Thunder Bay Reef Habitat Restoration

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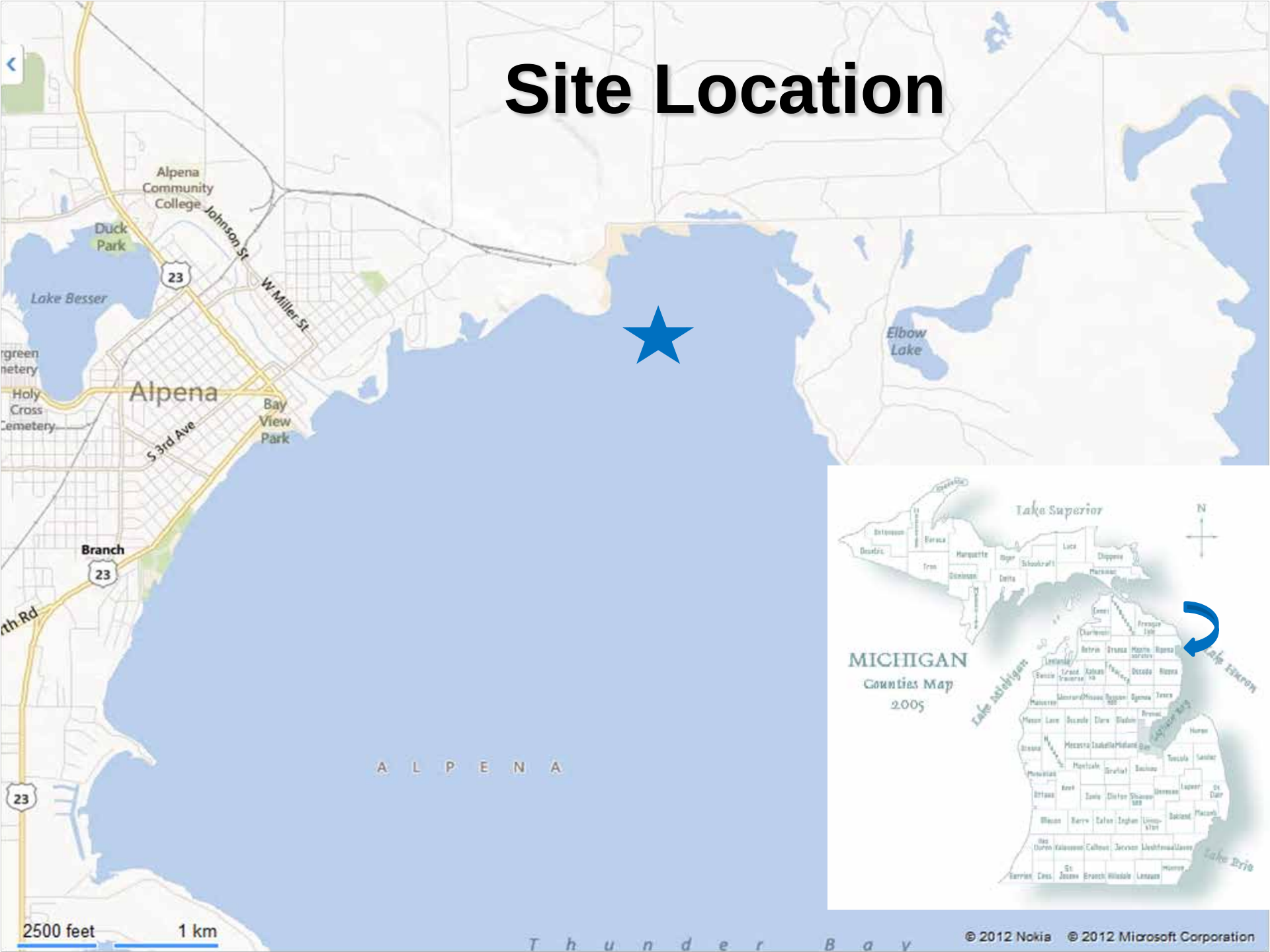
Overview

- Site Location and History
- Project Funding
- Reef Construction
- Project Goals
- Annual Assessments
- Results
- Research Platform

Site Location

- Site located off the shores of Alpena in Thunder Bay, Lake Huron within the Thunder Bay National Marine Sanctuary

Site Location



Site Location

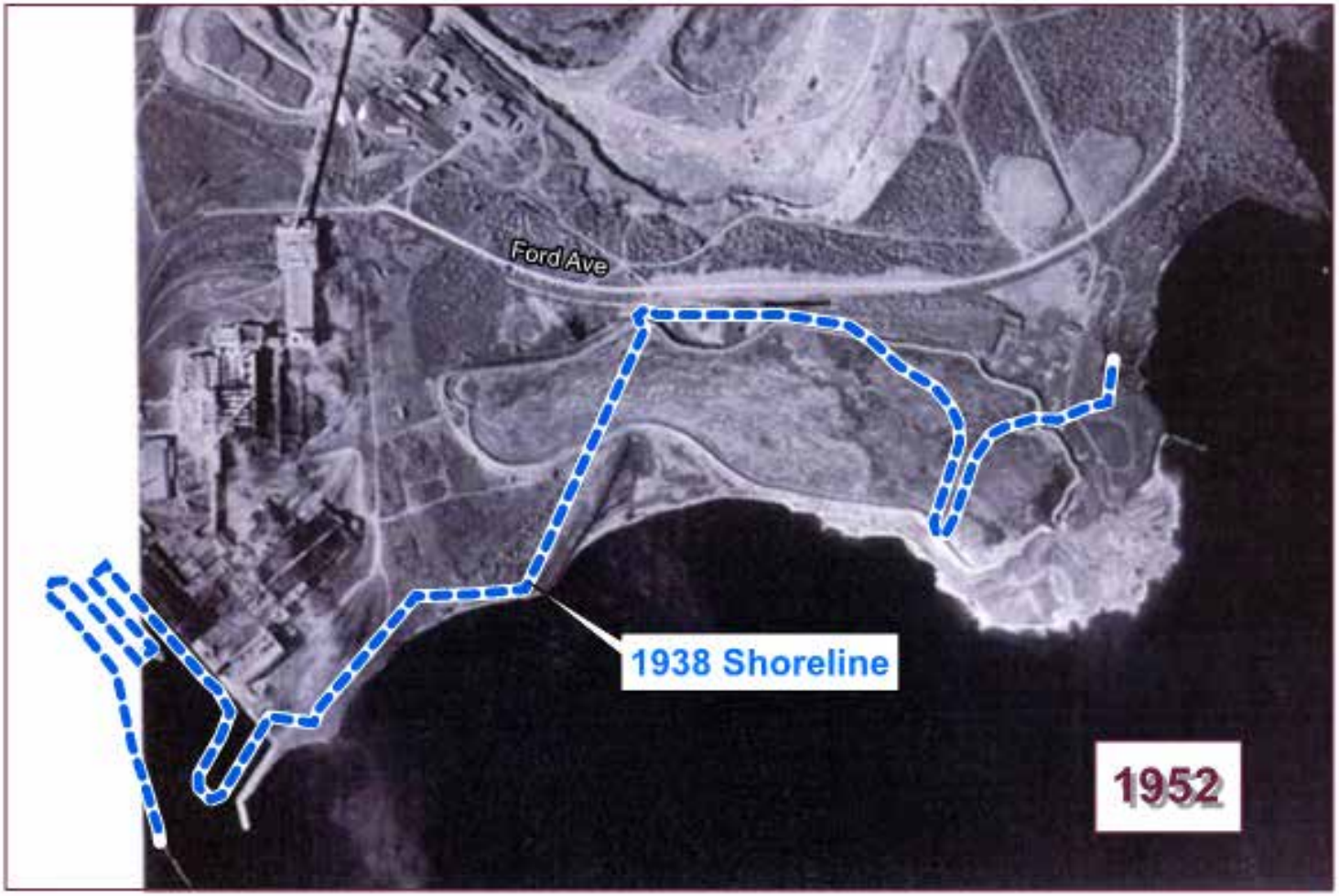
- Former cement production facility
- Three naturally occurring reefs present:
  - Cement Plant Reef and CKD Pile Reef – *DEGRADED*
  - East Reef


Ford Ave
CKD Pile Reef
Cement Plant Reef
East Reef

Site History

- Stockpiling of Cement Kiln Dust (CKD) started in 1950’s
- 80 acres; 59 feet above lake level
- 5,400 feet of shoreline impacted
- Erosion into Thunder Bay

Site History



Site History

Underwater CKD Slabs

- In 2002 - 2003 the property owners, not liable for contamination, substantially re-graded and covered the CKD pile.
- Revetment wall installed along the lakeshore to prevent further erosion of CKD into Lake Huron.

Site History

Site History

Mitigation

- Problems Associated with Cleanup of Natural Reefs
  - Cost restraints
  - Possible re-suspension of CKD
- Mitigation Solutions
  - Enhance existing reef habitat

State-Funded Project Components

- Support Team
  - DLZ Michigan, Inc.
  - Dr. Ellen Marsden, University of Vermont
  - Michigan Department of Environmental Quality, Remediation and Redevelopment Division
- Funding for Mapping, Design & Construction, Monitoring
- Formed Thunder Bay Reef Restoration Team

State-Funded Project Components

- Sought Grant Funding for Project
- Applied for 14 Grants in 3-Year Period
- Investigated project area for historical artifacts (e.g., shipwrecks, rock cribs, net stakes); worked with NOAA & State of Michigan
- Funded construction of small pilot reefs

Thunder Bay Reef Restoration Team

- City of Alpena
- Lafarge – Alpena Plant
- Michigan Department of Environmental Quality, Remediation and Redevelopment Division
- Michigan Department of Natural Resources, Alpena Fisheries Research Station
- Thunder Bay National Marine Sanctuary (NOAA)
- U.S. Fish & Wildlife Service
- U.S. Army Corps of Engineers, Detroit District
- U.S. Geological Survey, Hammond Bay Biological Station

Project Funding

- Additional funding sources include grants from:
  - U.S. Fish and Wildlife Service; The Great Lakes Fish and Wildlife Restoration Act
  - U.S. Army Corps of Engineers, Detroit District; Estuary Restoration Act

GLFWRA Grant

- Great Lakes Fish & Wildlife Restoration Act
  - $64,000 grant with $32,900 in matching funds
  - Pre-construction monitoring

    Fall of 2009 thru spring 2011
  - Post-construction monitoring

    November 2011 thru May 2012

GLFWRA Grant

Estuary Restoration Act Grant

- U.S. Army Corps of Engineers Estuary Habitat Restoration Program
  - $516,876 grant with $412,697 in matching funds
  - Matching monies from state and Lafarge (12,159 tons of limestone rock donated)
  - Funds Stage II Construction and four years of monitoring (2012-2016)

Estuary Restoration Act Grant

Contractor Durocher Marine Installing Limestone Rock

Reef Restoration

- Stage I Pilot Reefs
  - 8 reefs constructed in 2010:
    - Size (9’ high and 30’ diameter)
    - 1,200 tons of limestone rock donated by Lafarge

Reef Restoration

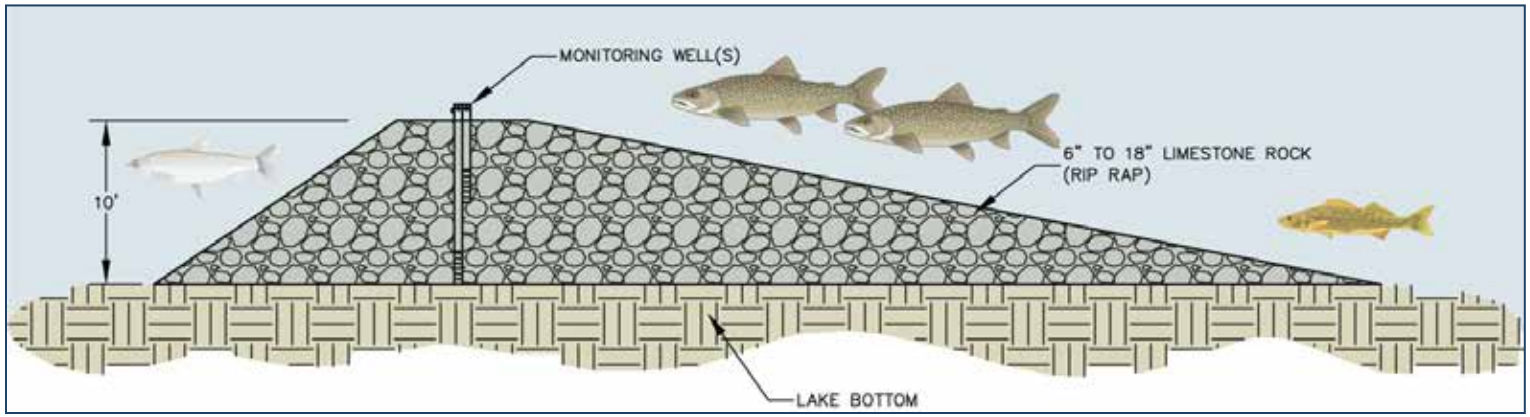
- Stage I Pilot Reefs, cont'd
  - 8 reefs constructed in 2010:
    - Monitoring wells installed at 6 reefs
    - Is this size sufficient to draw fish spawning activity?

Reef Restoration

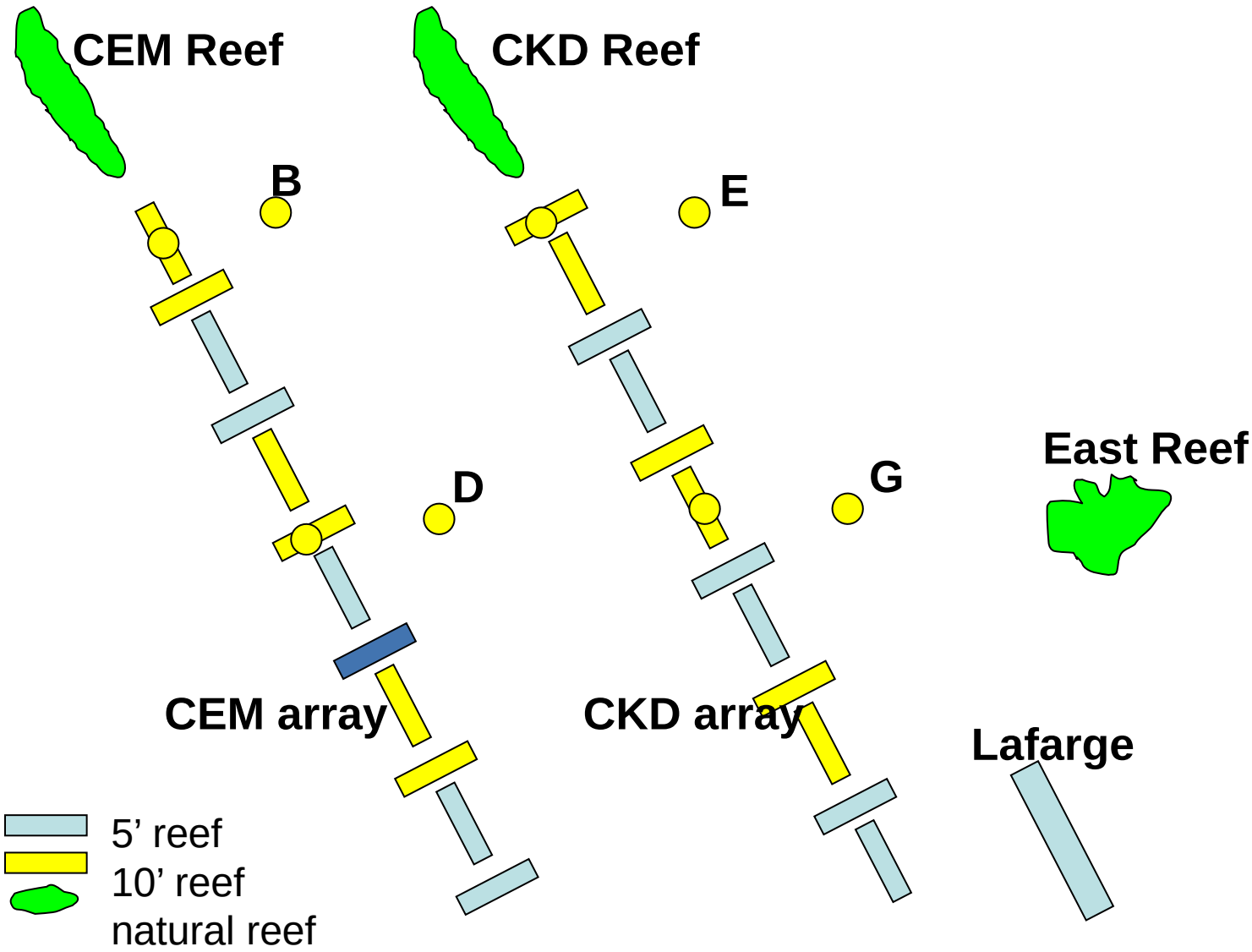
- Stage II Reefs
  - 24 functional prototype reefs constructed in 2011, allowing for reef height and orientation comparisons
    - Height (5’ and 10’)
    - Orientation (NE-SW and NW-SE)
    - Size (8’ top width x 75’)
  - An additional 5’ high by 300’ long reef was also constructed at toe of CKD Pile array.

Reef Restoration

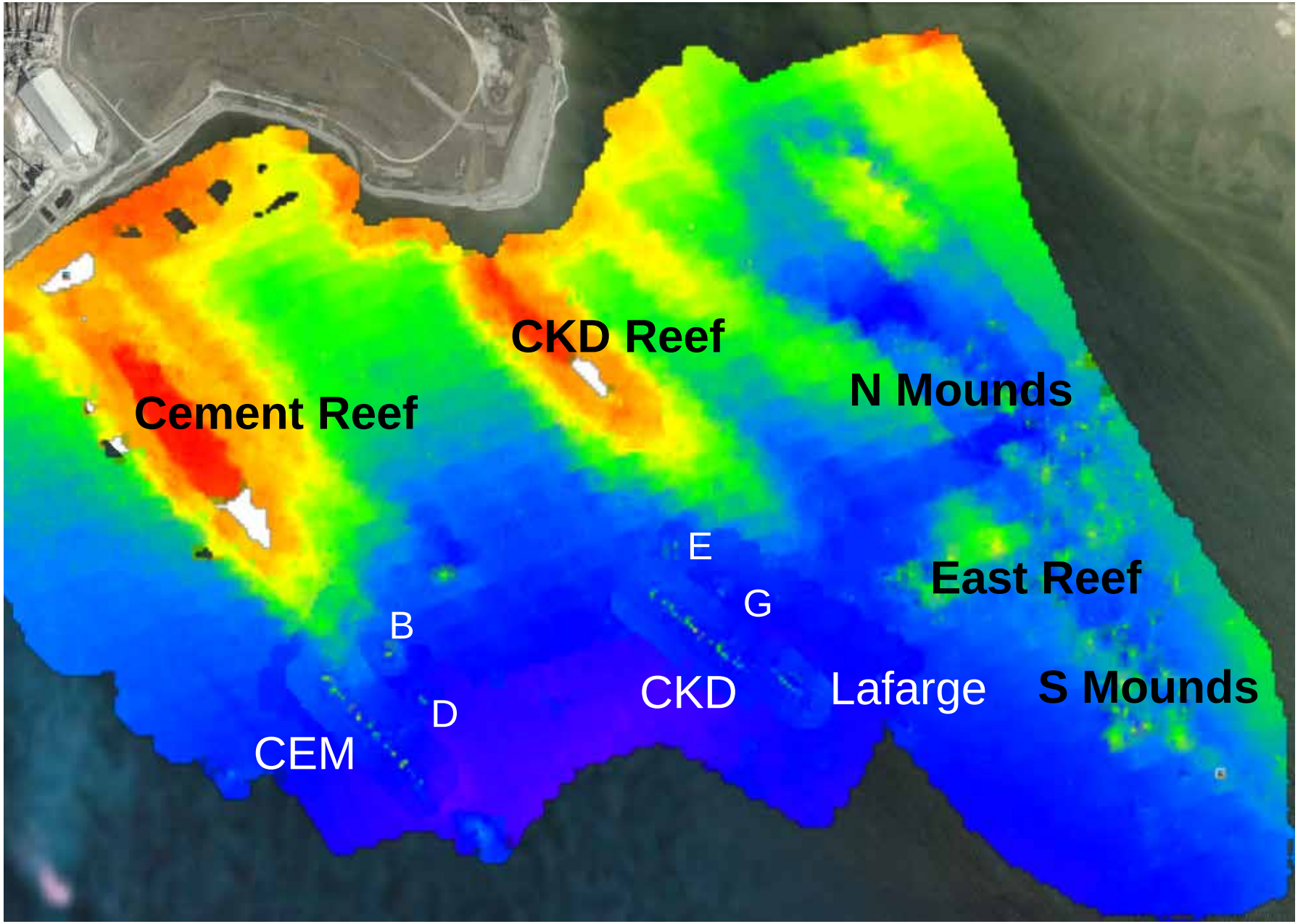
- Stage II Reefs, cont'd
  - 12,159 tons of local limestone rock used; donated by Lafarge.
  - 4 reefs built with ramps for assessment gear



2011 Stage II Full Build-Out



Images of Reefs



Project Goals

- Improve spawning and recruitment of lake trout
- Enhance whitefish and walleye spawning habitat
- Provide habitat attractive to smallmouth bass and other species

Reef Restoration

- If we build it, will they come?

Annual Assessment

- Pre-construction assessment of natural reefs (2009)
- Post-construction monitoring of natural and restored reefs (2010-2016)

Annual Assessment

- Adult spawner density

Annual Assessment

MDNR and USFWS using trap nets to catch adult fish

Annual Assessment

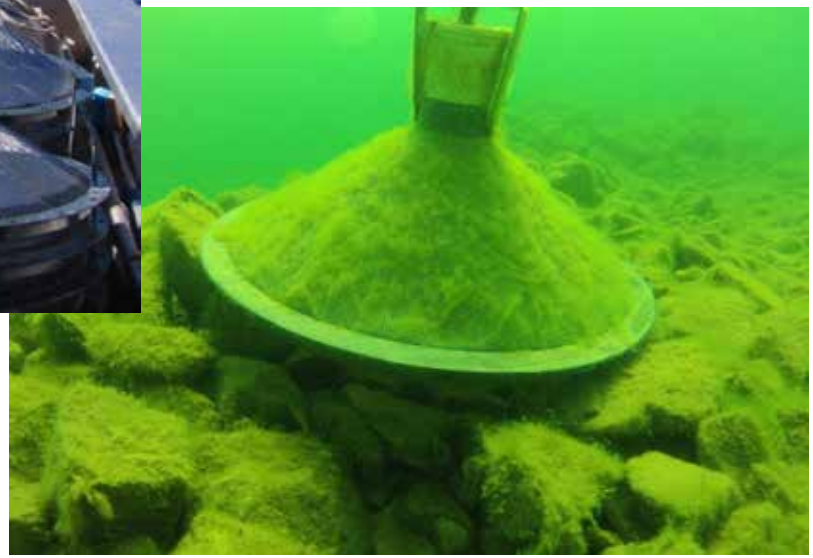
- Lake trout, whitefish egg sampling

Annual Assessment

Egg Sample Processing

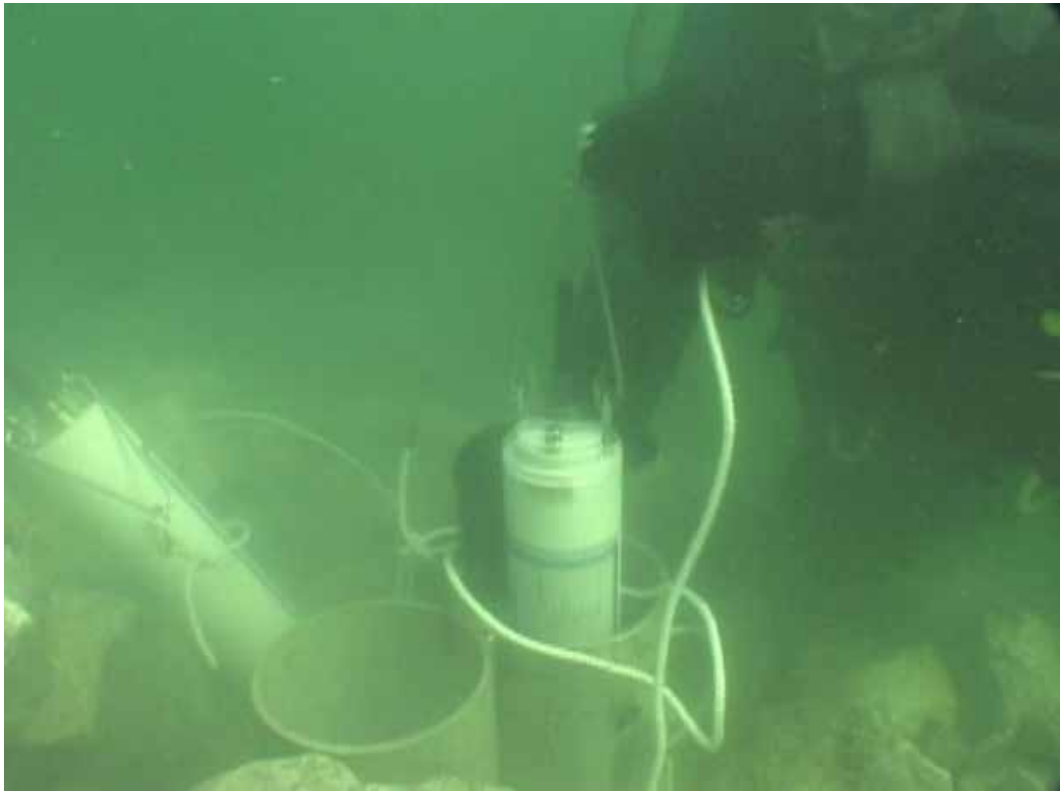
Annual Assessment

- Fry & larval density



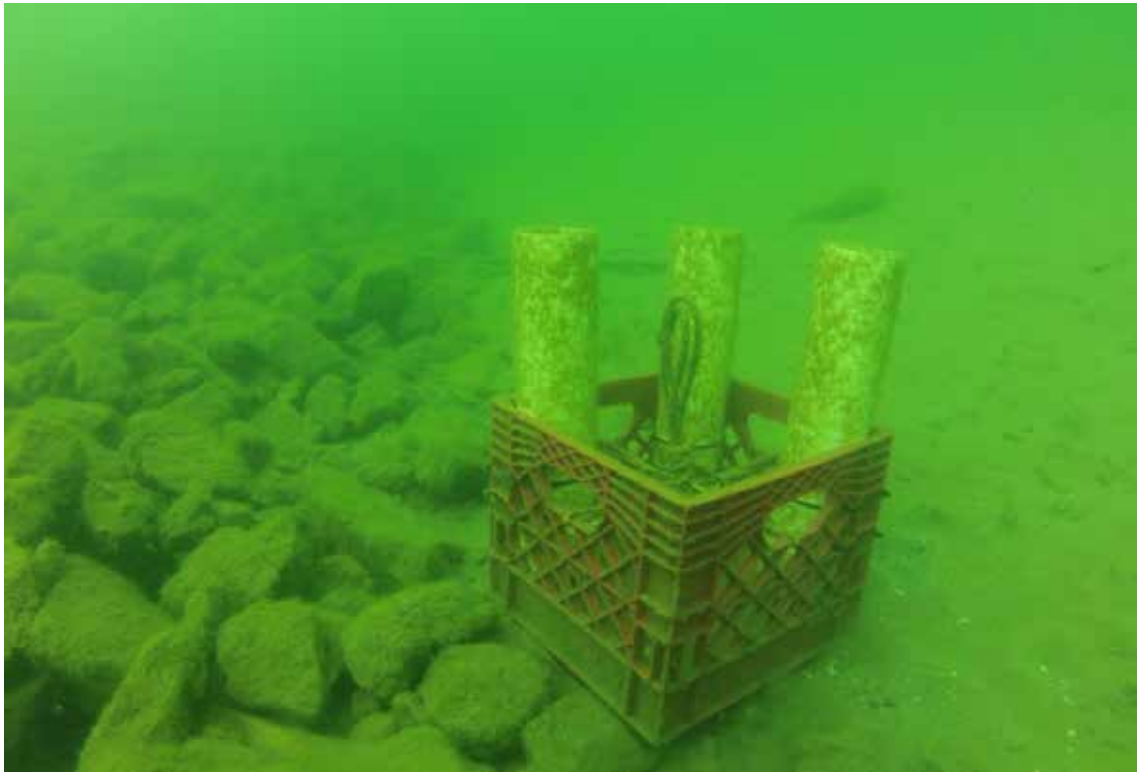
Annual Assessment

- Dissolved oxygen & temperature at base and center of 2 reefs



Annual Assessment

- Sediment samples on 2 reefs

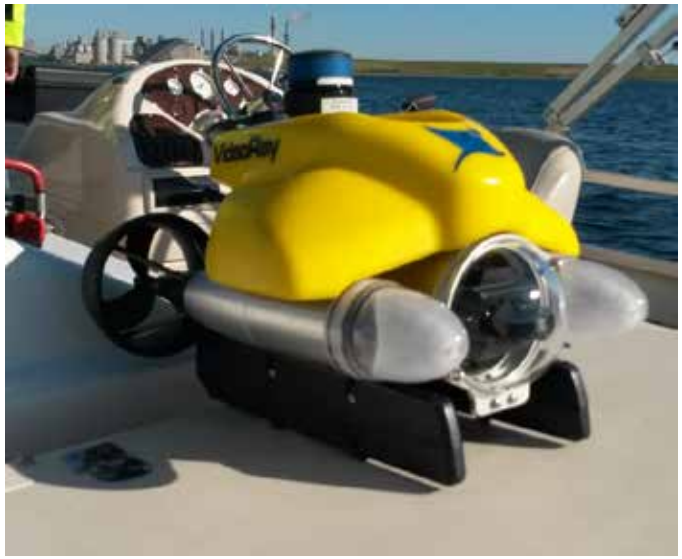


Annual Assessment

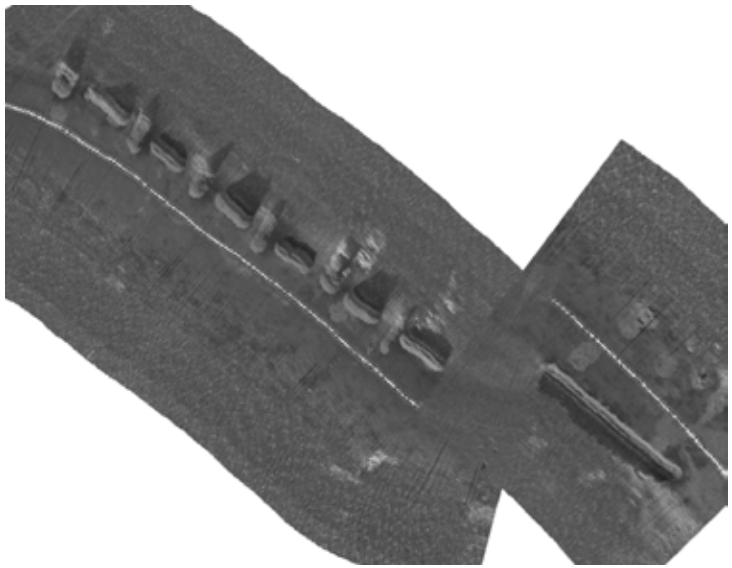
- Benthic colonization
- Collect samples of invertebrates & dreissenids

Annual Assessment

- Side scan sonar and video documentation with MDEQ



Annual Assessment



Mapping Discoveries

- Working with State of Michigan/NOAA archaeologists;
- Discovery of scow barge wreck

Results

- Reef ‘aging’:
  - Dissolved oxygen is high

Year 1: New Construction

Results

- Reef ‘aging’:
  - Growth of periphyton (expected; typical of natural reefs)

Year 4: July, 2015

Results

- Reef ‘aging’:
  - Little colonization by quagga and zebra mussels (unexpected)
  - Colonization by gobies (expected)

Results

Lake Trout Eggs (#/cm^2)

Reef Type	2009	2010	2011	2012	2013	2014
East	nd	X	155.6	4.7	4.7	nd
CKD	0	X	0	0	0	nd
Cement	0	X	nd	nd	nd	nd
Small	X	X	0	0	0	nd
NE high	X	X	0	6.1	0.6	10.1
NE low	X	X	0	84.9	0.6	25.5
NW high	X	X	0	1.4	1.7	14.1
NW low	X	X	0	1.4	3.5	8.7
Lafarge	X	X	nd	nd	nd	nd

X = reefs not yet constructed

Results

Lake Trout Fry (# from 6 replicates)

Reef Type	2010	2011	2012	2013	2014	2015
East	14	0	47	127	47	2
CKD	0	2	nd	0	nd	nd
Cement	0	nd	0	nd	0	0
Small	X	1	0	0	0	0
NE high	X	X	0	1	25	5
NE low	X	X	1	1	9	1
NW high	X	X	3	0	44	3
NW low	X	X	0	2	14	4
Lafarge	X	X	2	1	17	2

X = reefs not yet constructed

Artificial Reefs

- **If we build it, will they come?**
- It takes time
  - Density of spawners increased over time
  - Residence on constructed reefs increased over time
- Size matters?
  - Smaller “Pilot” reefs ignored, largest reef consistently attracted fish
- Height, orientation do not matter

Platform for Other Research

- Fecal Attraction
  - U Vermont, MDNR, USFWS
  - Would “baiting” new reefs with fry feces attract lake trout?

Fecal Attraction

- 400 lb of lake trout fry feces from Jordan River National Fish Hatchery
- No significant difference in spawning activity on the new reefs

Platform for Other Research

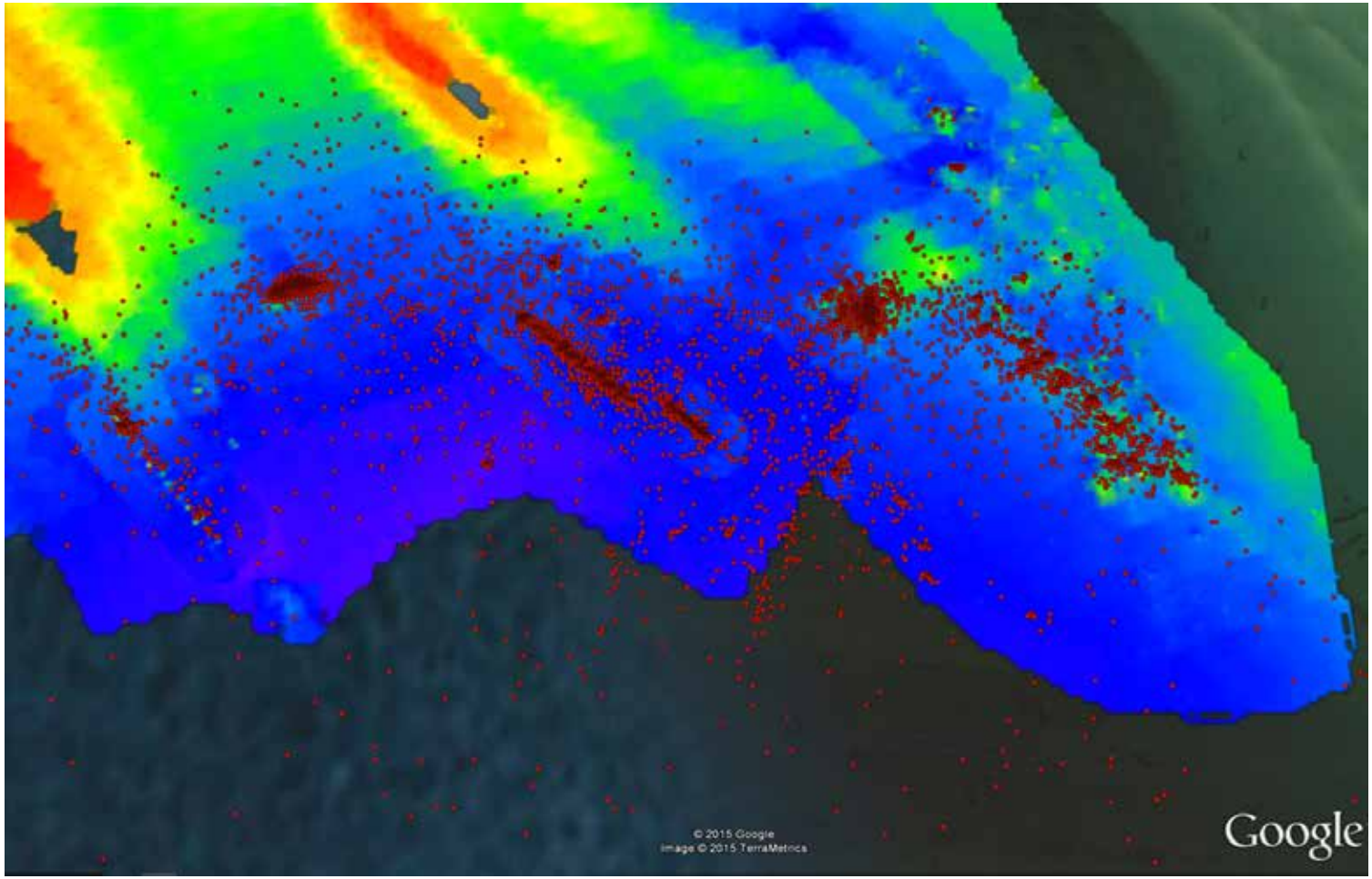
- Acoustic Telemetry
  - U Vermont, MDNR, USGS, MSU, DLZ, MDEQ
  - Spawning lake trout were tagged to monitor movement within the bay

Acoustic Telemetry

- 15 females, 25 males tagged in fall 2012
- 3-year lifespan
- 17 fish returned in 2014

Acoustic Telemetry

- Movements of one tagged fish-2014



Questions?

Find us at: www.uvm.edu/rsenr/thunderbay/

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