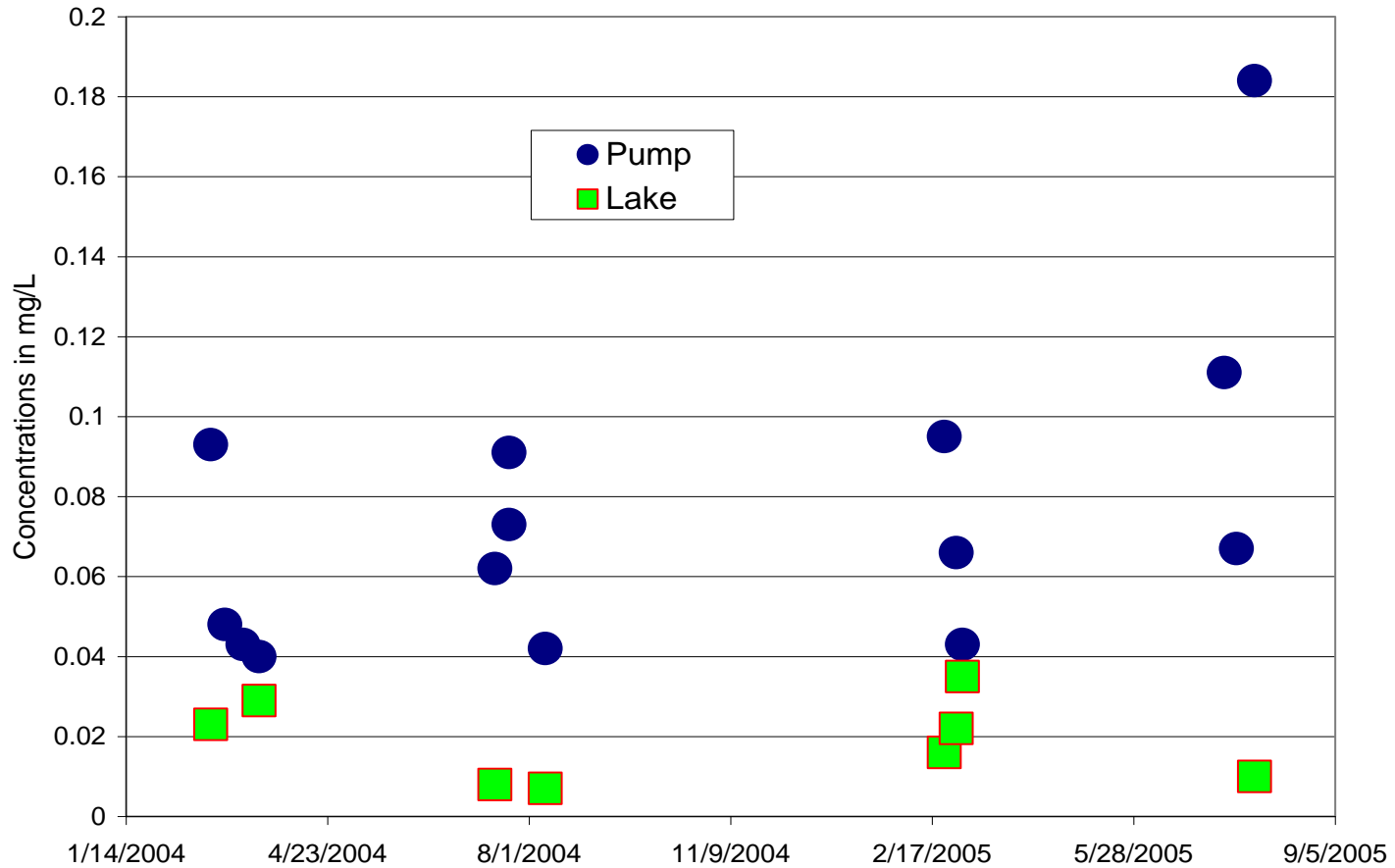
Goals of sampling and analysis plan of Kettle Lake HDS

- Measure the effectiveness of the system in reducing nutrients, internal cycling, oxygen depletion & primary production.
- Identify the most effective period and length of time to run the HDS pump.

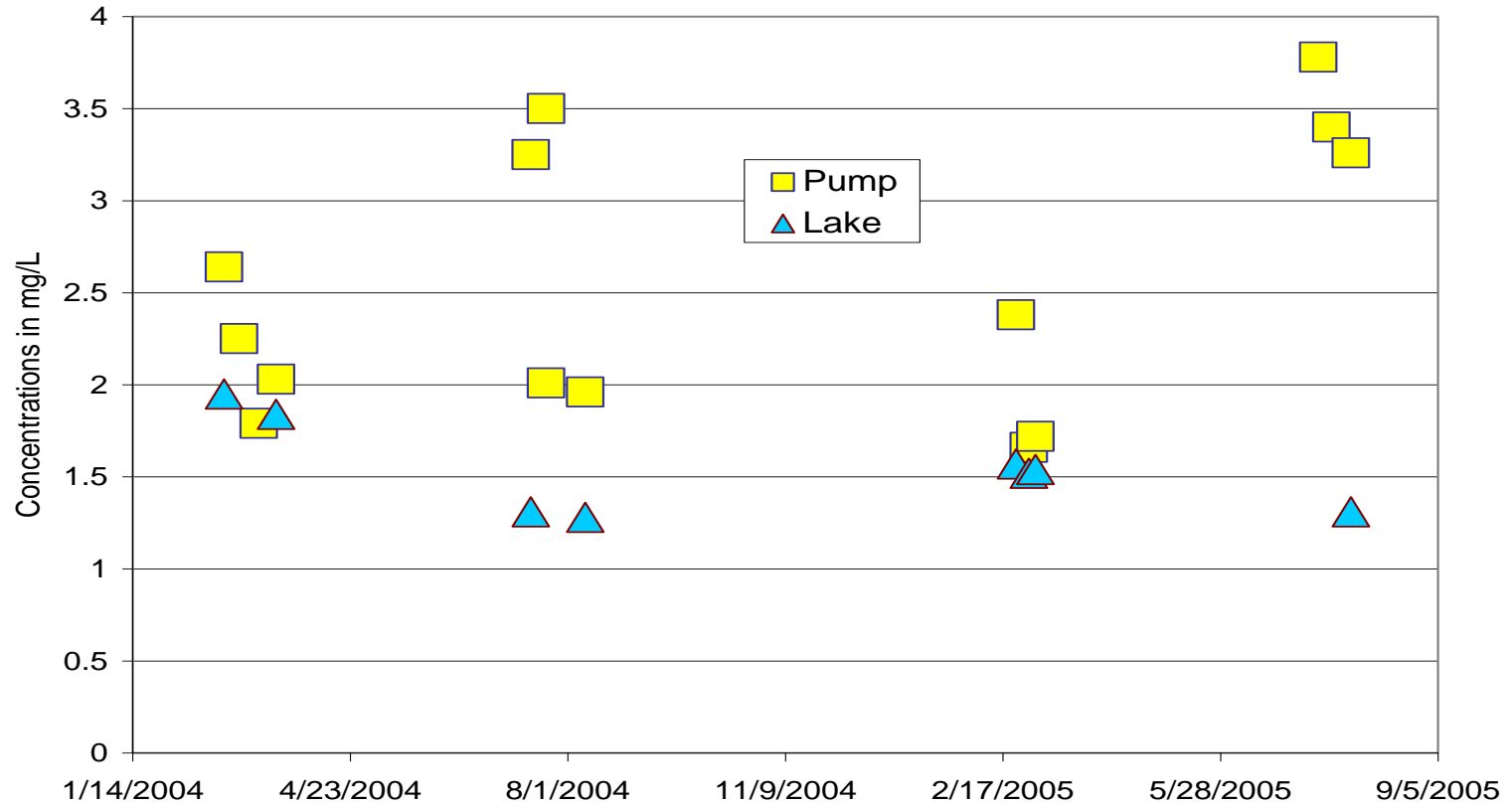
Kettle Lake's Temperature & Dissolved Oxygen Profiles, 2005



Difference in Lake Volume Weighted Mean Concentration and the Concentration of Total Phosphorus Discharged by the HDS Pump



Difference in Lake Volume Weighted Mean Concentration and the Concentration of Total Nitrogen Discharged by the HDS Pump



Summary Results of Kettle Lake HDS study 2004-2005

An Assessment of the Effects of Hypolimnetic Pumping on Kettle Lake's
Hydraulic and Nutrient Budgets, Trophic Response,
and Dissolved Oxygen Concentrations

Second Annual Report

Based on Data Collected by the North Dakota Game and Fish Department
February, 2004 through December, 2005

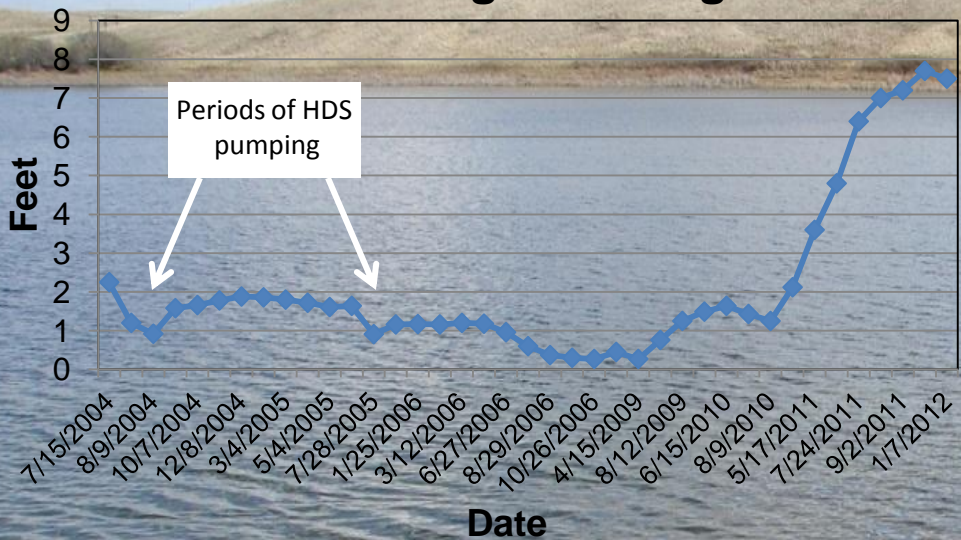
- The HDS proved to be effective in removing a significant mass of nutrients.
- The N:P ratio indicated that the lake was phosphorous limited; periods when the lake was the most strongly stratified (late summer) proved to be the most effective for removing both phosphorus and nitrogen, and also had the greatest effect on reducing dissolved oxygen depletion.
- Water quality sampling results documented the lake's immediate and temporal trophic response to the nutrient removal.
- Results indicated that a negative nutrient budget could be achieved through timely operation of the HDS.

Prepared by
Peter Wax, ND Department of Health
and
Fred Ryckman, ND Game and Fish Department

March 2006

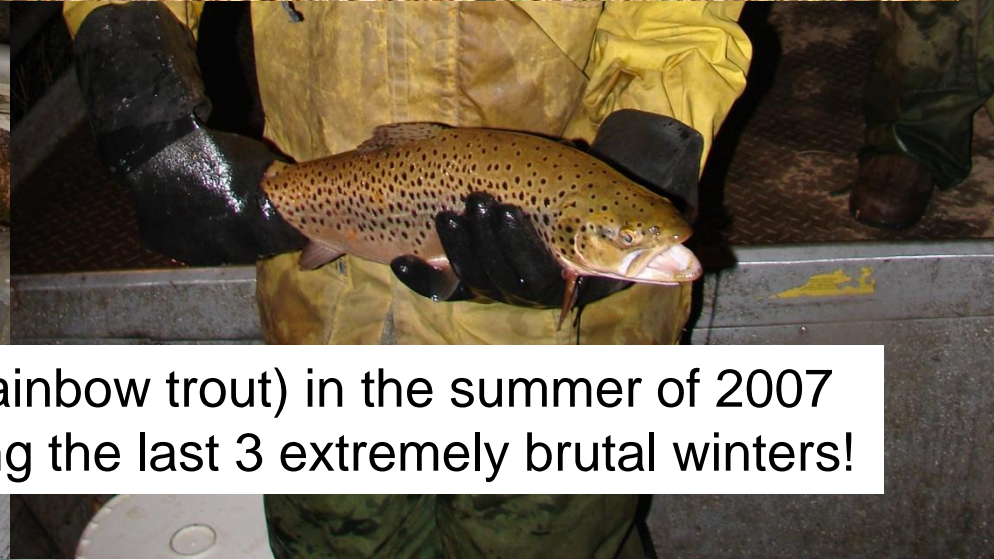
Kettle Lake Staff Gauge Readings

5/11/2009
staff gauge 0.76



October 2011 water level
staff gauge 7.7





last fish kill – a partial kill (rainbow trout) in the summer of 2007
no fish kills since, even during the last 3 extremely brutal winters!

9/2/2011

Questions??

