

# *Erosion Vulnerability Index*

## *Evaluating the Vulnerability of Forested Lands to Erosion in the Upper Couderay River Watershed at the Parcel Level*

Presented by

Douglas Miskowiak

Senior GIS Education Specialist

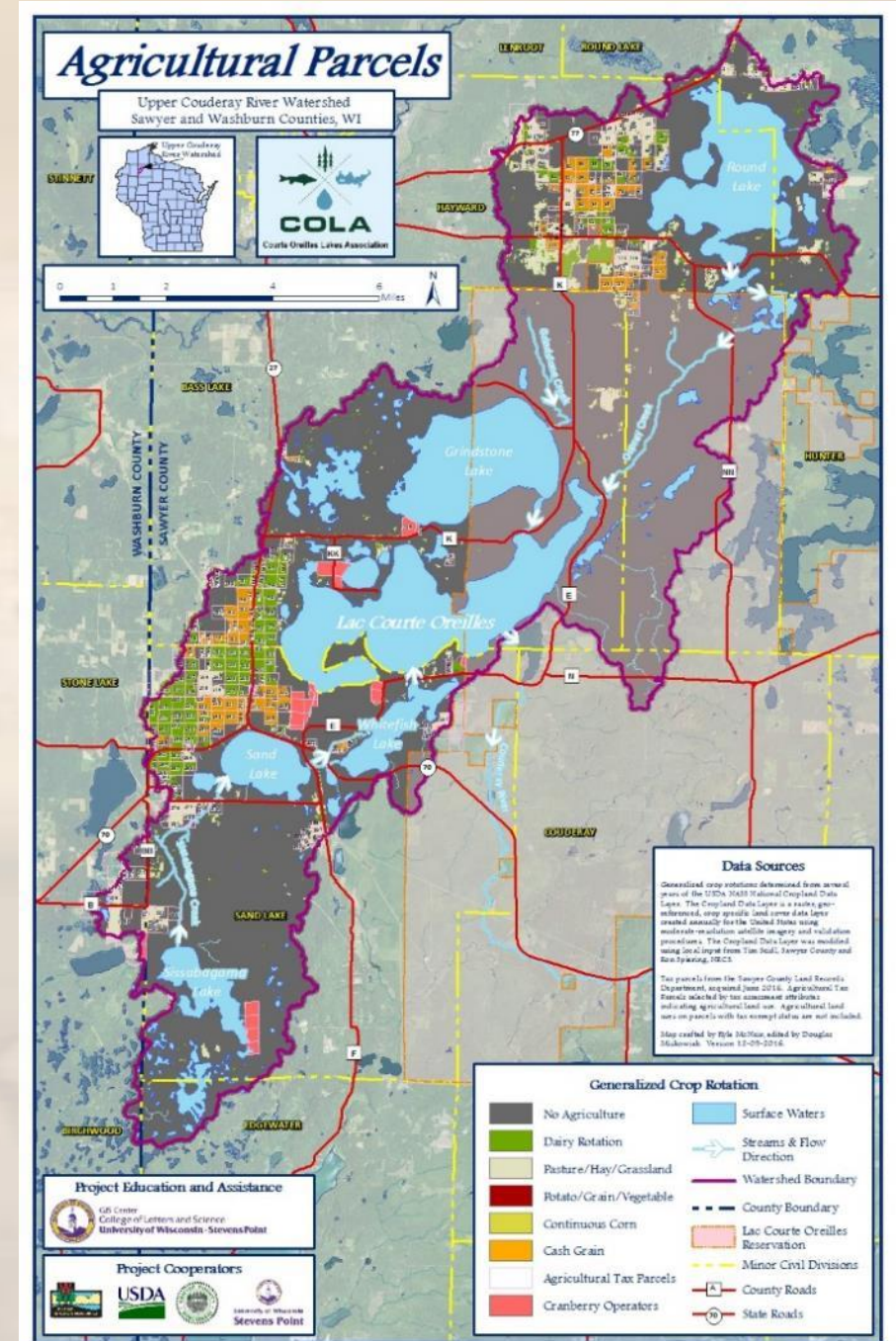


University of Wisconsin  
**Stevens Point**



# Lac Courte Oreilles

- Upper Couderay River Watershed
  - 125 square miles
    - Five Cranberry Bogs
    - > 8,000 Acres of Agriculture
    - >4,600 Acres of Development
    - > 30,000 Acres of Forest
- All water flows to Lac Courte Oreilles – All share/contribute nutrients to the commons.





# LCO: A Two-Story Fishery



2<sup>nd</sup> Story

Warm Eplimnion



1<sup>st</sup> Story

Cold Thermocline (Metalimnion)



Basement

Super Cold Hypolimnion

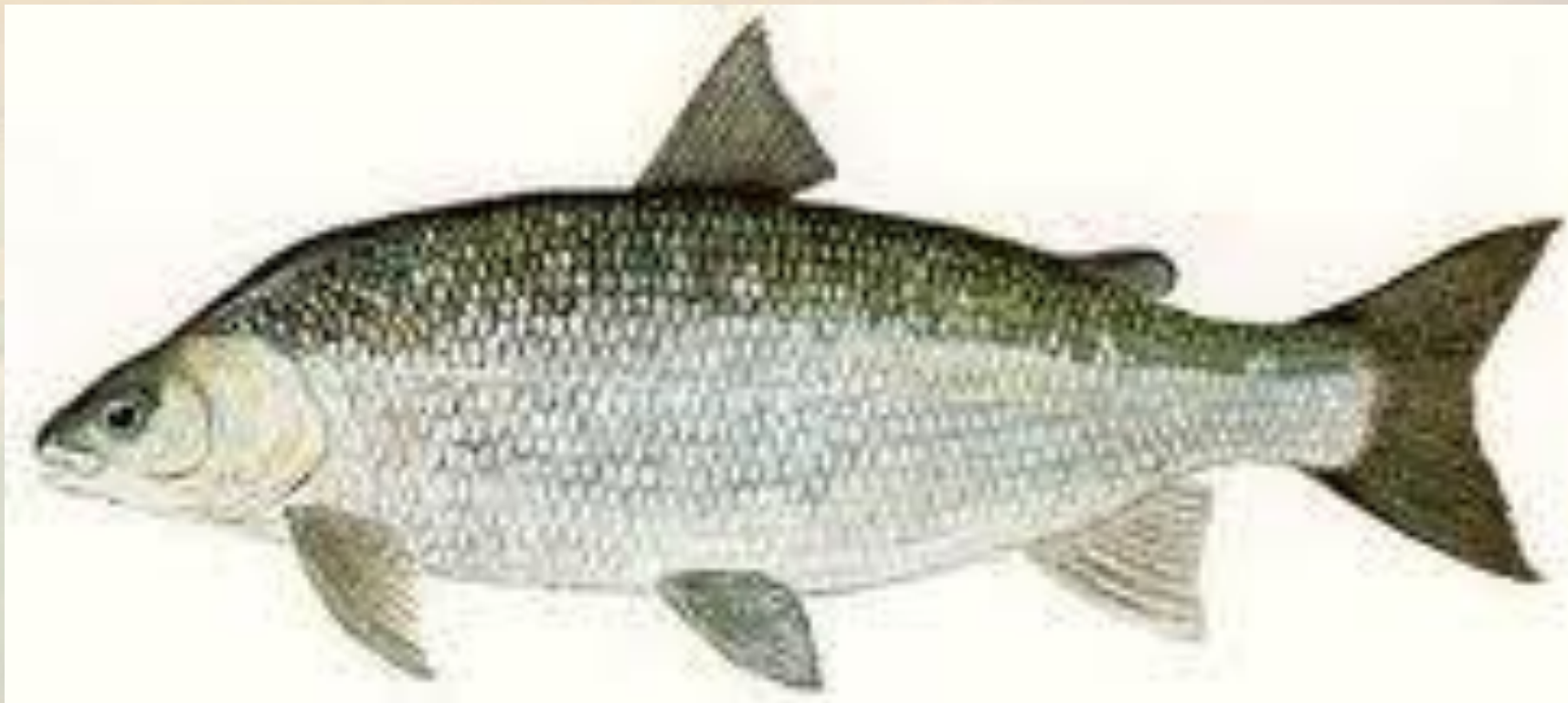


# Cisco (aka Tulibee or Lake Herring)



Cisco are suspending planktivores- found through-out the thermocline (all of 1<sup>st</sup> story, including center of the room, and not just along the walls.) Moderately abundant and smallish in LCO. Small cisco tend to be long and look very smelt-like. Size is usually an index of density. Big cisco come from small populations. Excellent forage fish for just about anything. Move upstairs to 2nd story, in evening, to feed, and to be preyed upon by warm water fish.

# Whitefish



**Lake Whitefish**- Cold, well-oxygenated water, close to bottom. Live a long time and grow big in LCO. Not abundant. Deep-bodied. Summer habitat is already severely limited- perimeter of thermocline (walls of 1<sup>st</sup> story). More omniverous than cisco, but also capable of eating zooplankton. Considered one of the world's best eating fish. Commercial fisheries in some waters.

# How Rare is the LCO Fishery?



- Wisconsin has...

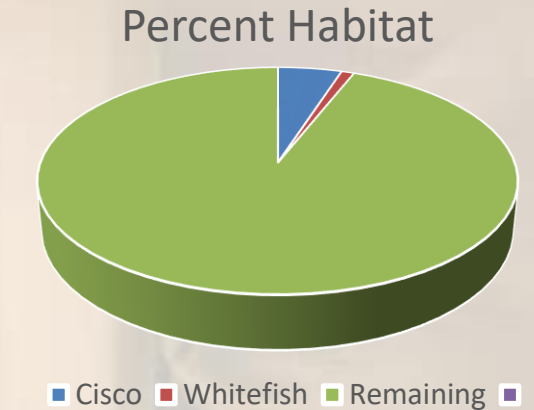
- 15,089 lakes
- 7,000+ lakes with fisheries
- 200 two-story fisheries (3%)
- 100 self-sustaining two-story fisheries (1%)

–5 Outstanding Resource Waters with  
Cisco AND Whitefish



# Cold Water Habitat in LCO

- Existing Habitat
  - 5.0% of LCO Volume is Suitable to Cisco
  - 0.25% of LCO Volume is Suitable to Whitefish
- Factors Threatening Cisco and Whitefish Habitat
  - Temperature
    - Warm September – No Escape Hatch for Cold Water Fish
  - DO<sub>2</sub> and Excessive Nutrients
    - Phosphorus Fosters Excessive Plant Growth
    - Anaerobic bacteria breaking down decaying plants consume O<sub>2</sub>



# What's at Risk up the Foodchain?



Lac Courte Oreilles  
1940  
Louie Spray World  
Record Muskie  
61 lbs. 13 oz.



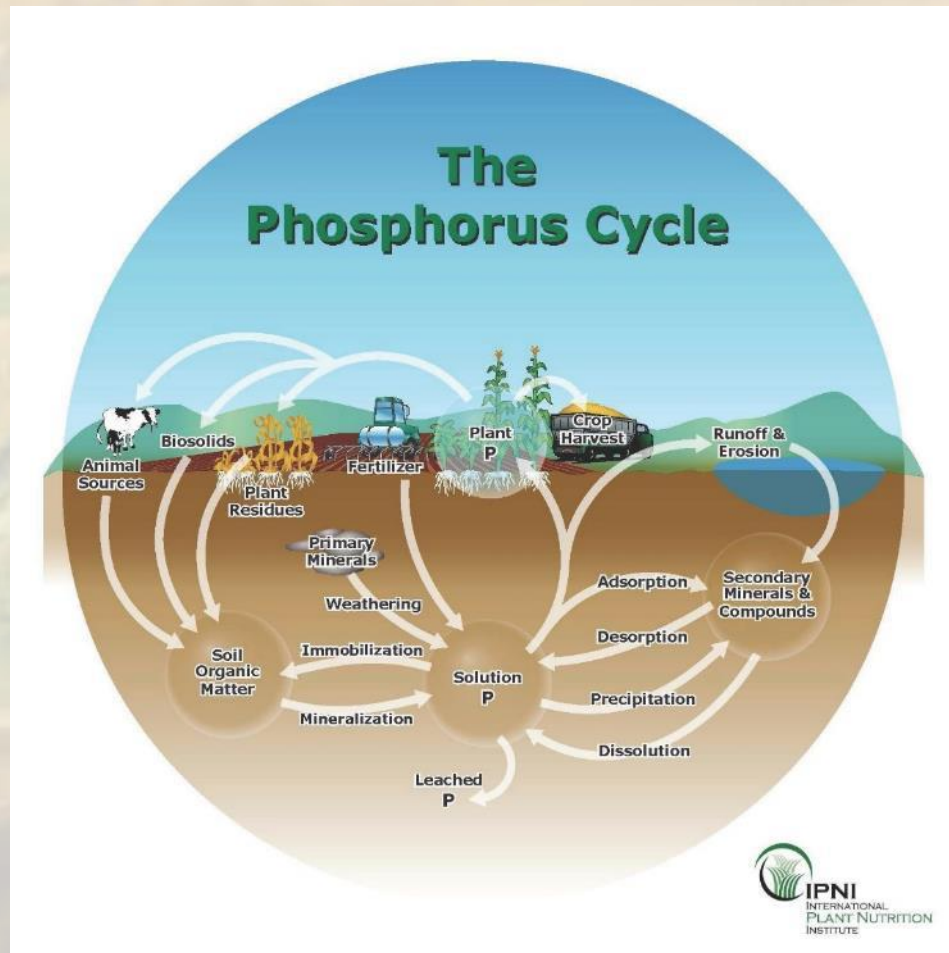
Lac Courte Oreilles  
1949  
Cal Johnson World  
Record Muskie  
69 lbs. 8 oz.



<http://www.gmmoorebooks.com/portfolio?lightbox=i41wss>  
<http://www.freshwater-fishing.org/>



# Phosphorus



- A nutrient essential to plant growth (including aquatic plants)
- A nutrient generally bound
  - Microorganisms break down organics (plant residue, manure etc)
  - Mineralization
  - Mineralization released by sediments
  - Inorganic P can be dissolved in water
- Excessive P leads to eutrophication in water bodies

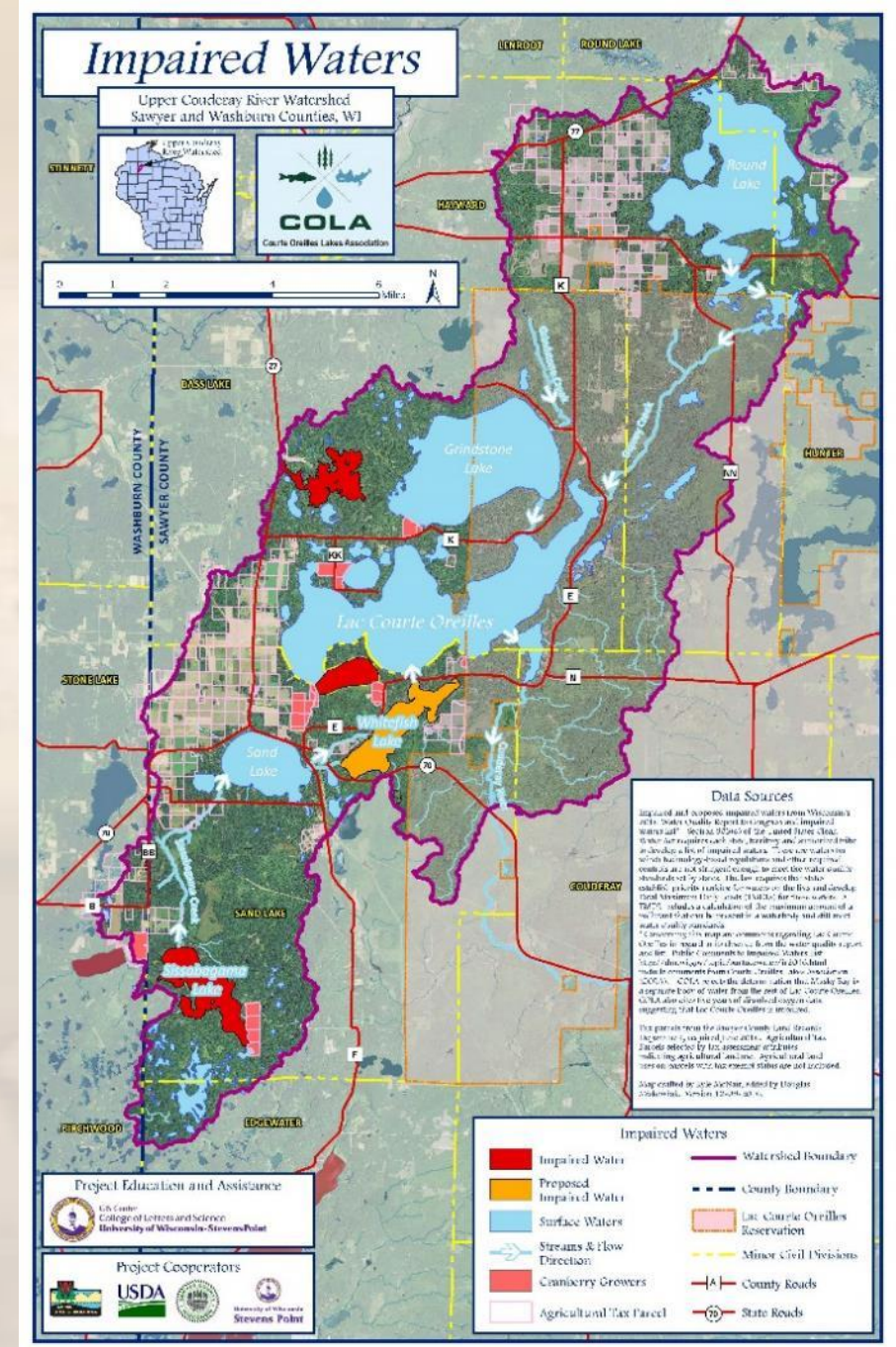
# Phosphorus, Clean Water Act and LCO

- Clean Water Act Objective: restoration and maintenance of the chemical, physical and biological integrity of the country's water.
- Section 303(d) requires states to identify waters within their state where current pollution control technologies alone cannot meet the water quality standards set for that waterbody.
  - Two-story stratified fisheries have a current standard of 15ppb total phosphorus (TP)
    - NR102.06 (4)(b)1 (2010)
    - EPA Approved the Rule in 2012



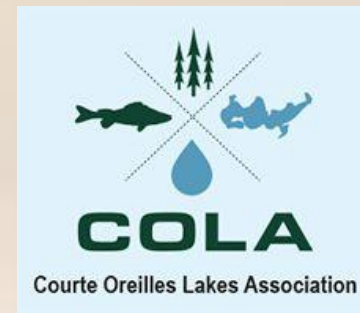
# Phosphorus, Clean Water Act and LCO

- Musky Bay and Sissabagama Lake declared impaired waters
- Whitefish Lake is a proposed impaired water
- Musky Bay falsely separated from Lac Courte Oreilles
  - Shares a lake number WBIC 2390800
  - Shares over .33 miles
- Dissolved O<sub>2</sub> shown impaired on LCO





# COLA



- Courte Oreilles Lakes Association
- Long term goal for TP for all LCO and natural bays is 10ppb (2014-proposed to WDNR)
  - Work with cranberry growers to eliminate discharges
  - Investigate dredging or chemical treatments (Technical Fixes)
  - Shore land development (buffers and septic tanks)
  - Land use in the LCO watershed
    - **Forestry**
    - Agricultural
    - Impervious surfaces

# Project Phases

- 1. Inventory Forest Ownership
- 2. Inventory Erosion Vulnerability Factors
- 3. Landcover Classification and Even-Aged Timber Management Inventory
- 4. Development of Internet Tools
  - A) Mapping Tools for Foresters
  - B) Story Mapping

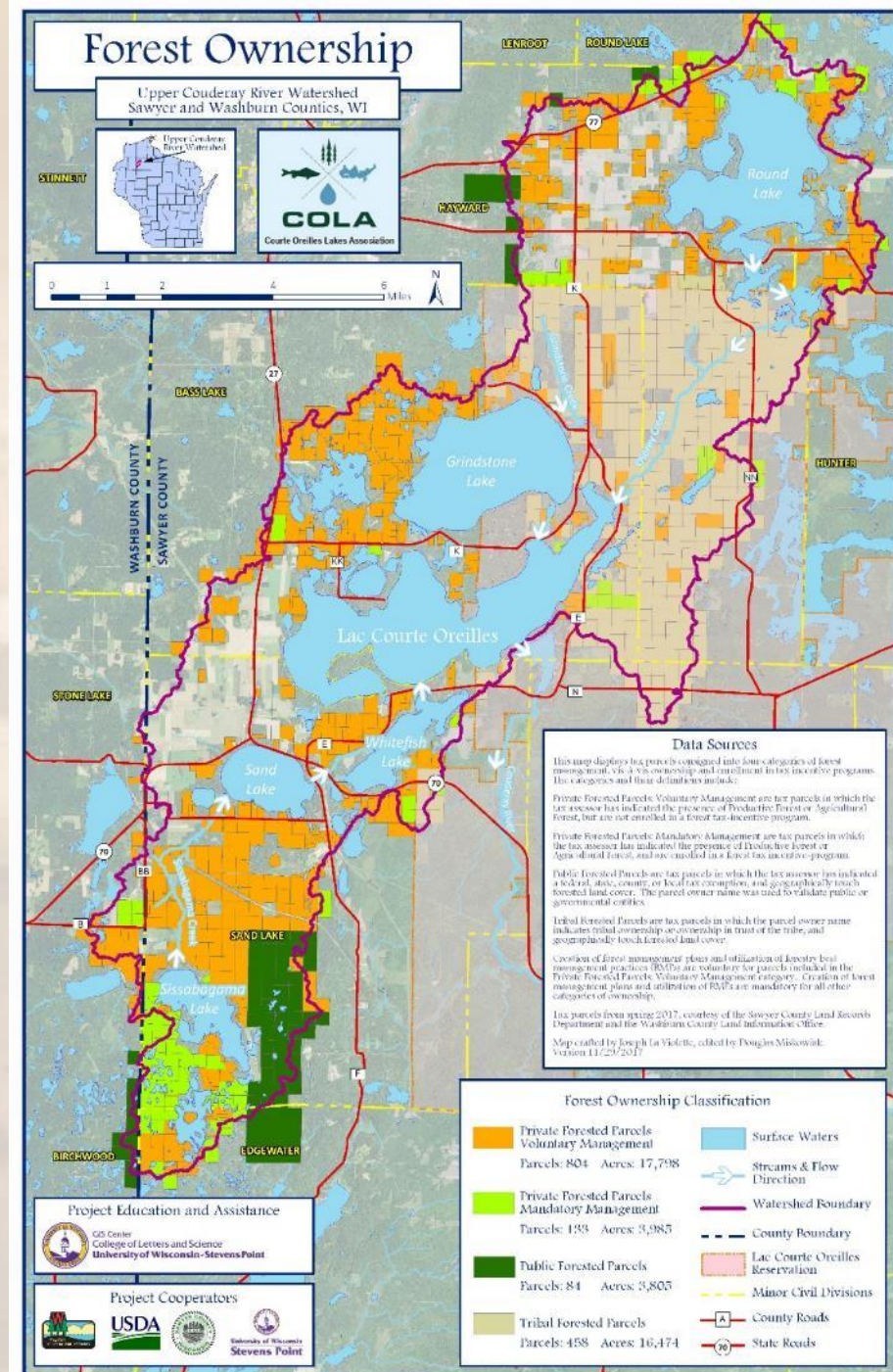


# 1. Inventory Forest Ownership



# Forest Ownership Classification

- Creation and use of forest management plans are voluntary for parcels included in the **Private Forested Parcels: Voluntary** category
- Creation of forest management plans and use of BMPs are mandatory for all other ownership categories
  - Private Forested: Mandatory
  - Public Forested Parcels
  - Tribal Forested Parcels





## 2. Inventory Erosion Vulnerability Factors



# Forestry Best Management Practices

- **Forestry BMP Factors of Consideration**

- **Sensitive Species Habitat**: includes forest, wetland, and aquatic habitat, all affected by forest practices
- **K-factor**: an encompassing soil erosion vulnerability index
- **Percent Slope**: steep slopes are prone to erosion
- **Trout Streams**: streams designated by the DNR, water temperature is critical
- **Lakes/Rivers/Streams**: The water quality found in these resources is a reflection of the management of our forests
- **Wetlands**: provide fish and wildlife habitat, flood protection, pollutant storage, other ecosystem services
- **Additional Buffers**: Riparian Management Zones and Wetland Filter Strips designed to further protect against runoff pollutants





# Timber Management Sensitivity Index & Hydrologic Sensitivity Index for Timber Management

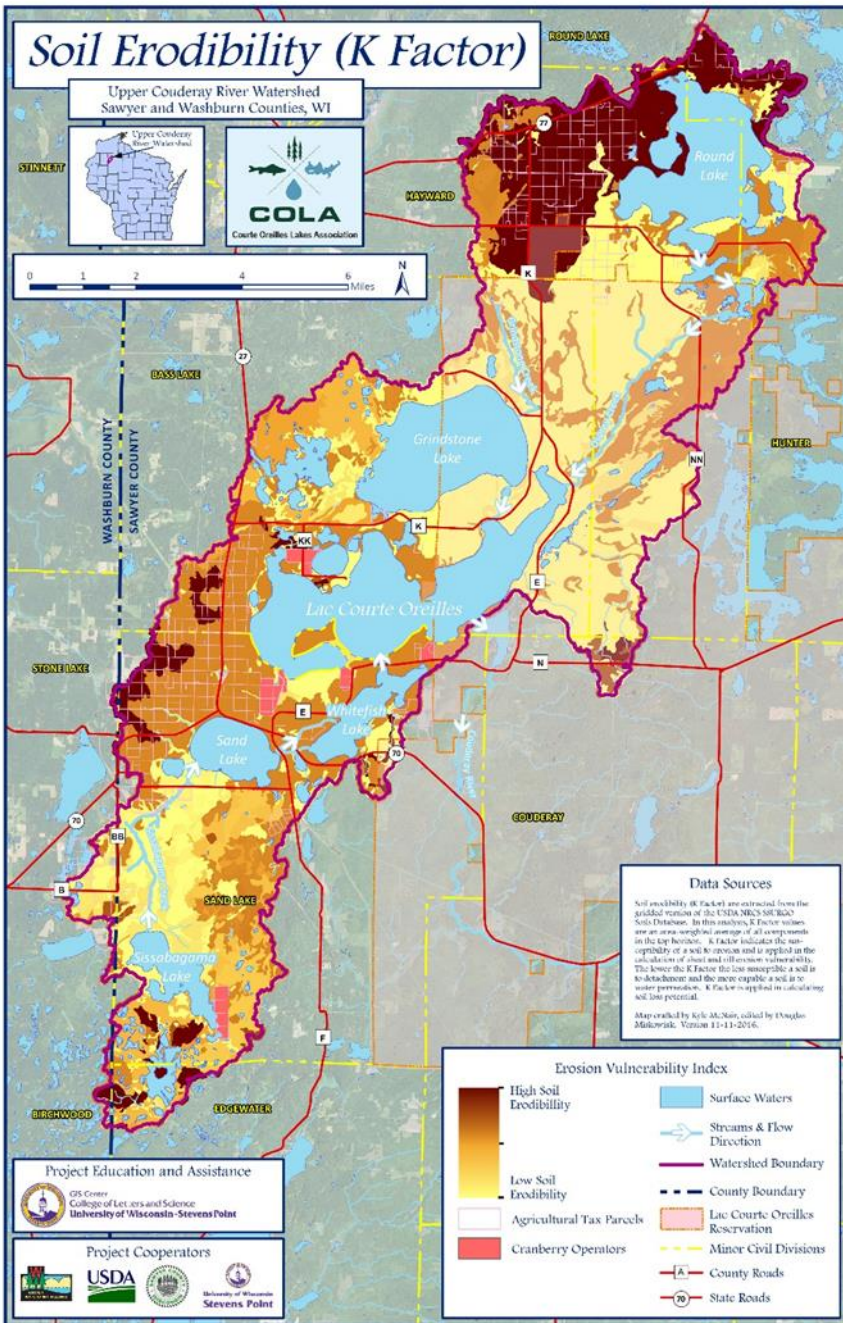
- Vulnerability Assessments for Forested Lands
  - designed to prioritize parcels within the watershed which may be vulnerable to the effects of timber management practices
  - Highlight parcels in a similar way but focusing on hydrologic features
  - Especially important to identify sensitive areas where management is not mandatory.



# Data Sources

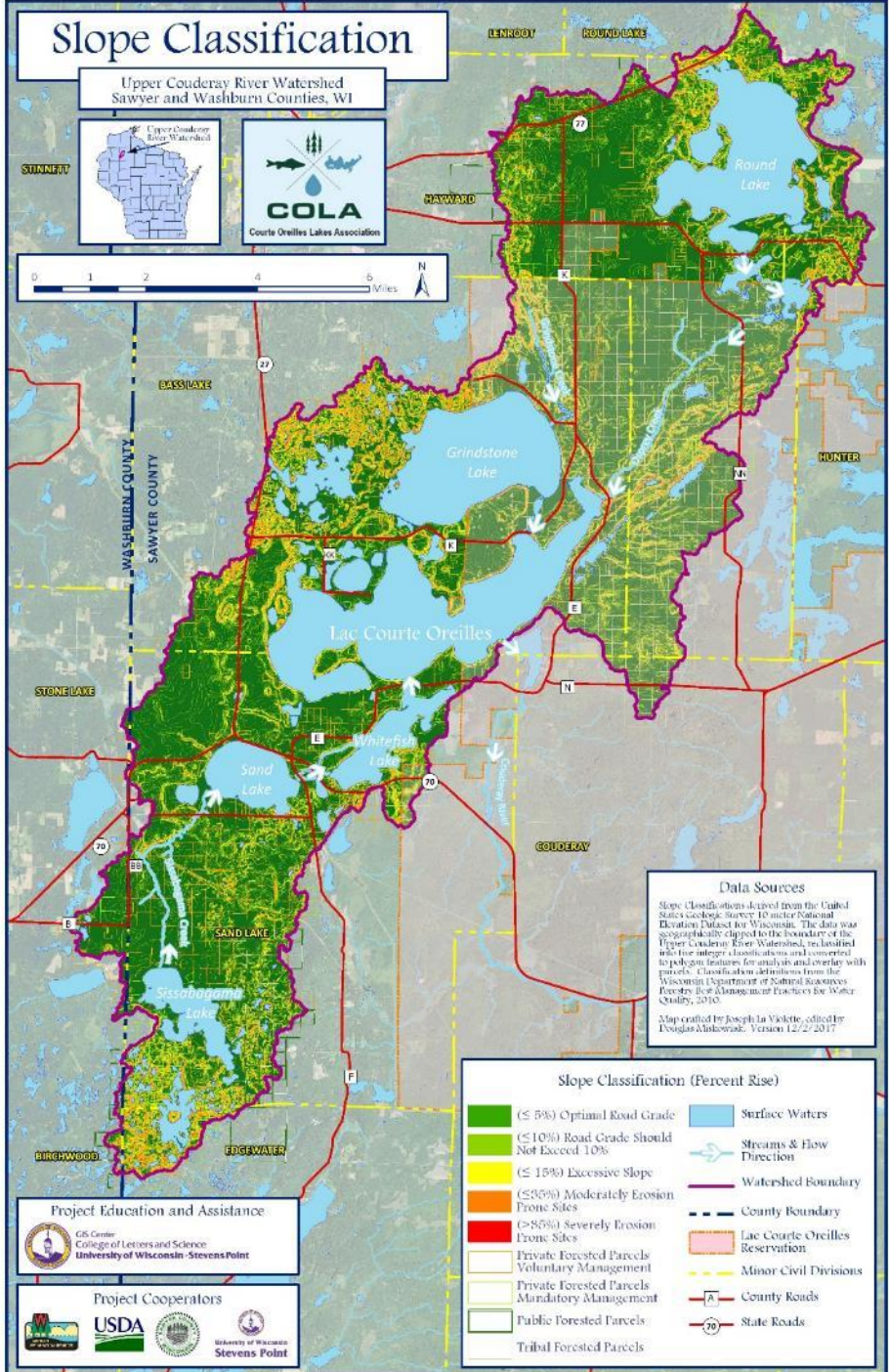
- Boundary
  - Upper Couderay River Watershed, LimnoTech.
- Parcel Boundaries
  - Sawyer County Land Records Dept. and Washburn County land Information office
- Digital Elevation Model
  - 10 Meter National Elevation Dataset, Natural Resources Conservation Service
- Soils (K Factor)
  - SSURGO Soils, Natural Resources Conservation Service
- Sensitive Species Presence
  - Natural Heritage Index, WI DNR
- Designated Trout Streams
  - WI DNR
- Lakes/Rivers/Streams
  - WI DNR hydrography geodatabase, central GIS data repository
- Landcover
  - WISCLAND2 from the WI DNR open GIS portal
- Wetlands
  - U.S. Fish and Wildlife Service and National Wetlands Inventory Index
- Ortho Imagery
  - Wisconsin View DOQQ for Sawyer and Washburn County 2005, 2010, 2015





- K factor
  - Indicates the susceptibility of a soil to erosion
  - Examples
    - Clay rich soils are resistant to detachment .05 to .15
    - Sandy soils, though easily detached, have low runoff potential .05-.2
    - Silty soils are most easily erodible .25-.4
  - Our Binary Classification
    - Parcels containing soils with K factor scores  $\geq .25$  assigned a “1”





- Slope

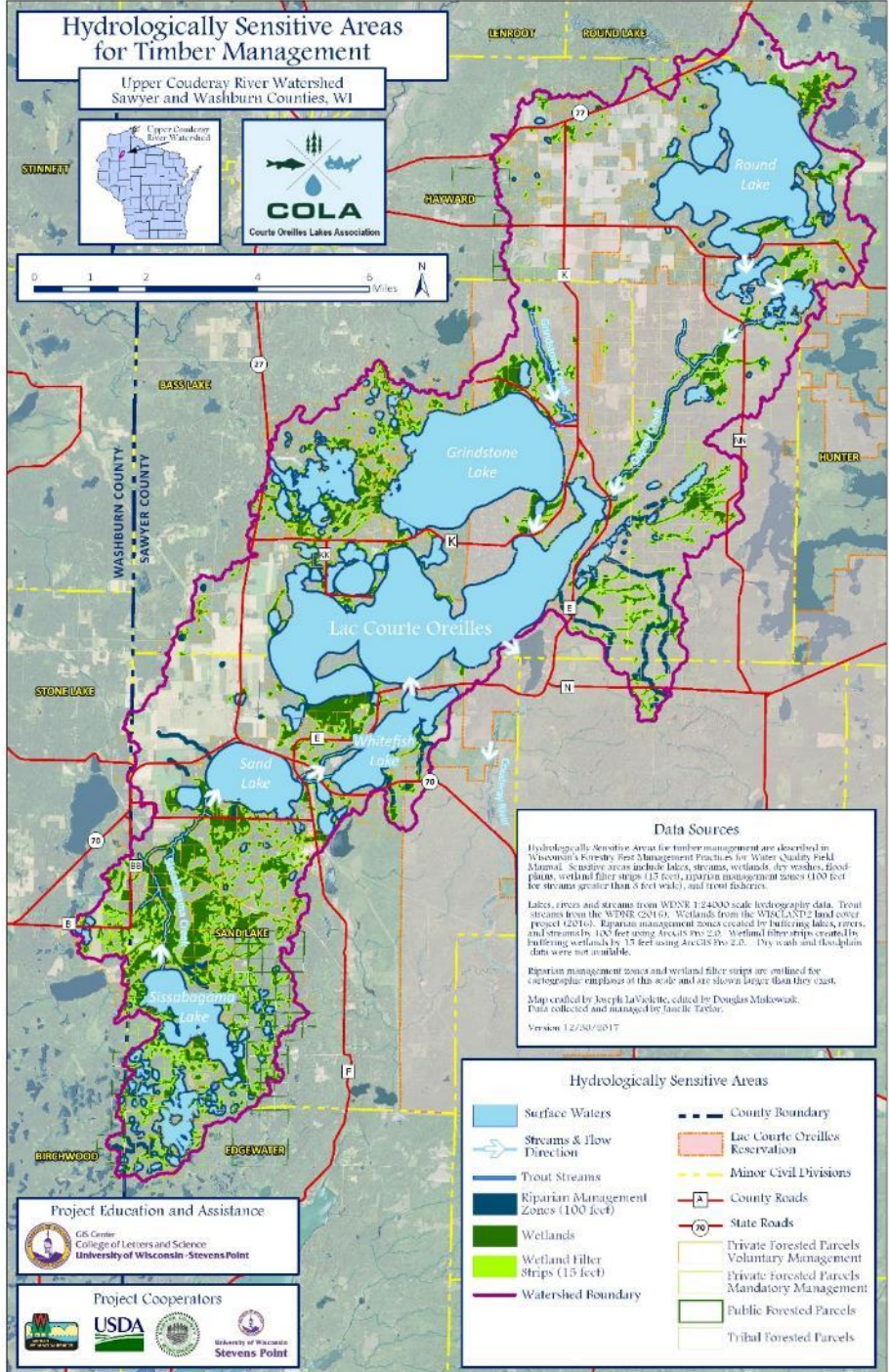
- Slope is an important factor of consideration not only for the risk of runoff potential, but also when planning access road construction

- BMPs

- Optimum road grades are ≤ 5%
- Road grades should not exceed 10%
- Forest soils occurring on 15%-35% slopes have a moderate erosion vulnerability rating
- Soils occurring on slopes ≥ 35% have a severe erosion vulnerability rating

- Our Classification considers 4 breaks as individual factors and assigns a binary “1” or “0” for each





- **Hydrologic Factors**

- Lakes/rivers/streams

- Water features  $\geq 3'$  in width must have a 100' buffer area we designate as a riparian management zone

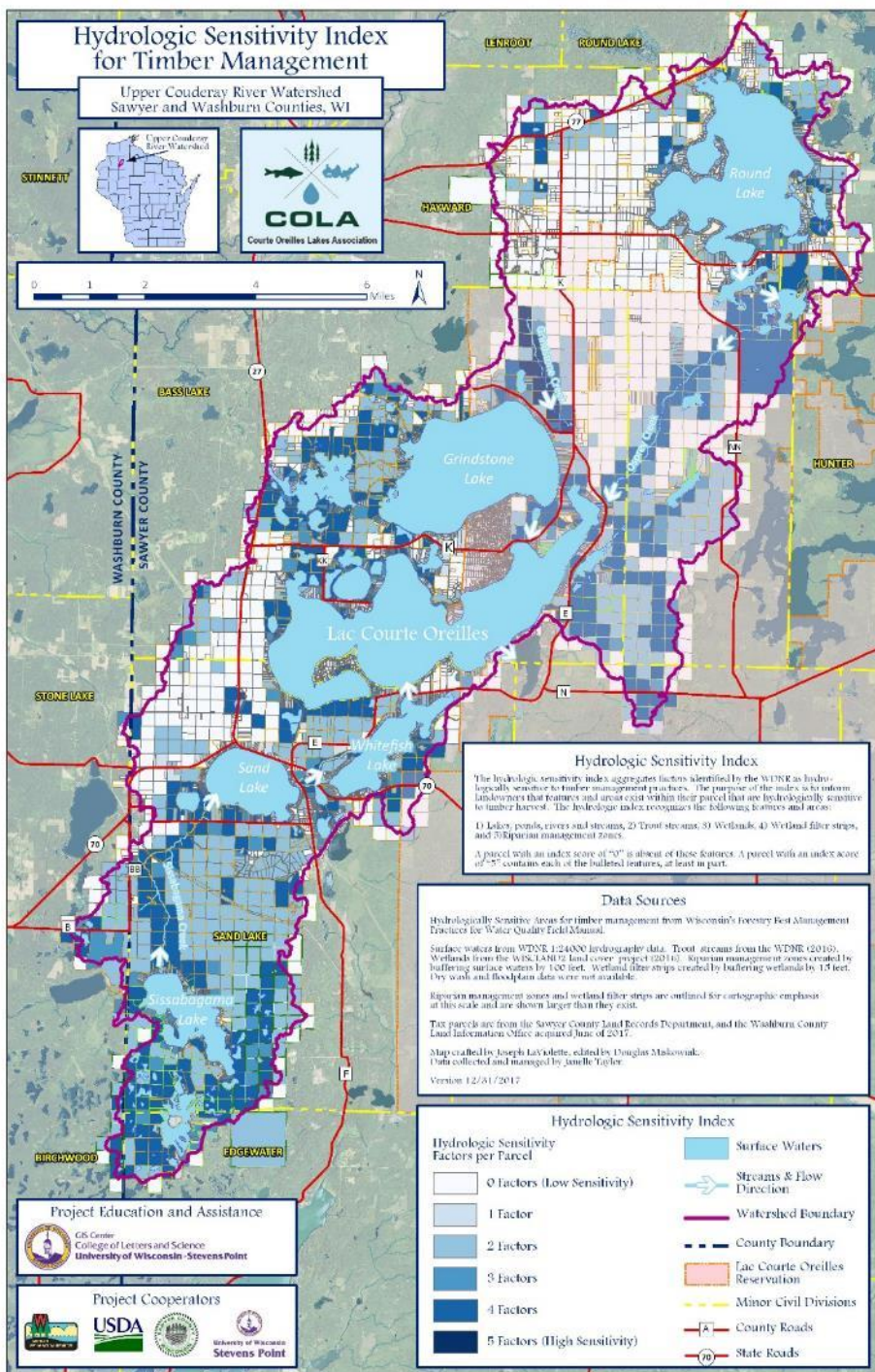
- Trout streams

- Designated by the DNR, must have a 100' buffer area regardless of width

- Wetlands

- Especially important habitat as well as ecosystem service provider
    - Wetlands must have a 15' designated buffer area called: wetland filter strips





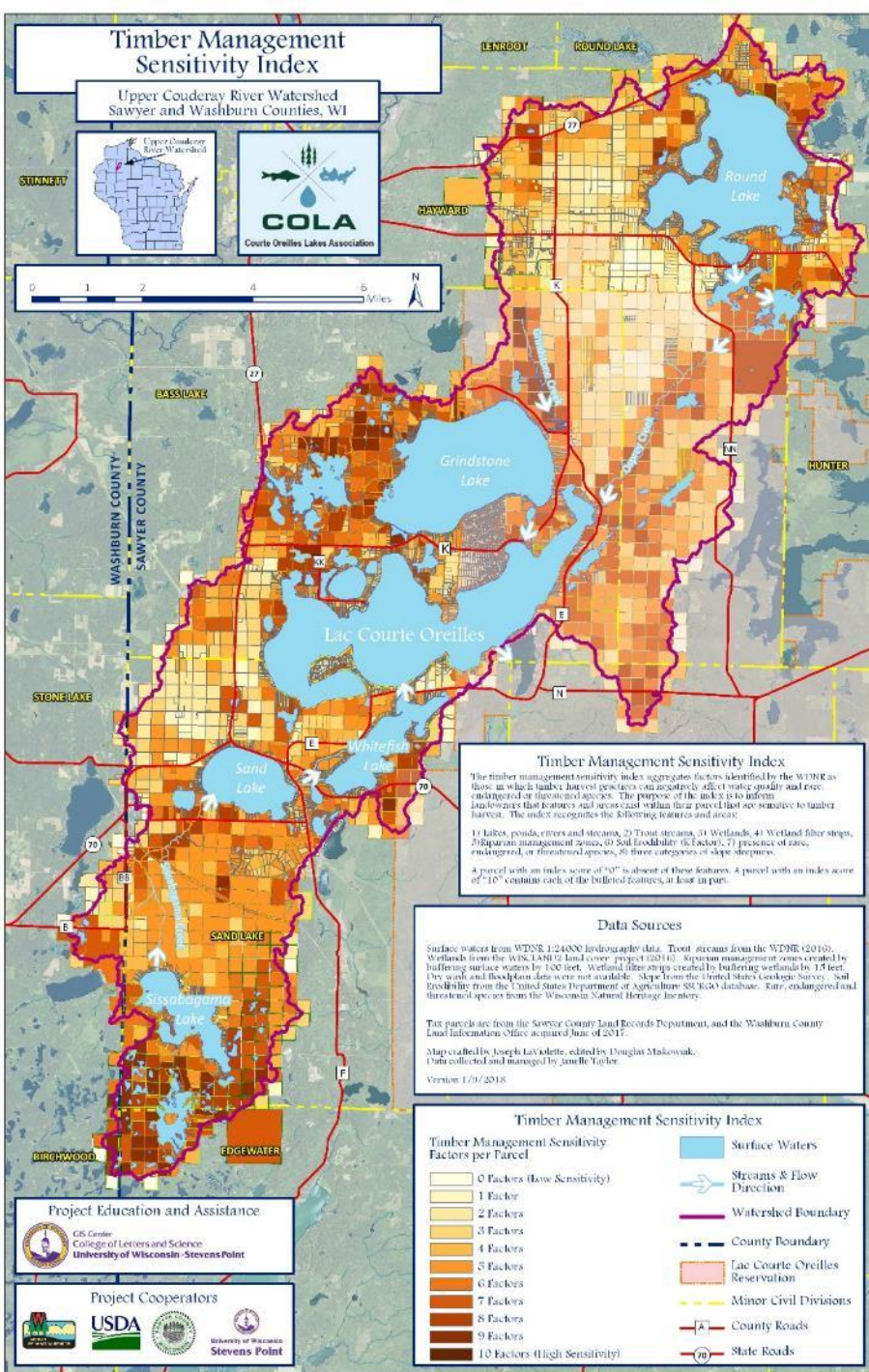
- Hydrologic Sensitivity Index for Timber Management

- An ordinal representation of the number of sensitive hydrologic factors within parcels

- Lakes/rivers/streams
- Trout streams
- Wetlands
- Riparian management zones
- Wetland filter strips

- Intended to highlight parcels of concern and promote landowners to take a closer look at their own properties



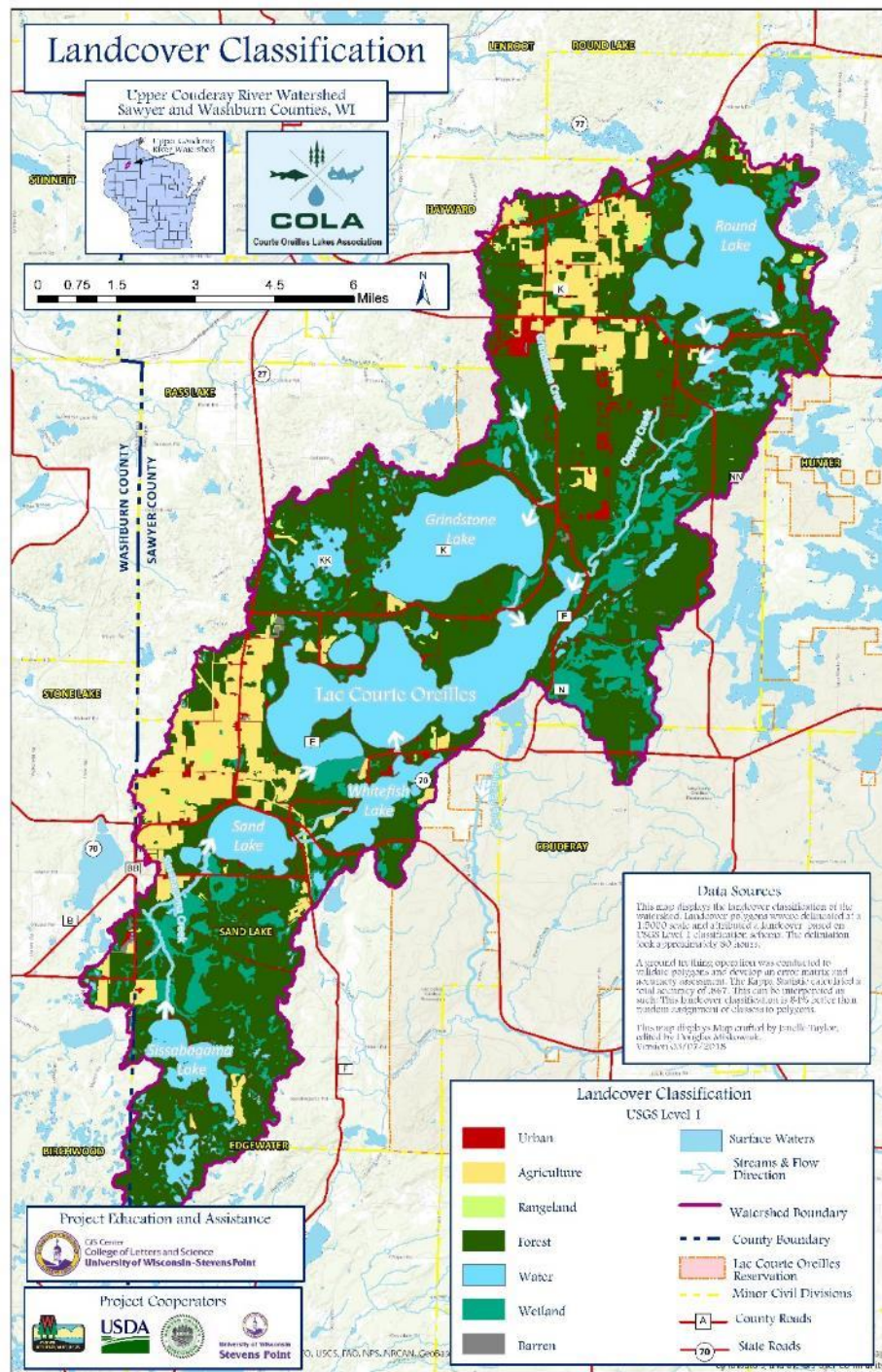


- **Timber Management Sensitivity Index**
  - An ordinal representation of the number of sensitivity factors within parcels
    - Four ranks of percent slope
    - K factor
    - Wetland filter strips
    - Riparian management zones
    - Wetlands
    - Rivers/lakes/streams
    - Trout streams
    - Sensitive species presence
  - Intended to highlight parcels of concern and promote landowners to take a closer look at their own properties



### **3. Landcover Classification and Clear-cut Inventory**





## – Landcover assessment

- Digitized at 1:5,000 scale
- Level 1 USGS classification
- Approx. 80 hours of digitizing
- Ground truthing and accuracy assessment using Kappa stat
- 84% Total accuracy





# - Identifying Areas of Even-aged Timber Management

- Even-aged management types include:

Coppicing

Seed-tree

Clear-cuts

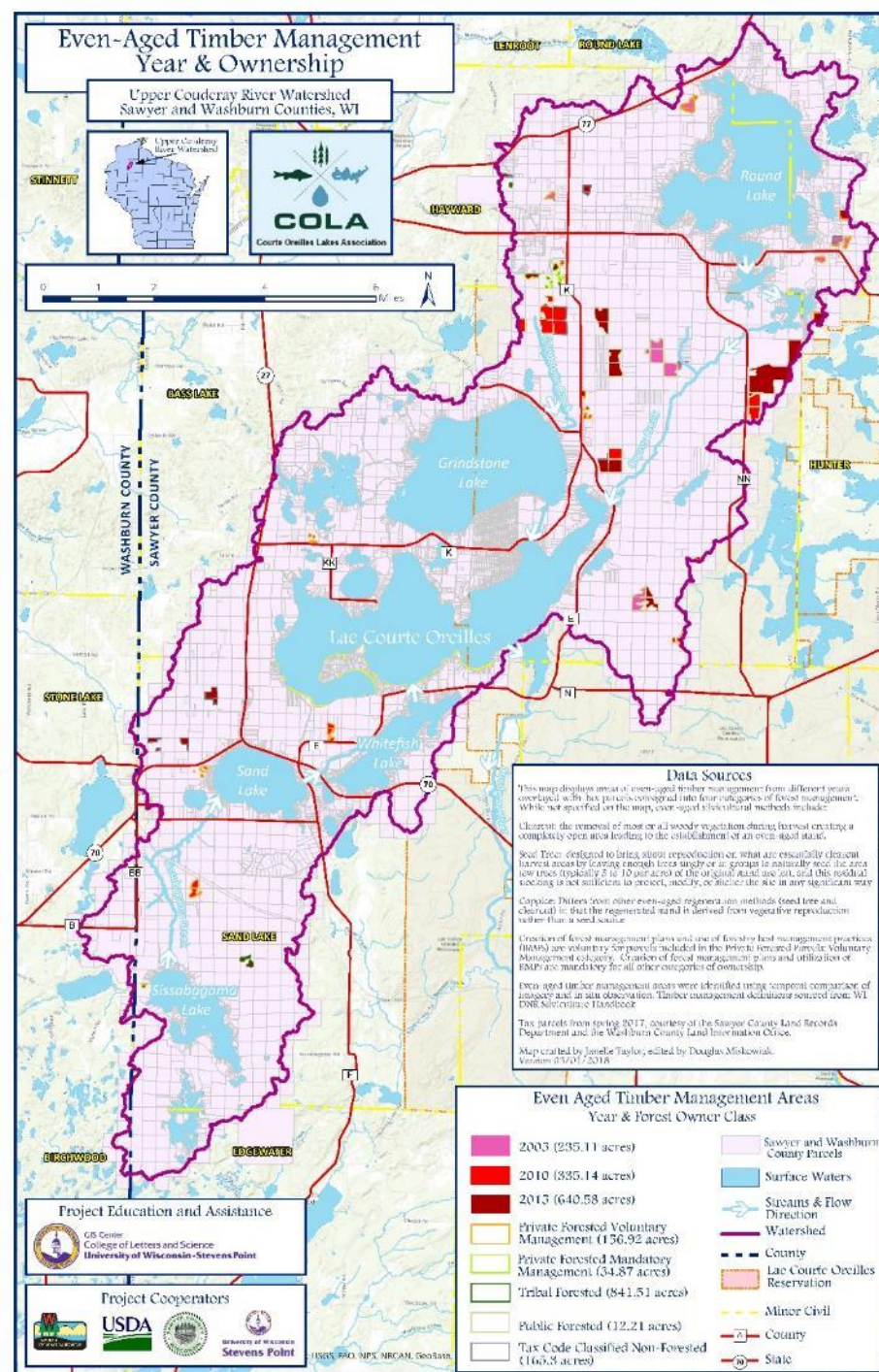


- Tested various remote sensing and visual techniques and ground truthing

- Looked at both year, and forest ownership class

Forest Ownership Class	Acres	Proportion
Null	165.319169	0.136534114
PRVM	34.86654105	0.028795646
PUB	12.20740779	0.010081877
PRV	156.9243136	0.129600954
TRB	841.5094068	0.694987409
<b>Total</b>	<b>1210.826838</b>	<b>1</b>

Year	Acres	Proportion
2005	235.1076389	0.194171149
2010	335.1433673	0.276788849
2015	640.5758322	0.529040001
<b>Total</b>	<b>1210.826838</b>	<b>1</b>





Timber Management Clear Cuts Assessment																	
Owner Name	Acres	Year	Sensitive Species	K factor	Trout Stream	Lake/River/Stream	Wetland	Riparian Mgmt Zone	Wetland Filter Strip	Slope ≥ 5%	Slope ≥ 10%	Slope ≥ 15%	Slope ≥35%	T.M.S.I.	H.S.I.	Forest Ownership Class	Parcel ID String
AMOS E & MABEL B MAST REVOC LIVING TRUST	0.0013154	2015	0	1	0	0	0	0	0	1	0	0	0	2	0		
BARRY R & DIANA J DELANEY	0.7450680	2005	0	1	0	0	0	0	0	1	1	0	0	3	0		
BENJAMIN S & DEBRA G HERSHEY	1.2688500	2015	0	0	0	0	1	1	1	1	1	1	1	7	3	PRV	230
BENJAMIN S & DEBRA G HERSHEY	0.7921340	2015	0	0	0	0	1	1	1	1	1	1	1	7	3	PRV	230
BENJAMIN S & DEBRA G HERSHEY	1.6337500	2015	0	0	0	0	1	1	1	1	1	1	1	7	3	PRV	230
BERNARD P KADLEC	0.0082877	2015	0	0	0	1	0	1	0	1	1	1	0	5	2		
CARL LANGHAM	8.2013900	2015	0	1	0	0	0	0	0	1	0	0	0	2	0		
CARL LANGHAM	20.4784000	2015	0	1	0	0	0	0	0	1	0	0	0	2	0		
CARLSON REVOCABLE LIVING TRUST	0.0137615	2005	0	0	0	0	0	0	0	1	1	0	0	2	0		
COLLEEN D PRESBREY	8.3896300	2005	0	1	0	0	1	0	1	1	1	0	0	5	2	PRV	407
DAROLD G & MARY E PETERSON	0.0019567	2015	0	0	0	0	0	1	0	1	1	1	0	4	1		
DAVID C ADAMS	0.1212550	2015	0	0	0	0	0	0	0	1	1	1	0	3	0	PRV	89
DAVID C ADAMS	0.1287100	2015	0	0	0	0	0	0	0	1	1	1	0	3	0	PRV	89
DAVID J QUADERER	0.0412540	2015	0	0	0	0	0	0	0	1	1	1	0	3	0		
DWIGHT M METCALF	2.1403800	2015	0	1	0	0	0	0	0	1	1	0	0	3	0		
DWIGHT M METCALF	0.0107771	2015	0	1	0	1	0	1	0	1	1	0	0	5	2		
DWIGHT M METCALF	12.0041000	2015	0	0	0	1	0	1	0	1	1	1	0	5	2		
DWIGHT M METCALF	0.2127770	2015	0	0	0	1	0	1	0	1	1	0	0	4	2		
DWIGHT M METCALF	8.7770600	2015	0	1	0	0	0	0	0	1	1	0	0	3	0		
DWIGHT M METCALF	0.2388730	2015	0	1	0	0	0	0	0	1	0	0	0	2	0		
ESTATE OF VINCENT A FROEMEL	0.2260570	2015	1	0	0	0	0	0	0	1	1	1	0	4	0	PRV	87
ESTATE OF VINCENT A FROEMEL	4.4787900	2015	1	0	0	0	0	0	0	1	1	1	0	4	0	PRV	86
ESTATE OF VINCENT A FROEMEL	1.5998400	2015	1	0	0	0	0	0	0	1	1	1	0	4	0	PRV	87
ESTATE OF VINCENT A FROEMEL	2.4366700	2015	1	0	0	0	0	0	0	1	1	1	0	4	0	PRV	87
ESTATE OF VINCENT A FROEMEL	1.7005900	2015	1	0	0	0	0	0	0	1	1	1	0	4	0	PRV	87
F V E INC	0.0003951	2015	0	0	0	0	0	0	0	1	0	0	0	1	0	PRV	482
F V E INC	0.0004733	2015	0	0	0	0	0	0	0	1	0	0	0	1	0	PRV	482
F V E INC	0.0020293	2015	0	0	0	0	0	0	0	1	0	0	0	1	0	PRV	482
F V E INC	0.0017916	2015	0	0	0	0	0	0	0	1	0	0	0	1	0	PRV	482
F V E INC	0.0000358	2015	0	0	0	0	0	0	0	1	0	0	0	1	0	PRV	482
F V E INC	14.3480000	2015	0	0	0	0	0	0	0	1	0	0	0	1	0	PRV	482
FRISCH TRUST	3.0765800	2005	0	0	0	0	0	0	0	1	1	1	0	3	0	PRV	509
GARY ROSSBACH	0.0107677	2015	1	0	0	0	0	0	0	1	1	1	0	4	0		
GERALD E & DEANNE FROEMEL	0.0747700	2015	0	0	0	0	1	0	1	1	1	1	0	5	2	PRV	68
GERALD O & CHRISTINA A FROEMEL	0.0003547	2015	0	0	0	0	0	0	0	1	1	0	0	2	0	PRV	75
GRANDMA'S FARM LLC	0.0038780	2015	0	0	0	0	0	0	0	1	1	1	0	3	0	PRM	53
GRANDMA'S FARM LLC	1.8682400	2015	0	1	0	0	0	0	0	1	1	1	0	4	0	PRM	56
GRANDMA'S FARM LLC	1.4187000	2015	0	1	0	0	0	0	0	1	1	1	0	4	0	PRM	56
GRANDMA'S FARM LLC	0.1119920	2015	0	1	0	0	0	0	0	1	0	0	0	2	0	PRM	57



## 4. Development of Internet Tools



# Internet Tools

## Story Mapping

- Share the story of LCO
  - Water quality/hydrologic aspects
  - Fishery
  - Effects of land management
  - Improvement strategies
- A tool to engage with the public and promote personal stewardship of common resources

## Mapping tools for Consulting Foresters

- Access to online maps to facilitate forest planning with BMPs
- User friendly for landowners
- Information available for individual parcels

# LCO Overview Story Map





# Lake Lac Courte Oreilles

A Rare and Fragile Resource in Sawyer County, Wisconsin





# Lake Lac Courte Oreilles is a Two-Story Fishery

In two-story fisheries, warm-water and cold-water fish species coexist in the same water body.

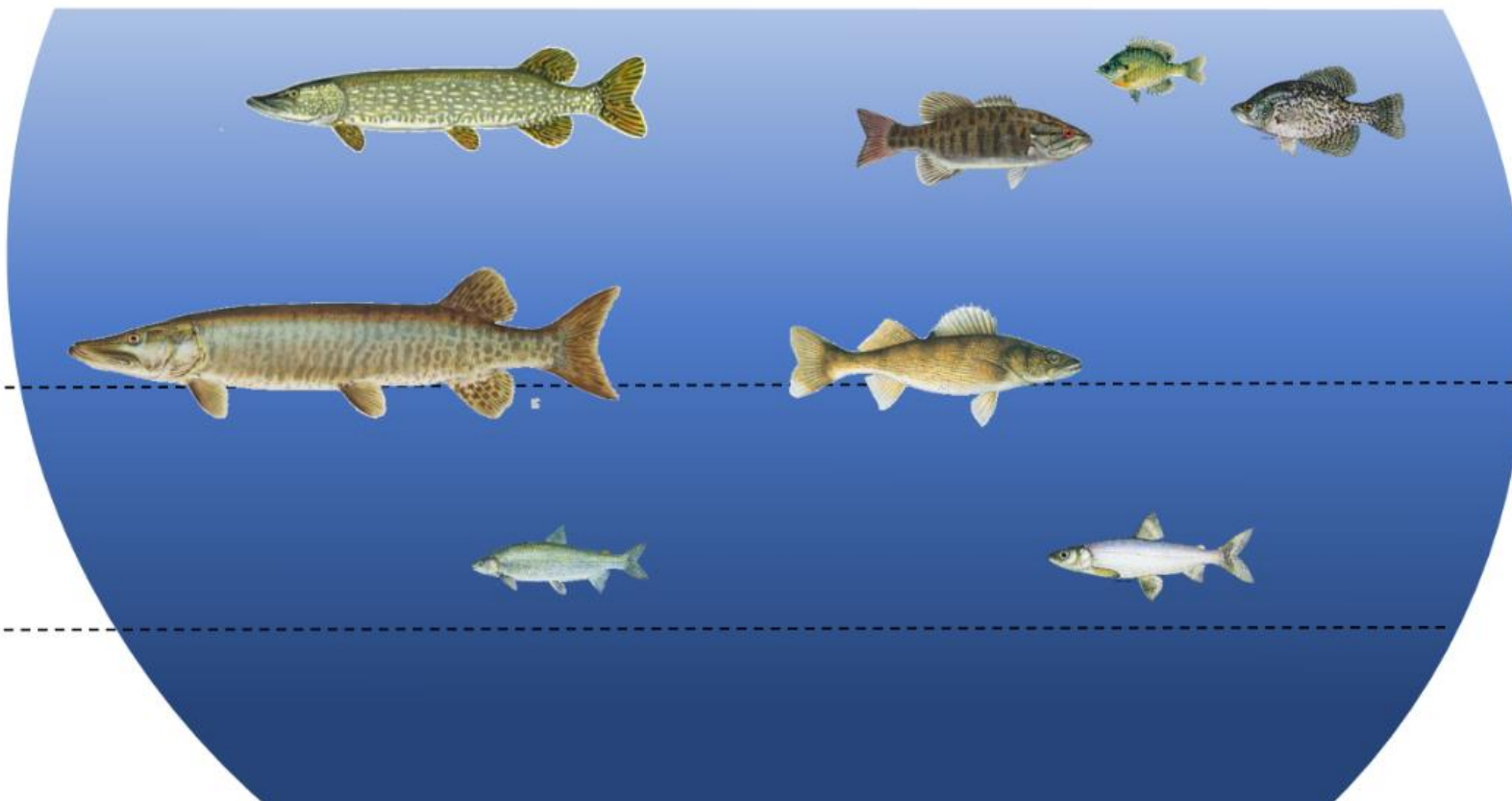
0  
Feet

Epilimnion: Upper layer (~34 ft)  
-Warm  
Temperature  
-Oxygen provided from wind and plant growth

Depth

Metalimnion: Middle layer (35-37 ft)  
-Colder  
Temperature  
-Lower oxygen levels

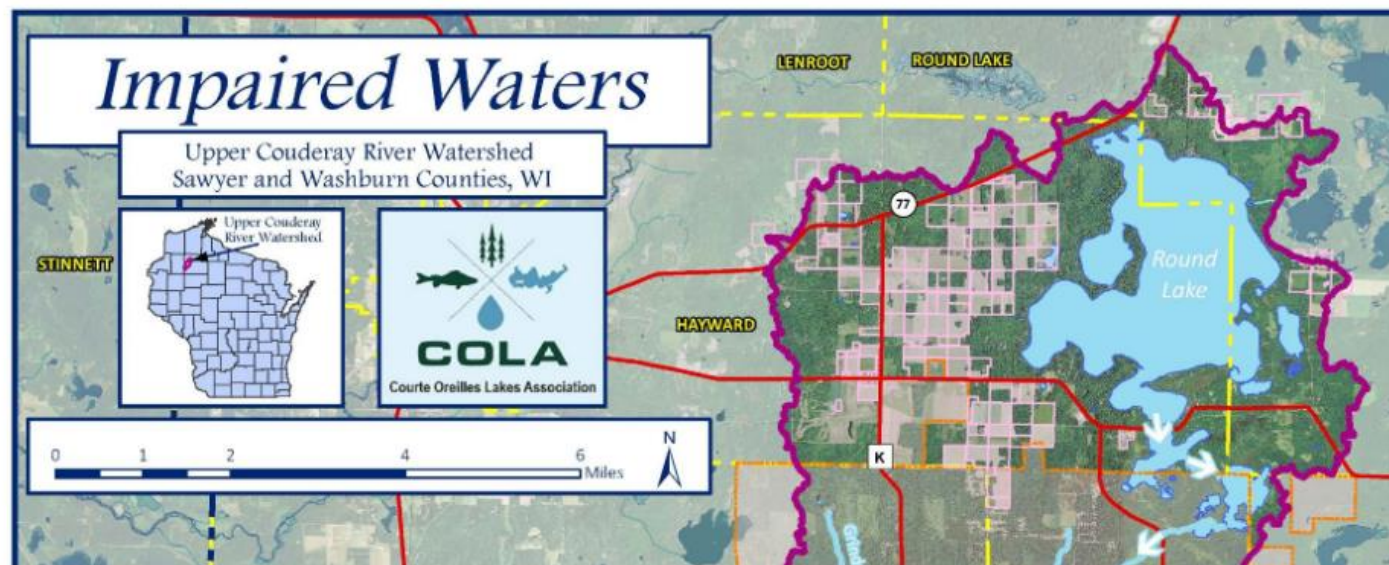
Hypolimnion: Bottom layer





# Impaired Water Status

Impaired water status means that a waterbody does not meet water quality standards and prompts action to restore conditions. Under the Clean Water Act 303(d), impaired waters are assigned priority for analyzing its Total Maximum Daily Load (TMDL) for phosphorus. A TMDL identifies the maximum amount of pollution that a water body can receive while still meeting water quality standards. LCO's watershed contains various surface waters that have been declared impaired. These waters include Windigo Lake, Sissabagama Lake, Whitefish Lake, and Musky Bay of LCO.





# Shoreland Development and Buffers

Equipped with GIS and assistance from Indiana University, COLA mapped and prioritized shoreland parcels based upon slope (flat, moderate, steep), shoreland cover (sand, vegetation, lawn, etc) and distance to inland vegetation (0-30 feet). The result indicates which parcels are high risk to aquatic habitats and water quality.

Street	
City	
Zip	
Date Surveyed	
Wall Presence/Absence	0
Buffer Score A	0
Buffer Score B	0
Erosion Presence/Absence	0
Slope Index 0-2	0
Relative Priority	0
PhotoPath2	

**Legend**

Shoreline Points - 2015

○

Shoreline Parcels - 2015

Relative Priority

- 14 to 15
- 10 to 13
- 6 to 9
- 3 to 5
- 0 to 2

This map is interactive! Zoom in and out in the lower right corner and click on features to view more details.



# Septic Systems

Failure of a private sewage system can cause discharges of sewage into surface or ground water. In 2013, 695 septic systems on 815 parcels on Big and Little LCO were inspected. Thirty-eight systems were considered failing and 106 orders were delivered to landowners for corrective maintenance and servicing or replacement. Orders for correction were sent to owners as a legal document from Sawyer County with deadlines for correcting issues.

**Parcel Info**

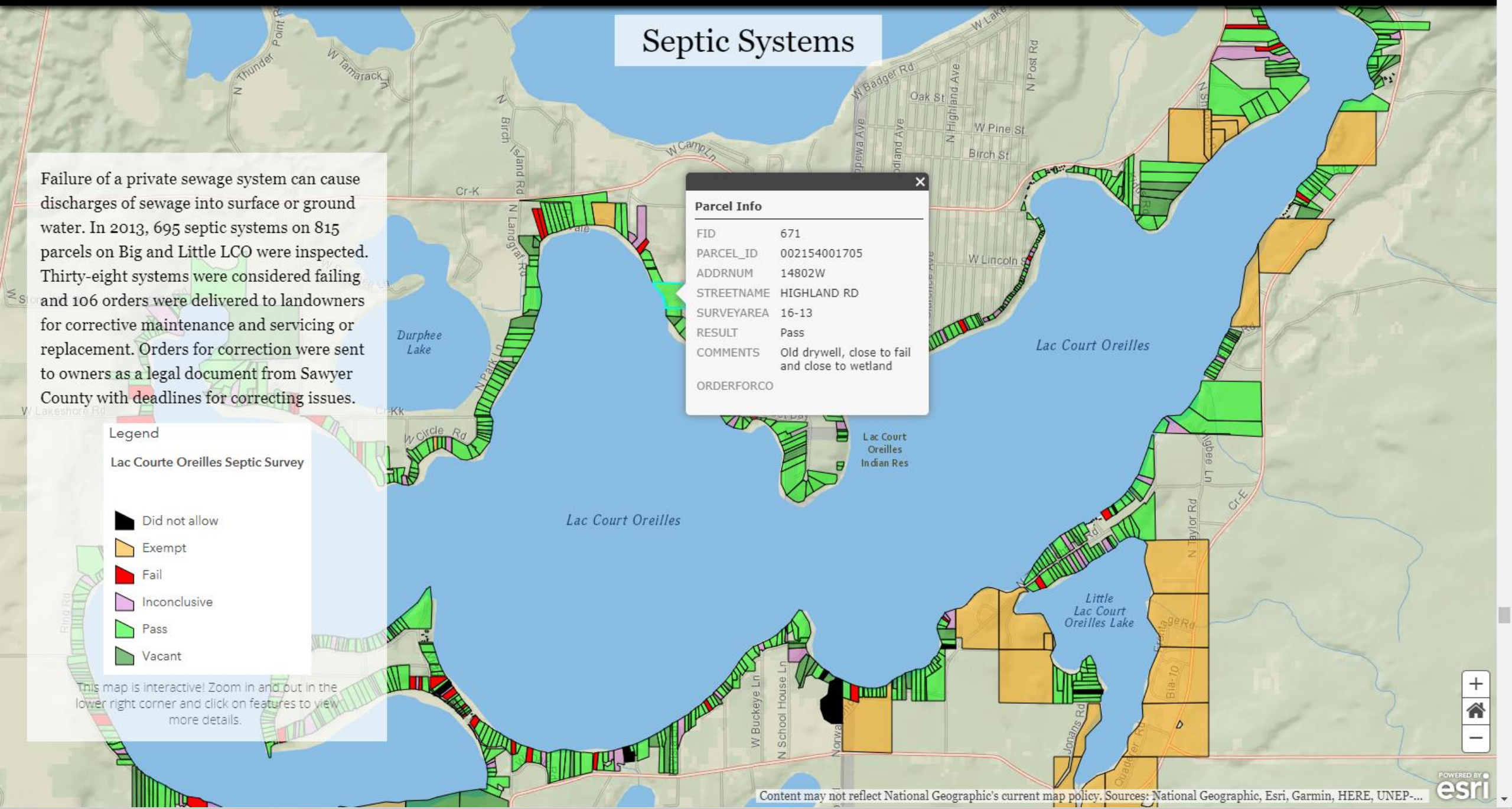
FID	671
PARCEL_ID	002154001705
ADDRNUM	14802W
STREETNAME	HIGHLAND RD
SURVEYAREA	16-13
RESULT	Pass
COMMENTS	Old drywell, close to fail and close to wetland
ORDERFORCO	

**Legend**

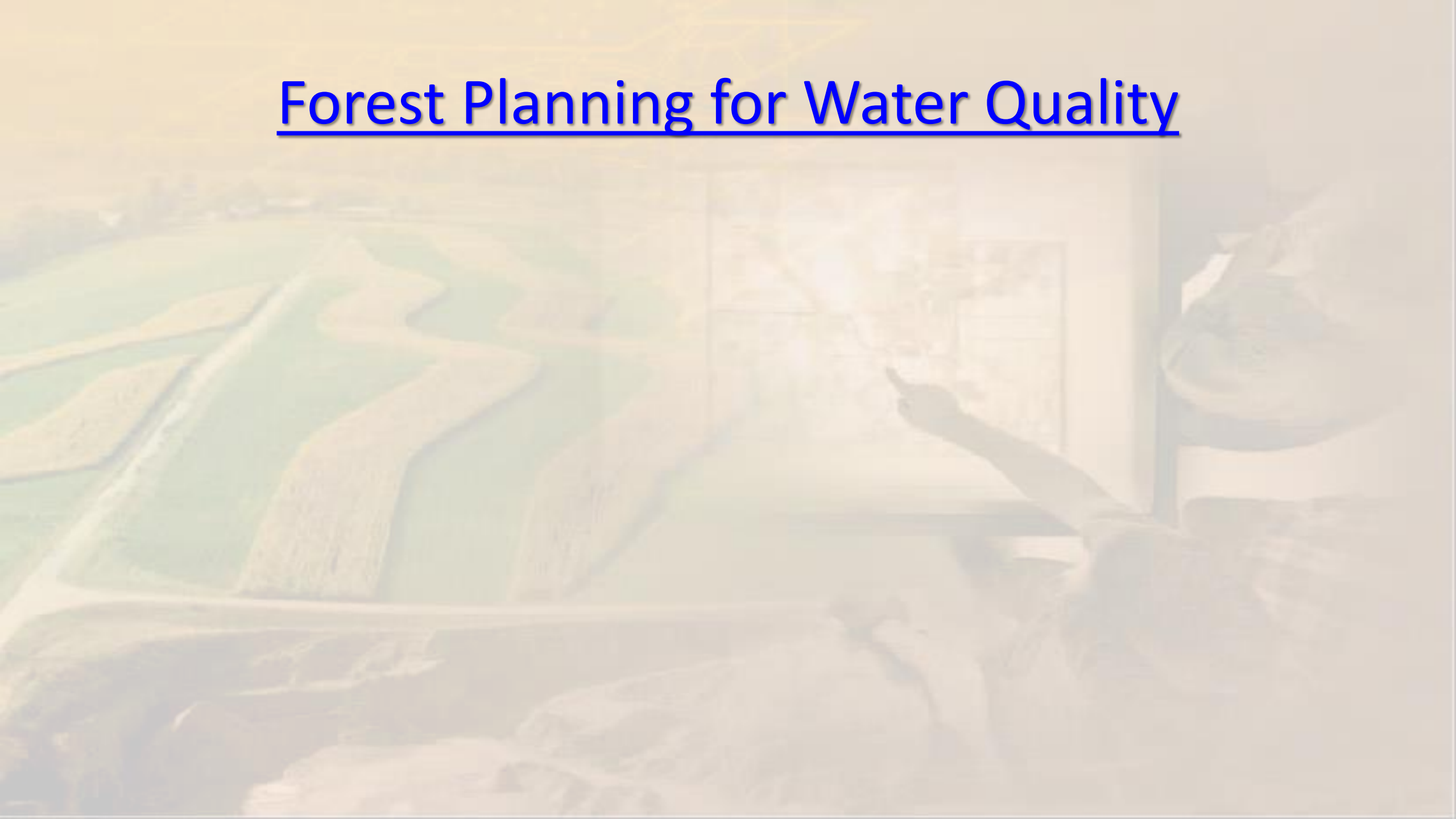
Lac Courte Oreilles Septic Survey

- Did not allow
- Exempt
- Fail
- Inconclusive
- Pass
- Vacant

This map is interactive! Zoom in and out in the lower right corner and click on features to view more details.



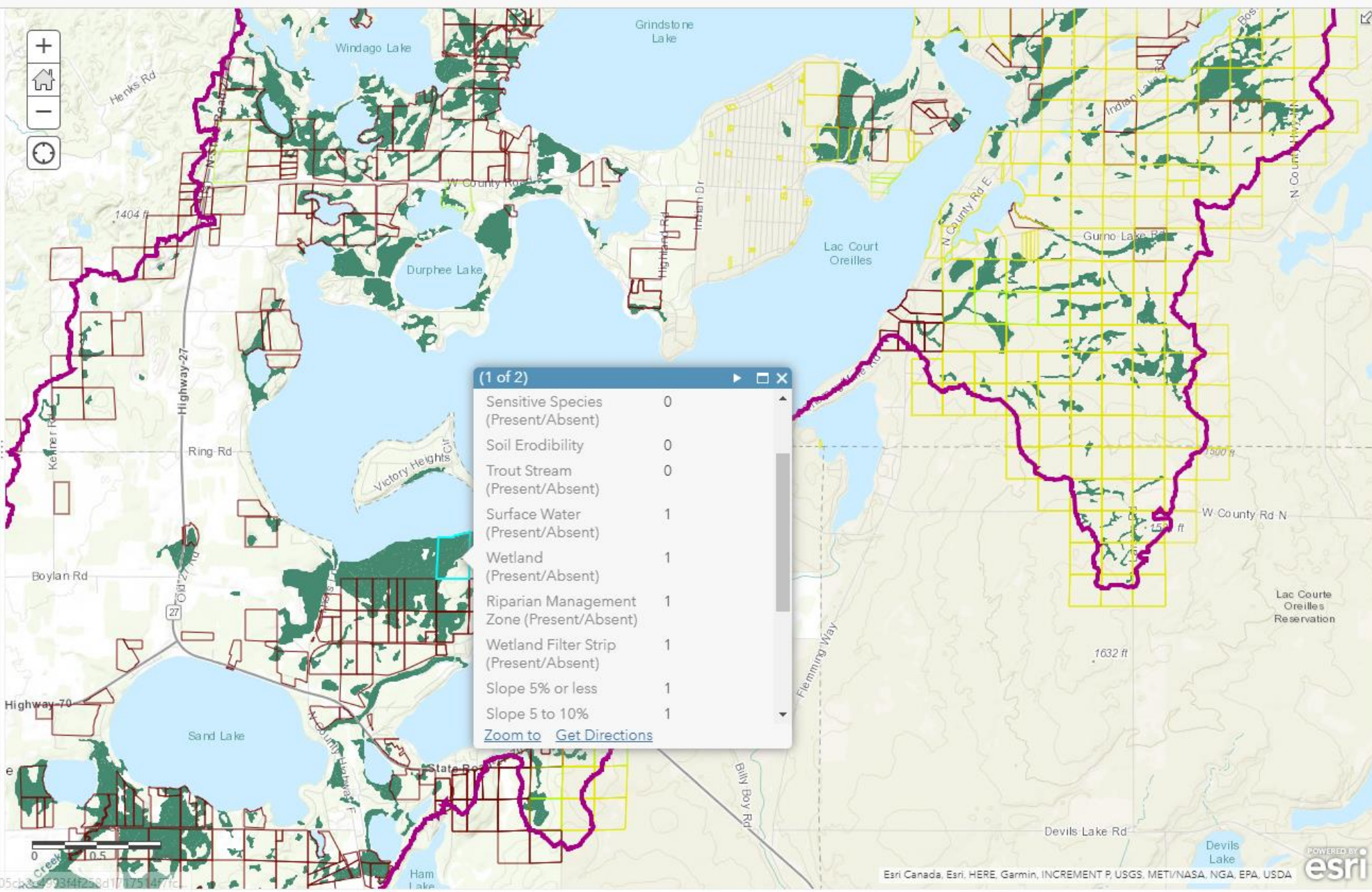
# Forest Planning for Water Quality





Contents

- Upper Couderay River Watershed
- Forested Ownership Classification (Polygon)
- Forested Ownership Classification (Polygon Outline)
- Lac Courte Oreilles Reservation (Polygon Outline)
- Lac Courte Oreilles Reservation (Polygon)
- Trout Streams
- Lakes and Ponds
- Rivers and Streams
- Riparian Management Zones
- Wetlands
- Wetland Filter Strips
- Timber Management Sensitivity Index
- Hydrologic Sensitivity Index
- Topographic





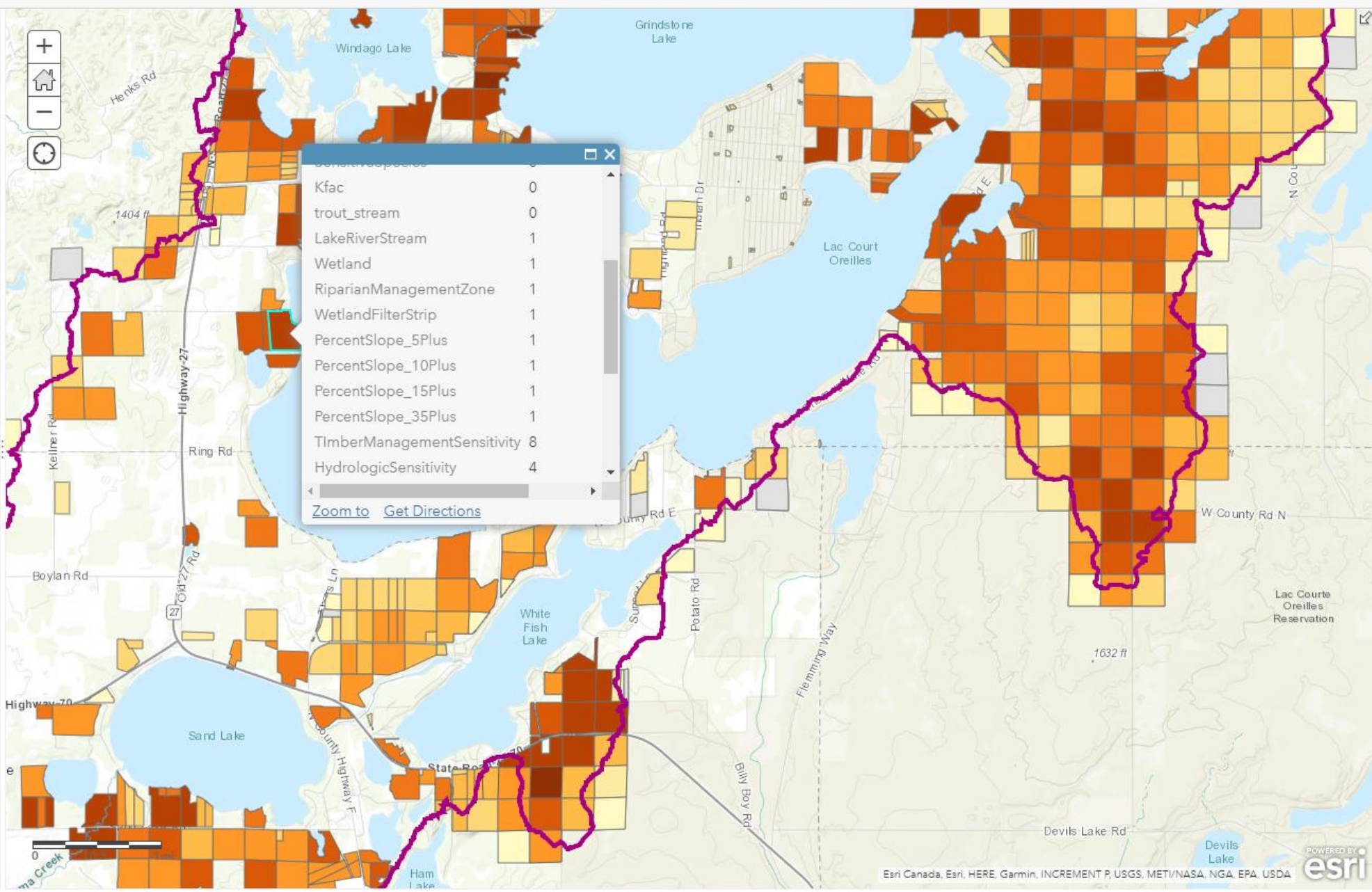
Details Add Basemap Analysis

Save Share Print Directions Measure Bookmarks Find address or place

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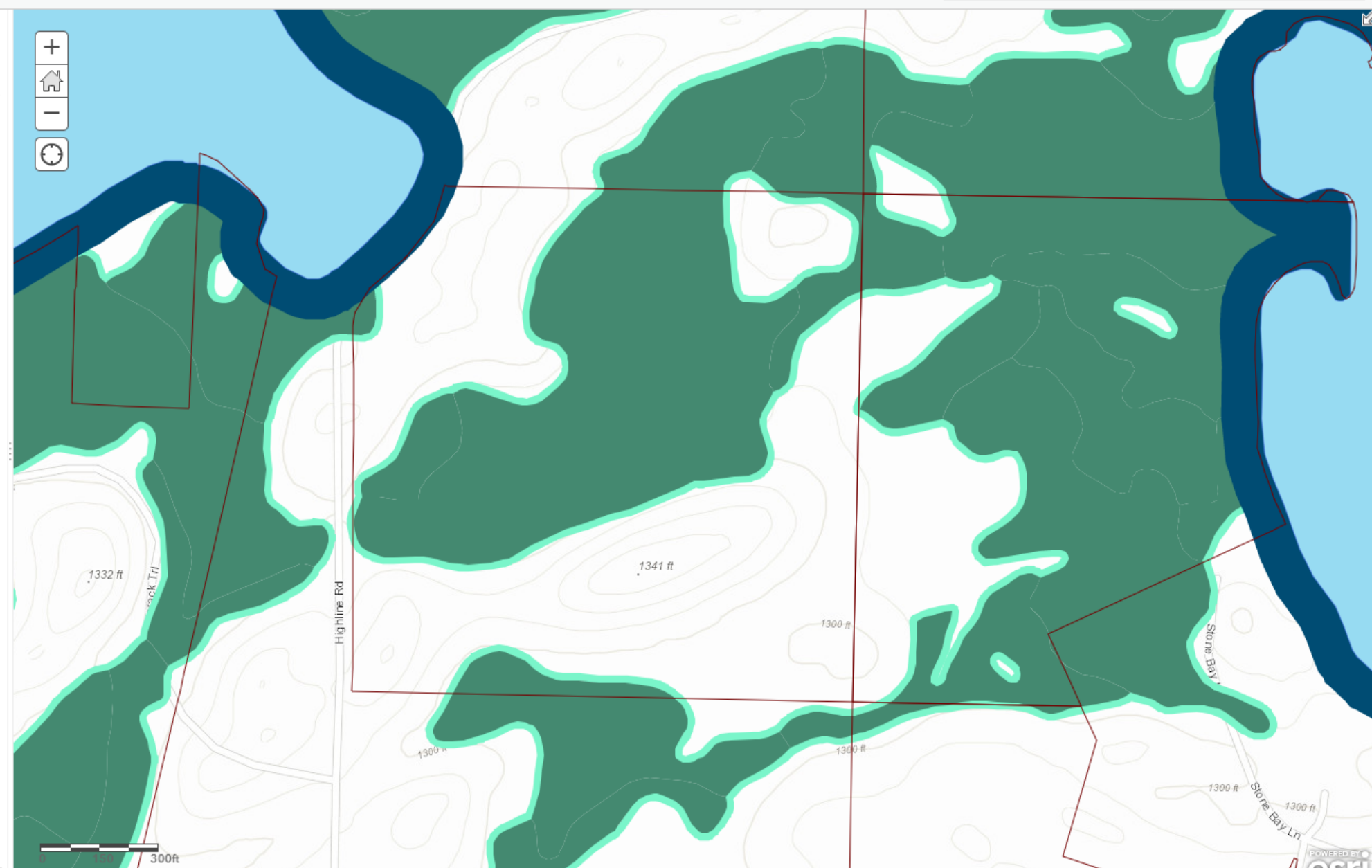
Details Add ▾ | Basemap | Analysis Save ▾ Share Print ▾ | Directions Measure Bookmarks

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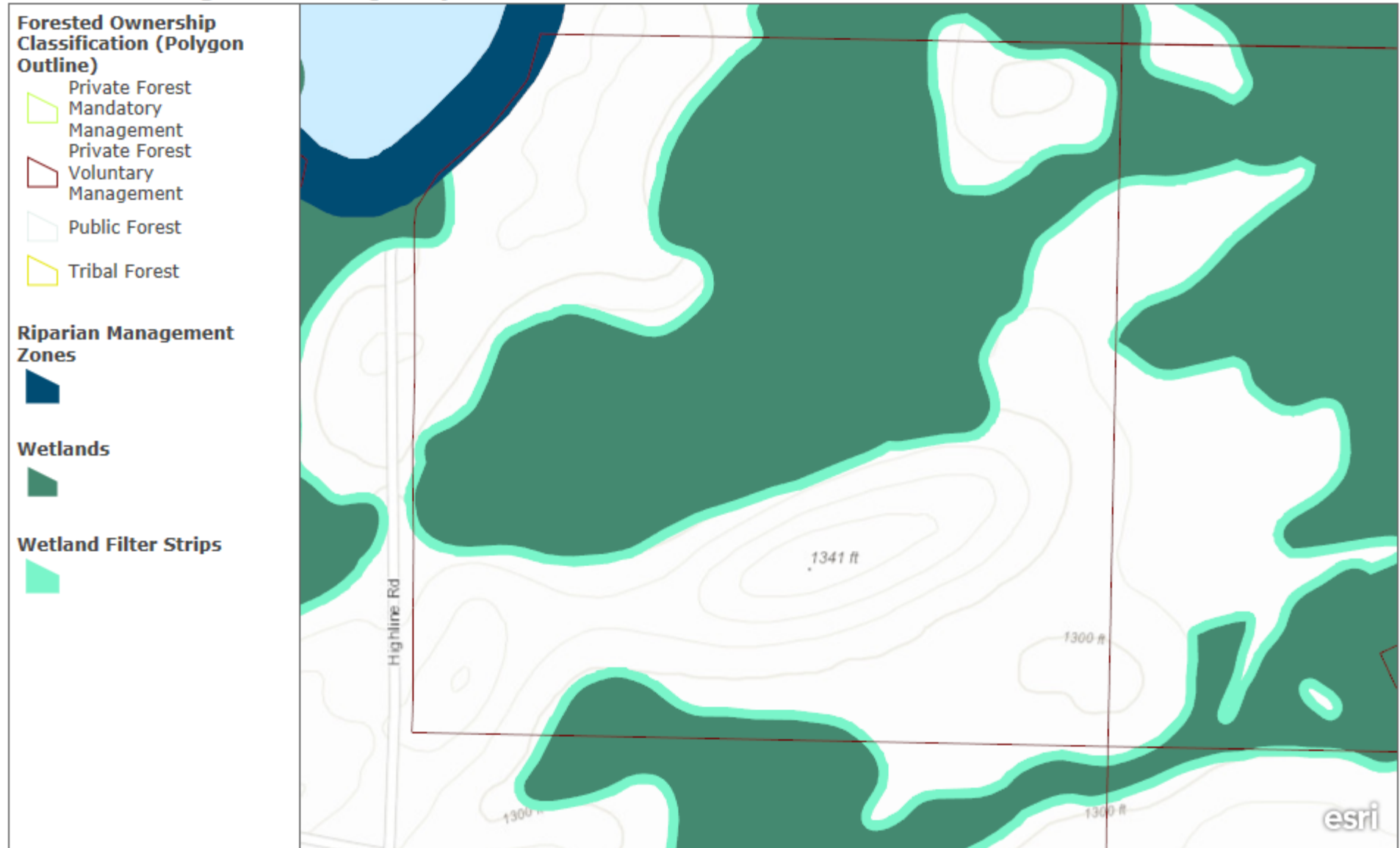
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## Forest Planning for Water Quality



This map is designed for landowners and consulting foresters working in the Upper Couderay River Watershed to assist with forest planning for best practices and water quality protection.



# Acknowledgements

- Courte Oreilles Lakes Association (COLA)
  - Project funding and administration
    - Mark Lastrup
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