Osoyoos Lake
Water Quality Status and Trends

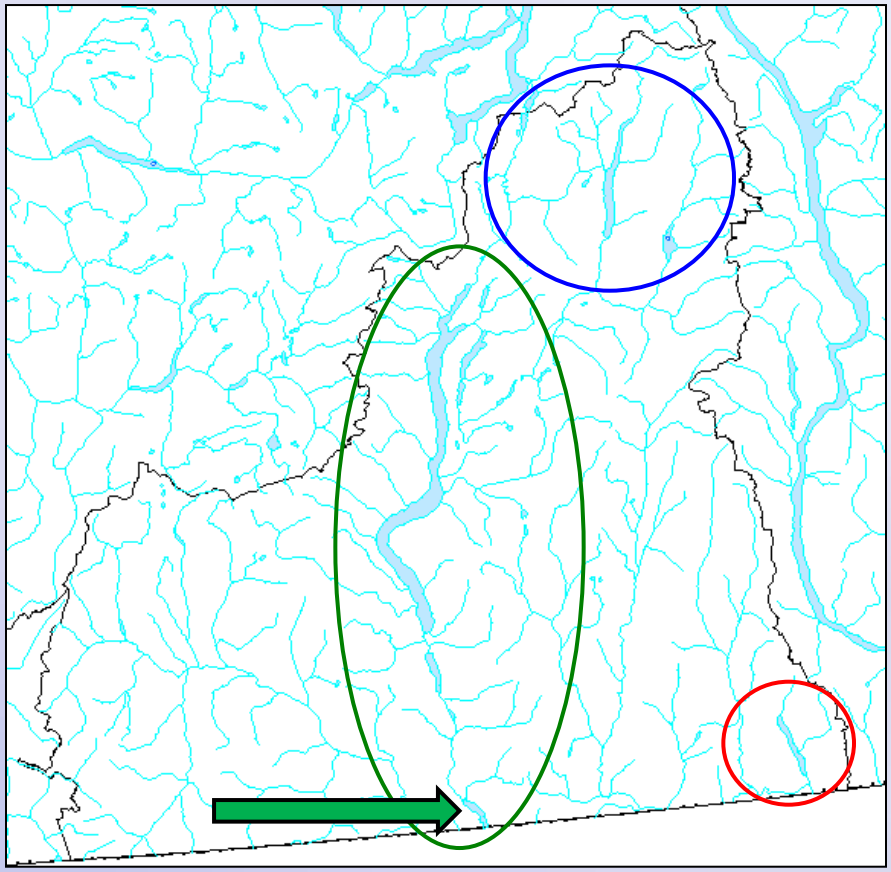
OLWQS Meeting - November 16, 2017

Michael Sokal, PhD
Environmental Protection Division, BC Ministry of Environment

Past Regional Sampling Area

Large Lakes Water Quality Trend Monitoring Program

1960s/1970s to 2014



Ellison Lake

Wood Lake

Kalamalka Lake

Okanagan Lake

Skaha Lake

Osoyoos Lake

Sugar Lake

Mabel Lake

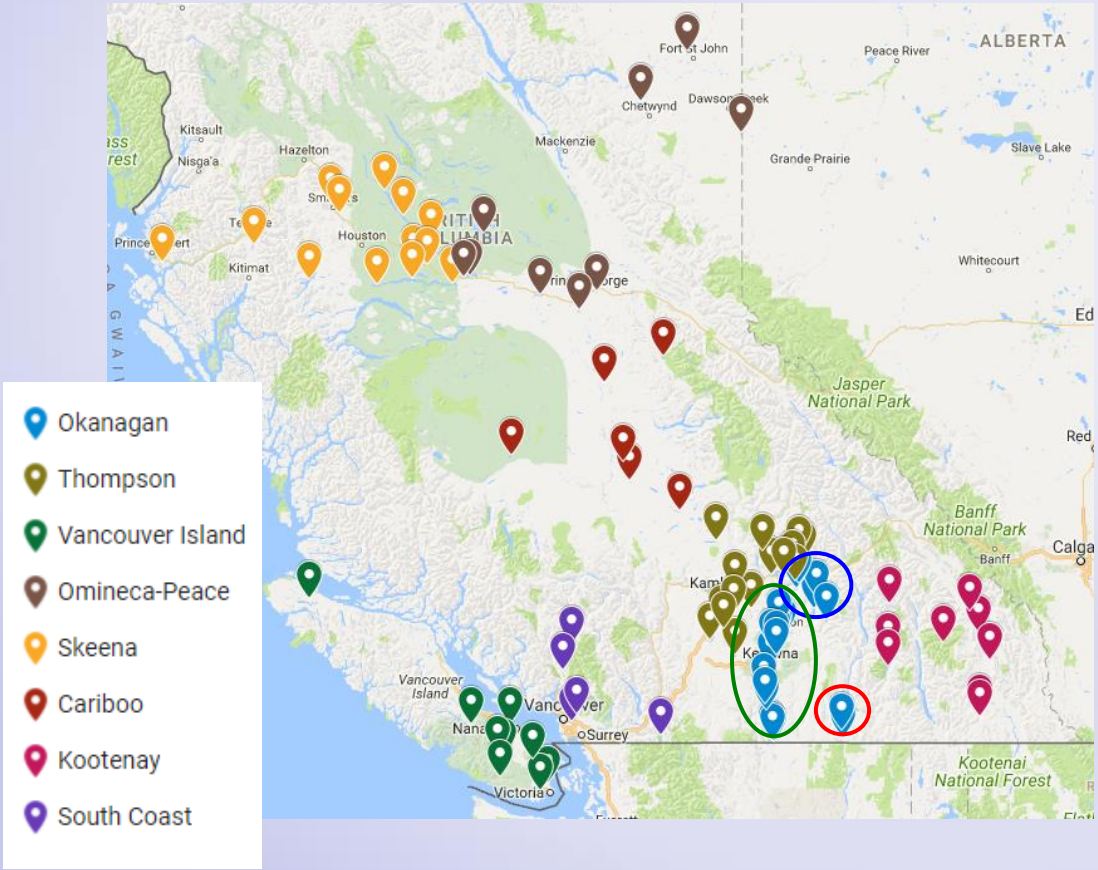
Mara Lake

Christina Lake

Total of 10 lakes (22 sites)

BC Lake Monitoring Network

Sampling 2015-Present



<u>Province-wide program</u> delivery of lake monitoring and stewardship functions

- Development and implementation of a cost-effective, science-based provincial lakes monitoring network
- **2017 = 60 Lakes (87 sites)**

BC Lake Monitoring Network

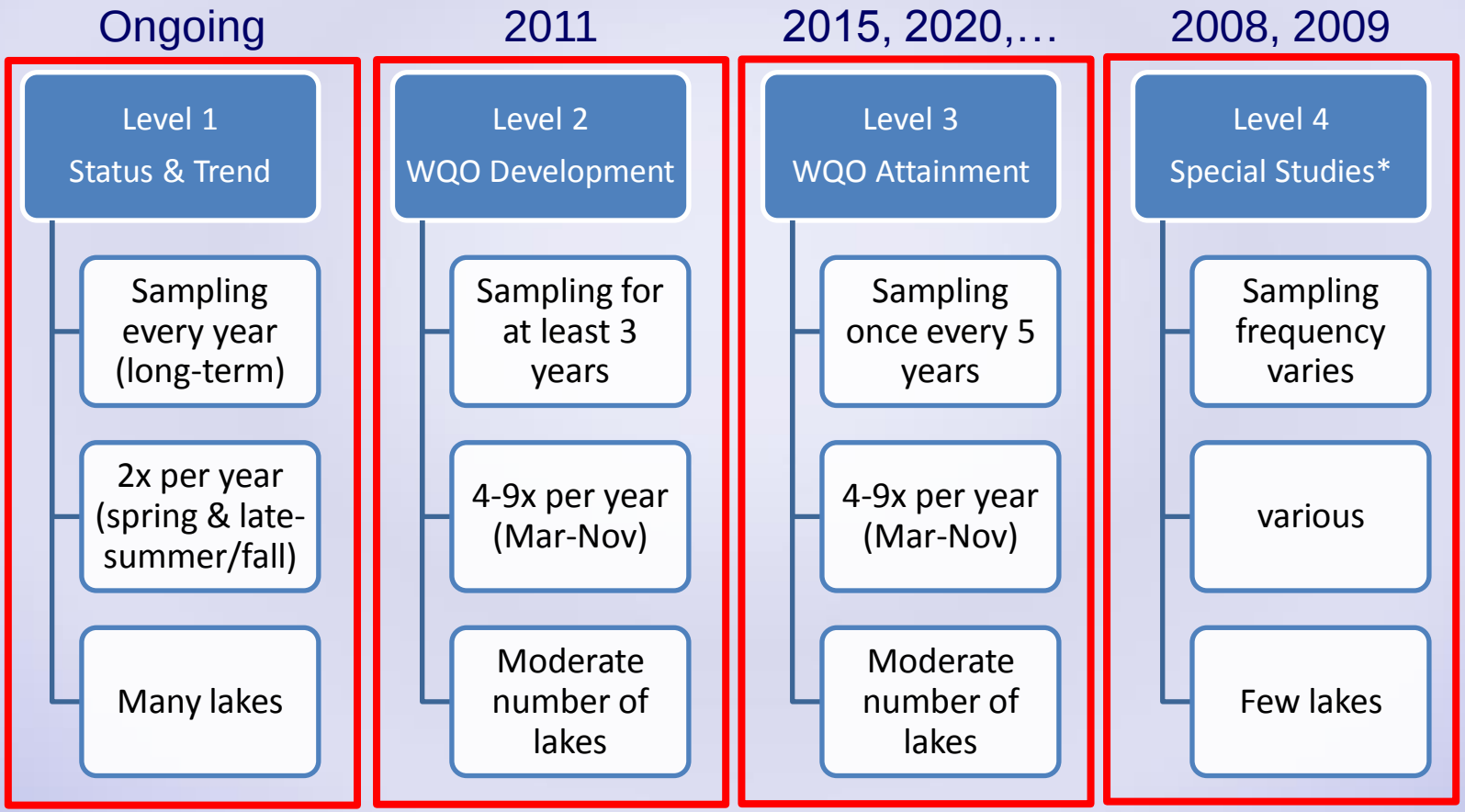
Goals

- Determine background water quality
- Assess status and trends
- Assess potential cumulative risks
- Evaluate effectiveness of regulations
- Evaluate Water Quality Objectives
- Provide accessible, accurate and timely water quality data
- Develop partnerships
- Provide strategic co-ordinated approach to sampling

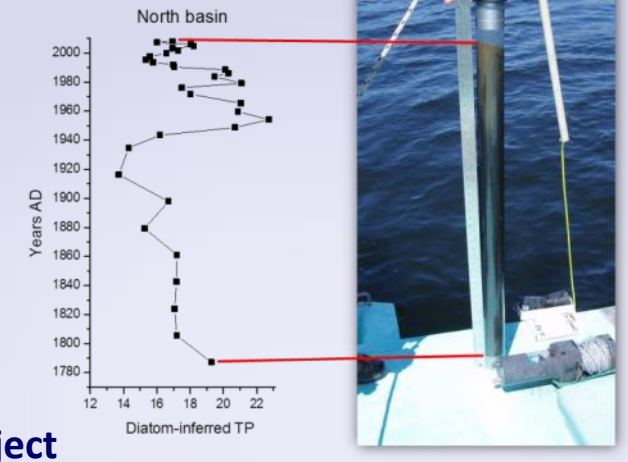
BC Lake Monitoring Network

Sampling Strategy

Osoyoos Lake…

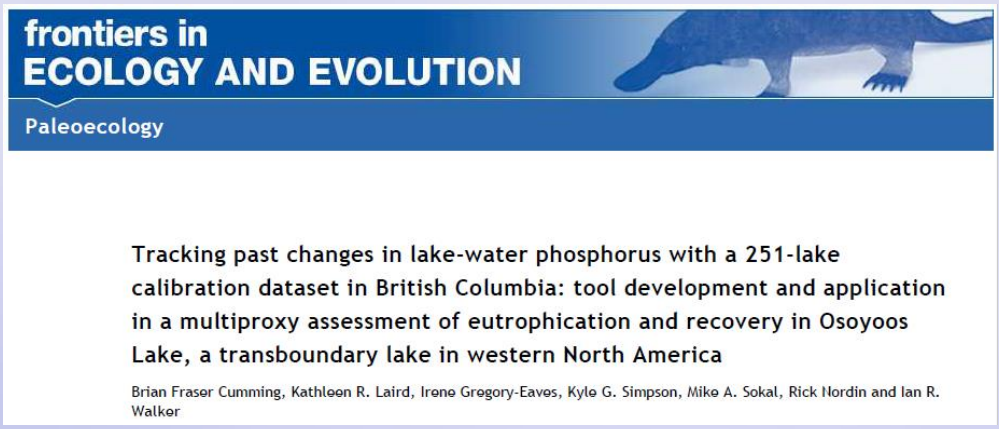


*special studies may include EIA, regulatory effectiveness, biomonitoring, paleolimnology, etc.



Osoyoos Lake Sediment Coring Project

- To establish an estimate of water quality conditions in Osoyoos Lake early in the settlement period using paleolimnological techniques.
- To establish an estimate of water column phosphorus for the past ~200 years.


frontiers in
ECOLOGY AND EVOLUTION

Paleoecology

Tracking past changes in lake-water phosphorus with a 251-lake calibration dataset in British Columbia: tool development and application in a multiproxy assessment of eutrophication and recovery in Osoyoos Lake, a transboundary lake in western North America

Brian Fraser Cumming, Kathleen R. Laird, Irene Gregory-Eaves, Kyle G. Simpson, Mike A. Sokal, Rick Nordin and Ian R. Walker

2008, 2009

Level 4
Special Studies*

- Sampling frequency varies
- various
- Few lakes

Goals of water quality monitoring in Osoyoos Lake

- Provide water quality data for the lake, to inform decision makers and the public.
- Assess the water quality status and trends in response to watershed and climate change, pollution control, and other management actions .
- Compare water quality to Water Quality Objectives (WQO) for key parameters and determine trophic status.

Water Quality Objectives

- WQO are site-specific management targets, which provide safe levels of substances to protect water quality for various uses.
- Osoyoos Lake WQO established in 2011.
- Targets for dissolved oxygen, total phosphorus, phytoplankton chlorophyll-a, Secchi depth, and cyanobacteria biomass.
- Sampled on a 5 year schedule (most recently in 2015).

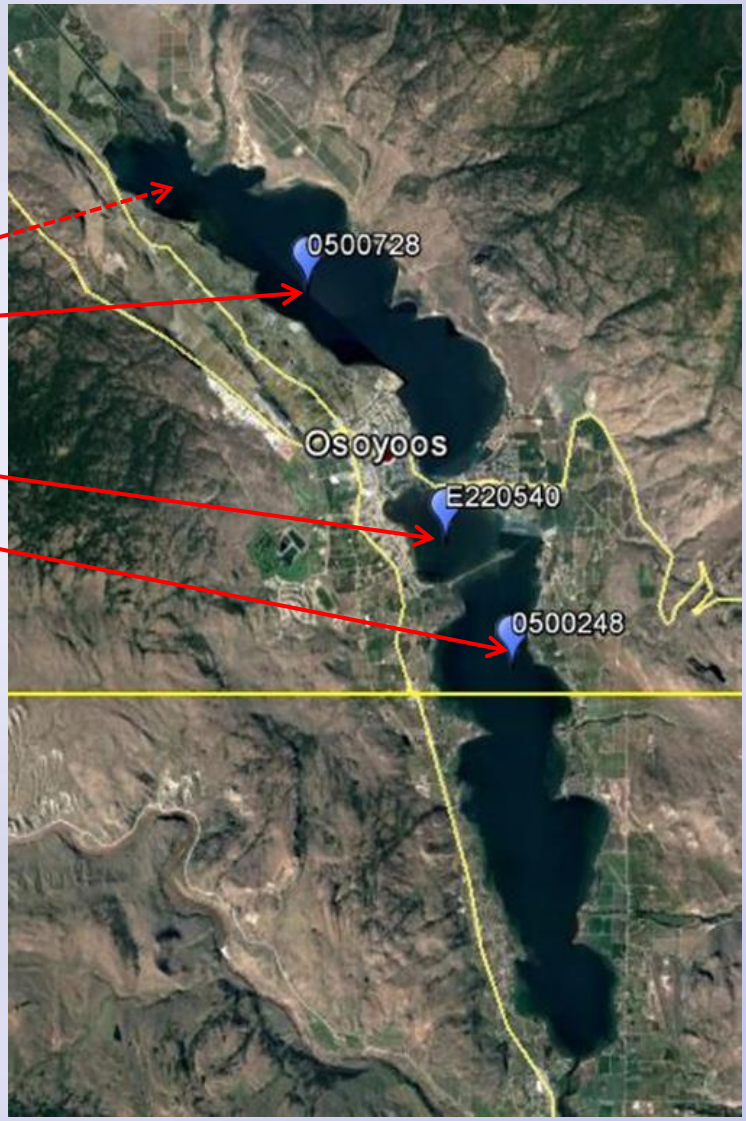
Osoyoos Lake Sampling: locations & frequency

- **ENV** 3 main sites:
  - *(North End site discontinued in 2011)*
  - North basin (64 m) site
  - Central basin (30 m) site
  - South basin (27 m) site

- **ENV** samples twice/year:
  1. Late-Winter/spring (mixed conditions)
  2. Late-Summer/Fall (stratified conditions)

- **ENV** also samples monthly (May-Aug) every 5 years (WQO attainment).

- **OLWQS** sampling conducted weekly July – September at 5 sites.

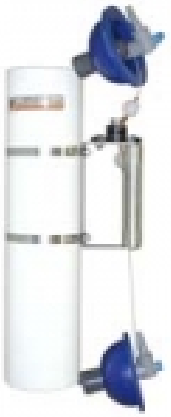


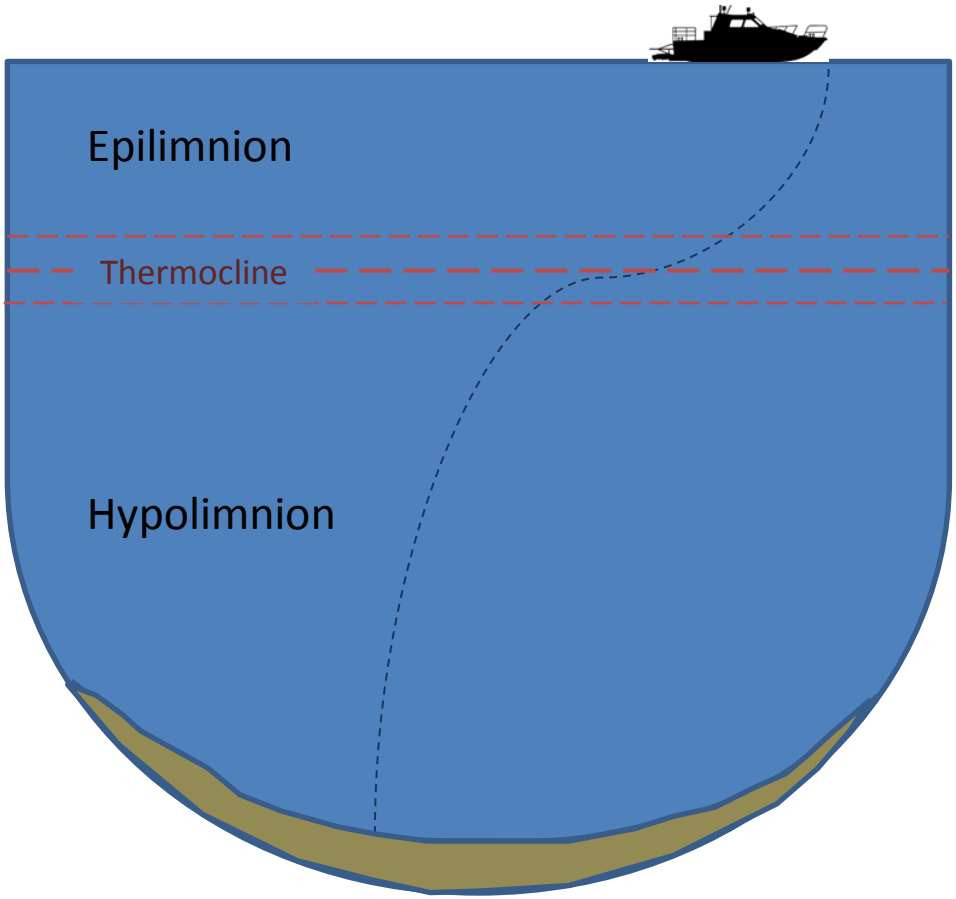
Osoyoos Lake Sampling: WQ parameters

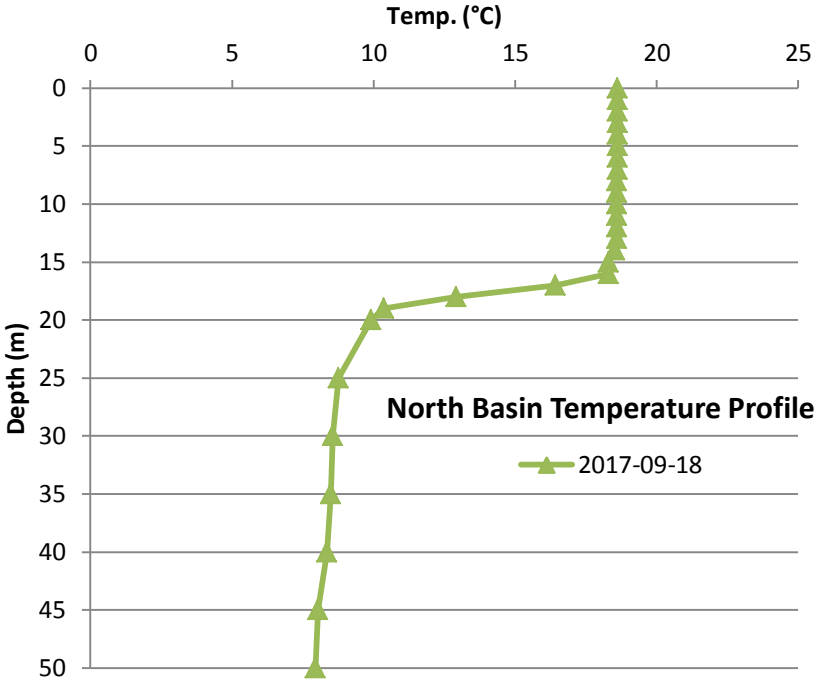
- **OLWQS** sampling includes:
  1. **Vertical Profile:** temperature, dissolved oxygen
  2. **Water Clarity:** Secchi depth
  3. pH & specific conductance
- **ENV** sampling includes:
  1. **Vertical profiles:** temperature, dissolved oxygen, Chlorophyll-a (*pH, turbidity and sp. conductance to be added in 2018*)
  2. **Water Clarity:** Secchi depth
  3. **Key Nutrients :** N & P
  4. **Chlorophyll-a** (algal productivity)
  5. **Other parameters**: Silica, Total Organic Carbon, Hardness ($CaCO_3$), Chloride, Sulphate, Calcium, Magnesium, and Metals (spring sample only)

Water Chemistry Sampling

Van Dorn Sampler



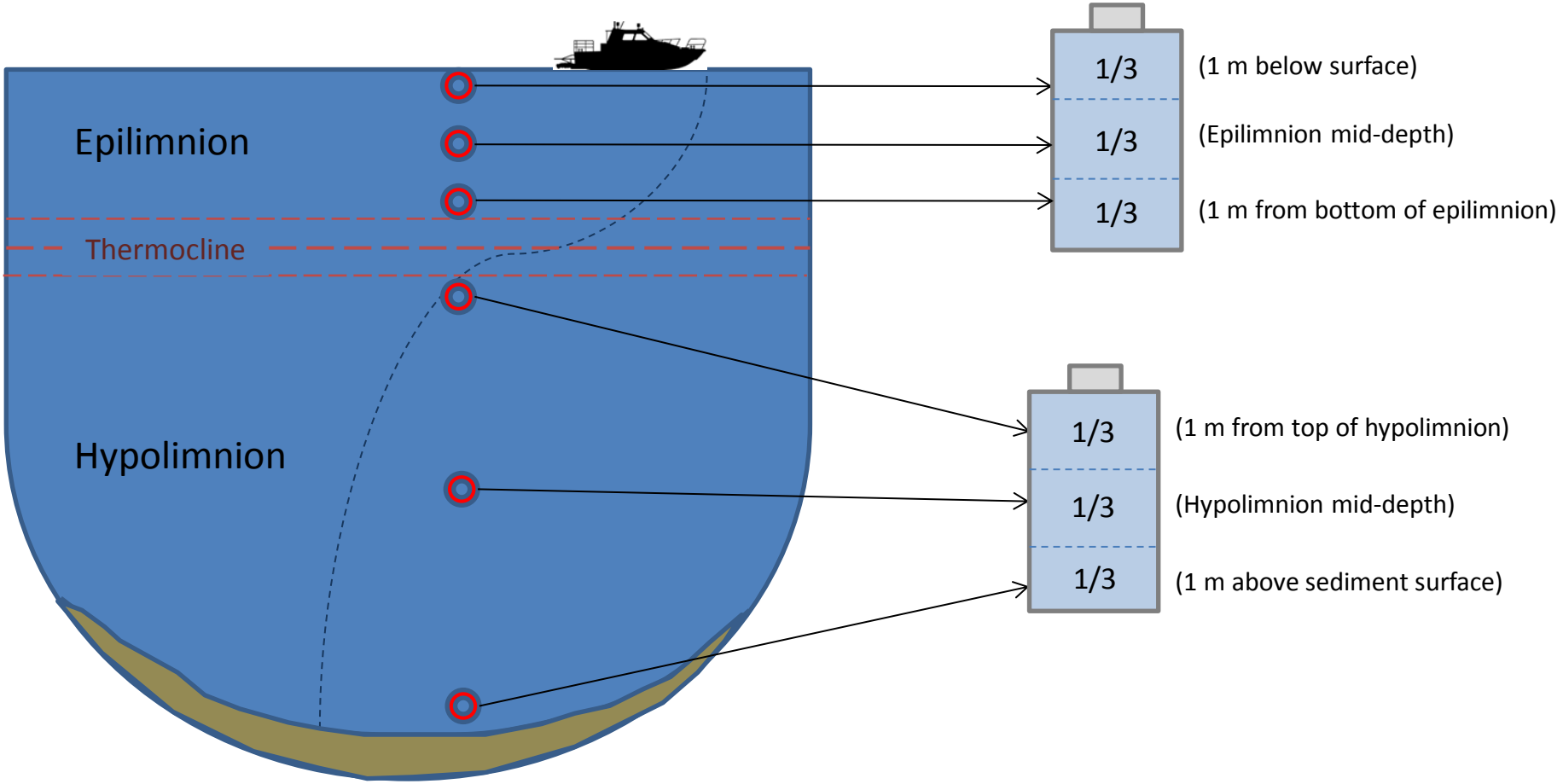




Water chemistry collected from 2 water layers:

Epilimnion = shallow (1-10m all basins)
Hypolimnion = deep (~20-45m north, ~20-30m central, and ~20-27m south)

Composite sampling for a deep lake (>10 m)



Osoyoos Lake Water Quality Sampling

Water Chemistry
Total Phosphorus

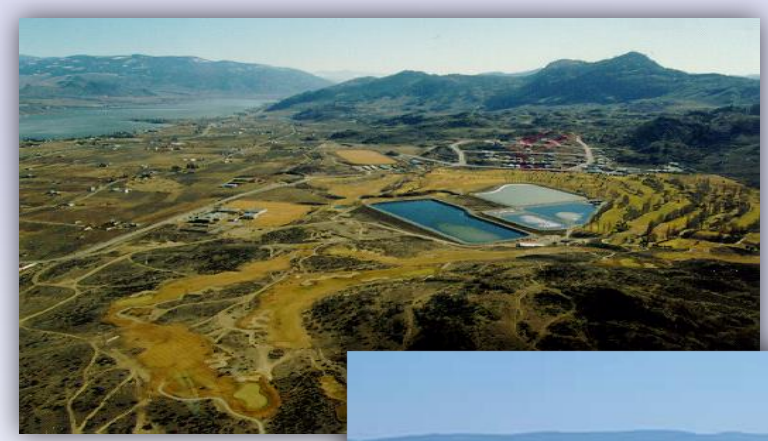
Algae Productivity
Chlorophyll-a

Water Clarity
Secchi Depth

Vertical Profiles
Temperature
Dissolved Oxygen

- Water quality status & long-term trends
- 2015 Water quality objectives

Key Nutrient



Total Phosphorus (TP)

Sources

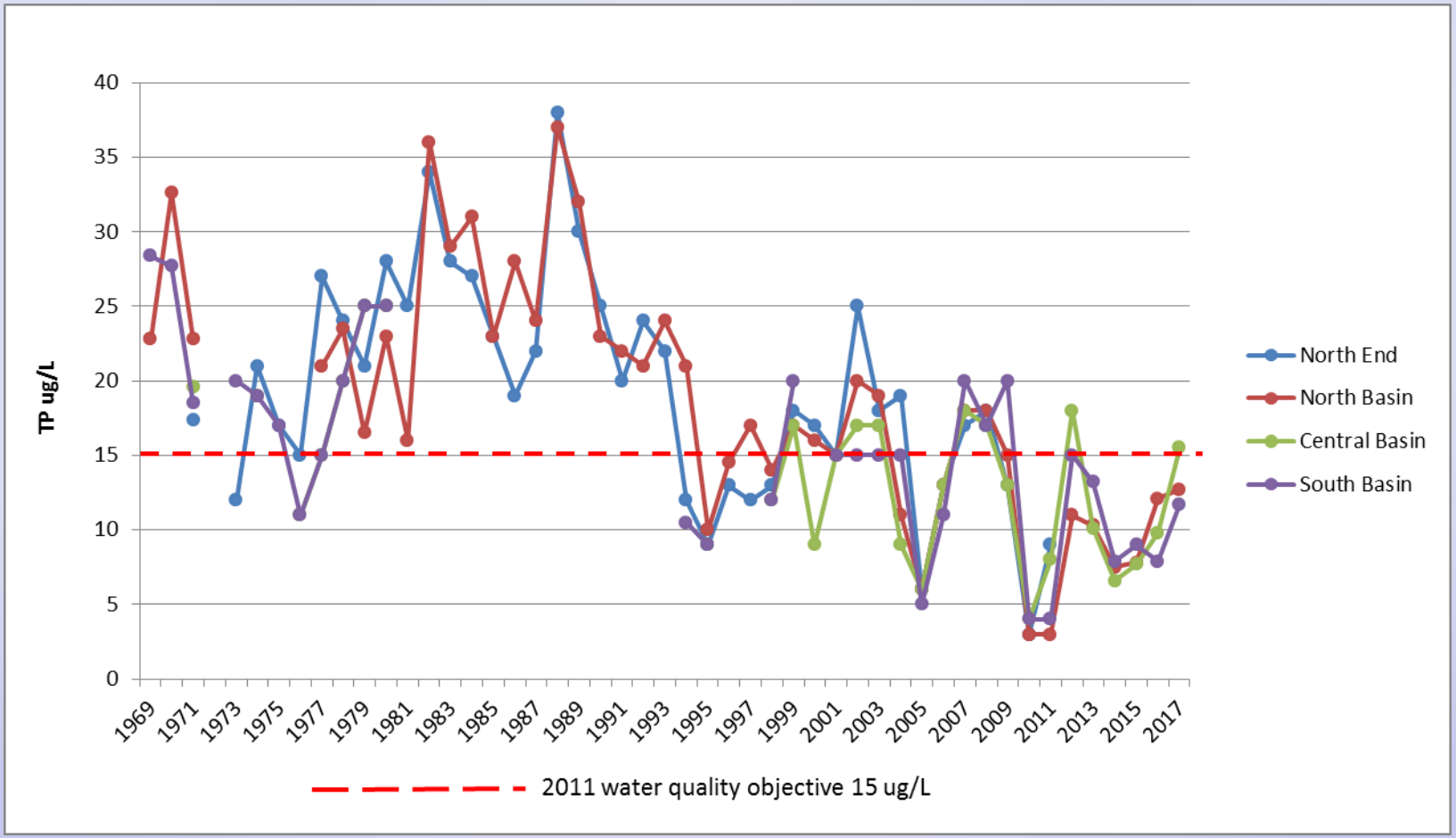
- watershed soils
- urban stormwater run-off
- seepage from septic tanks
- fertilizers and manure
- sewage discharge

Consequences of elevated TP load

- increased algal blooms (phytoplankton **chlorophyll-a**)
- reduced water clarity (**Secchi depth**)
- decreased dissolved oxygen in lake bottom

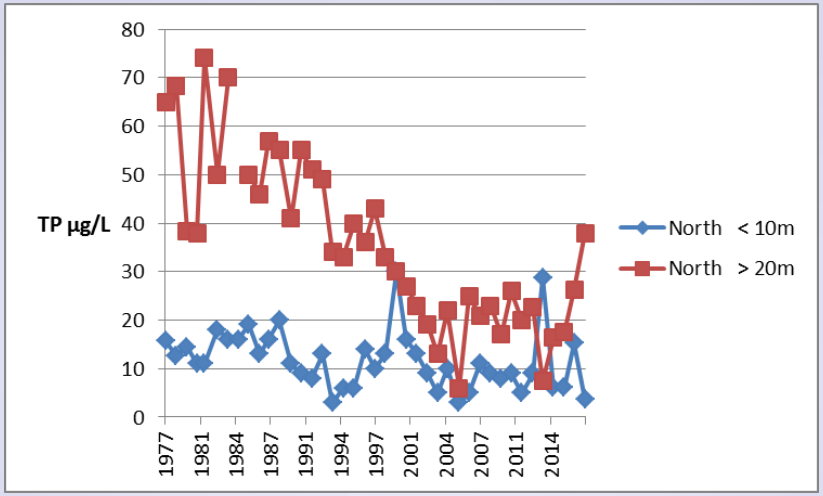
Spring Total Phosphorus Trends 1969-2017

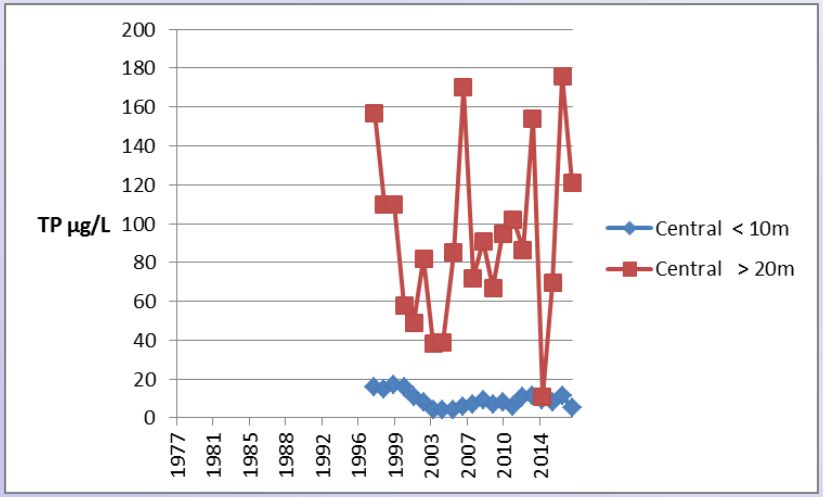
Osoyoos Lake Epilimnion

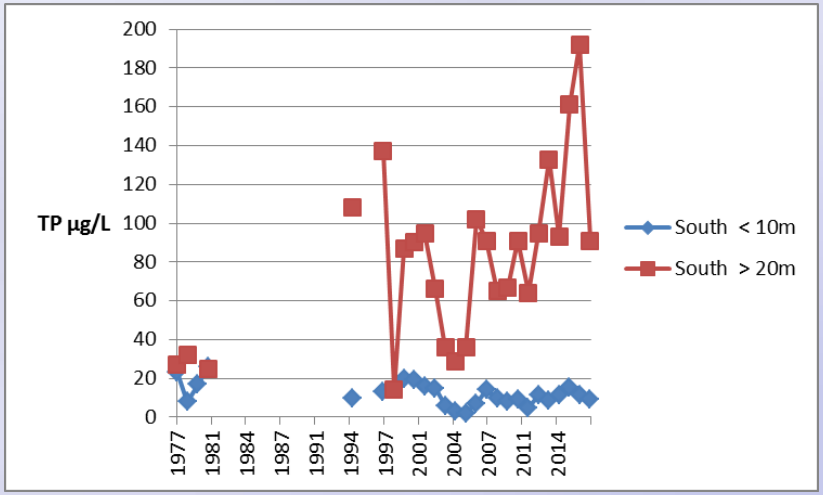


Fall Total Phosphorus Trends 1977-2017

Osoyoos Lake Epilimnion & Hypolimnion

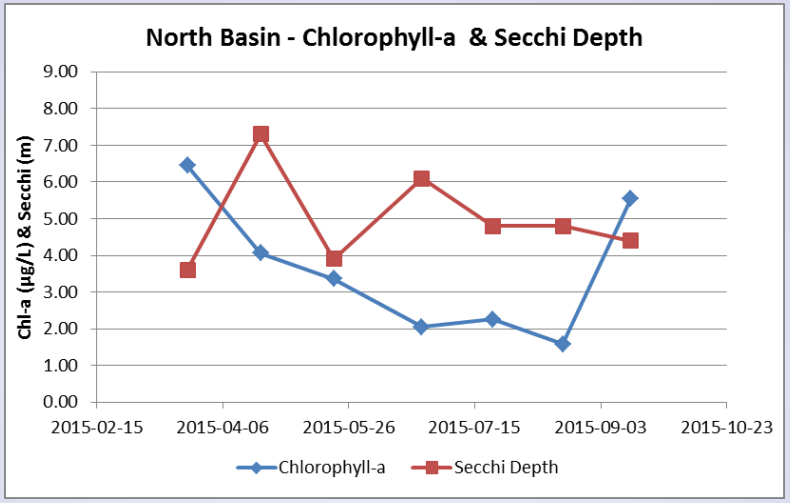


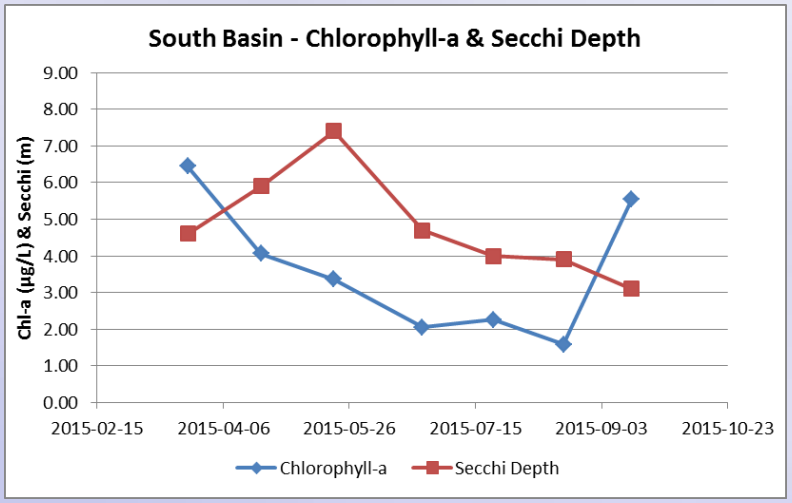


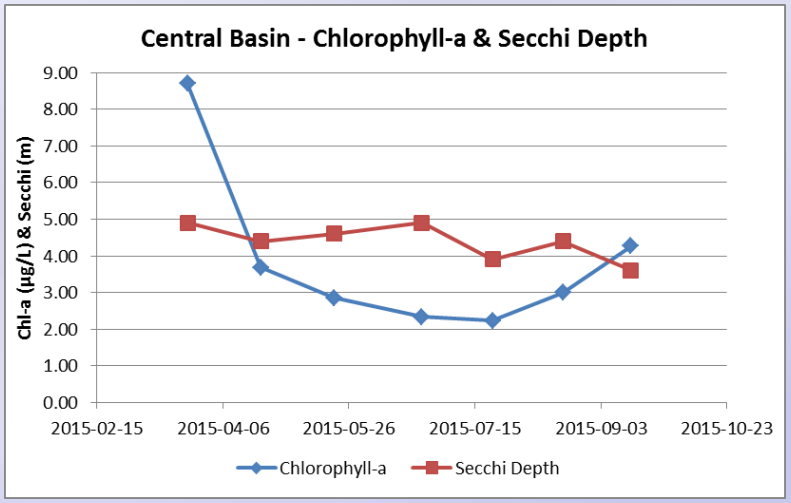


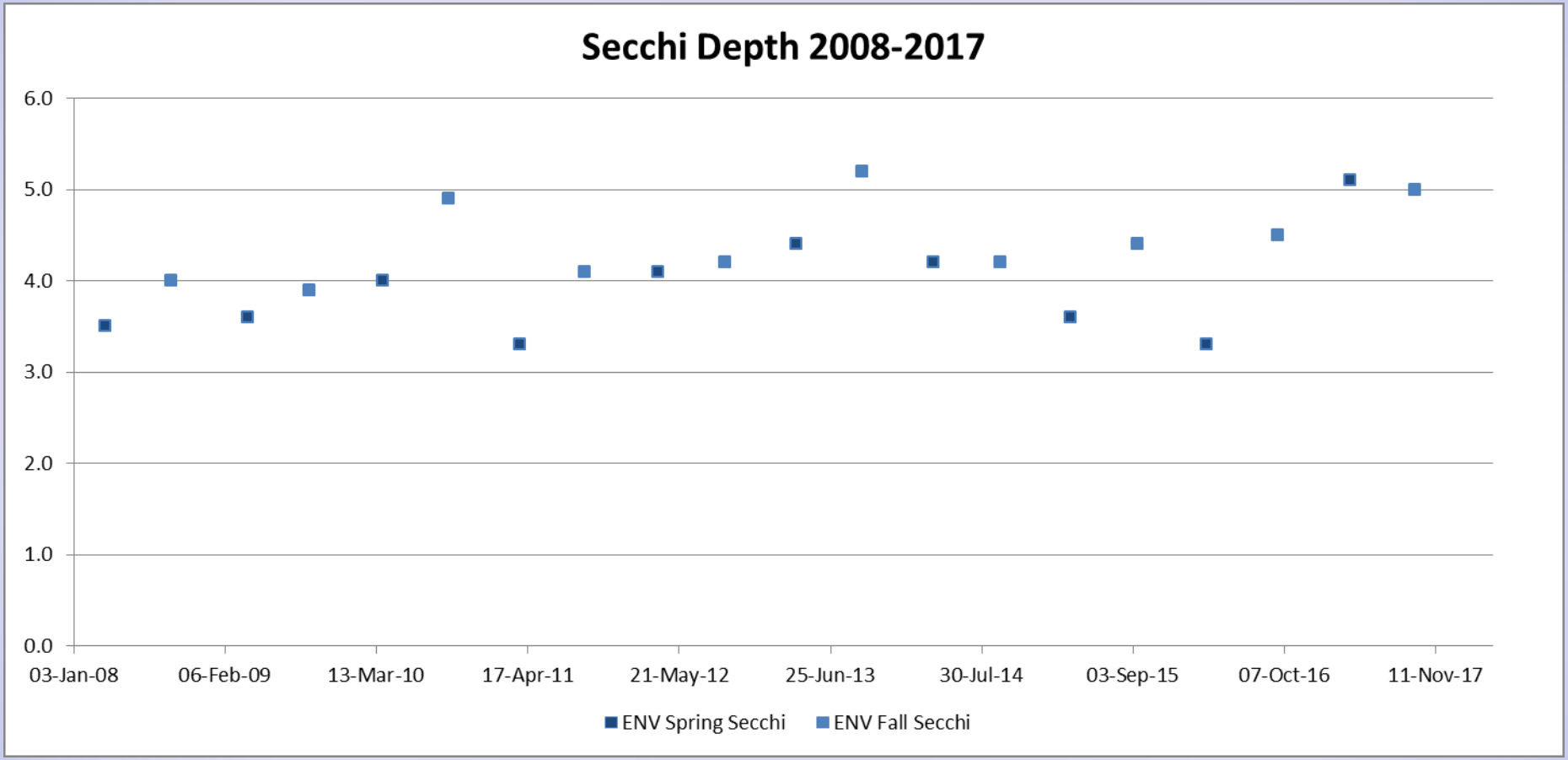
Chlorophyll-a & Secchi Depth

E.g., 2015 seasonal data

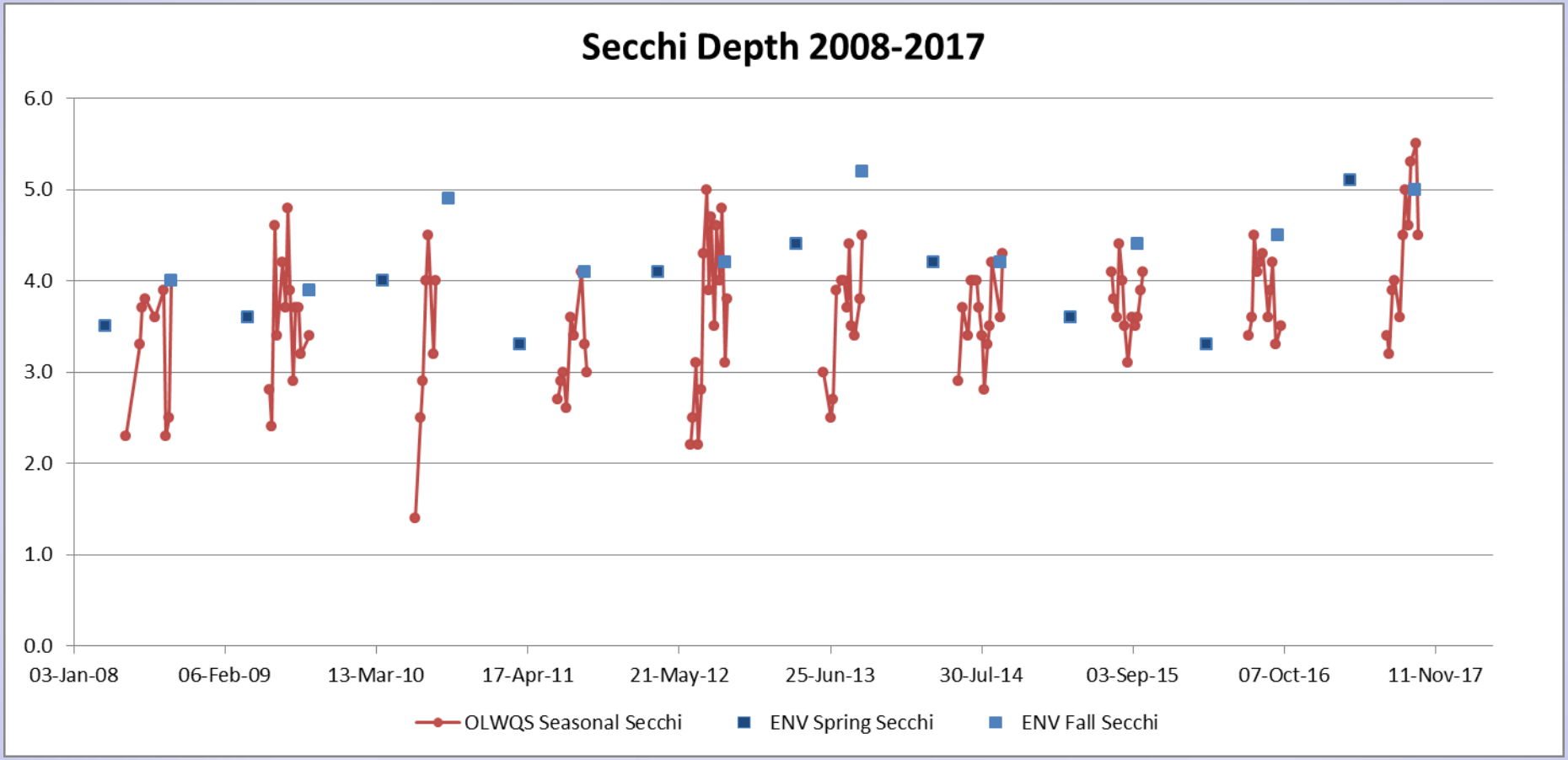








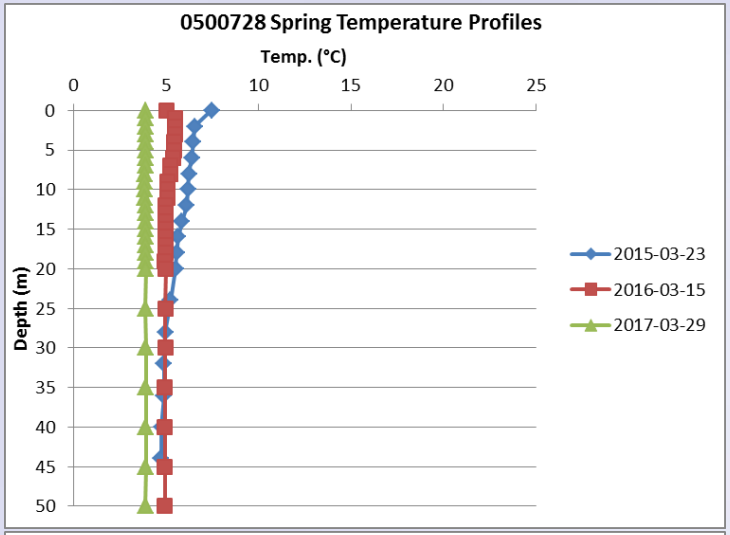
- The north basin of Osoyoos Lake has had relatively consistent spring and fall Secchi depths over the past 10 years.
- **But this is only a small part of the story…**

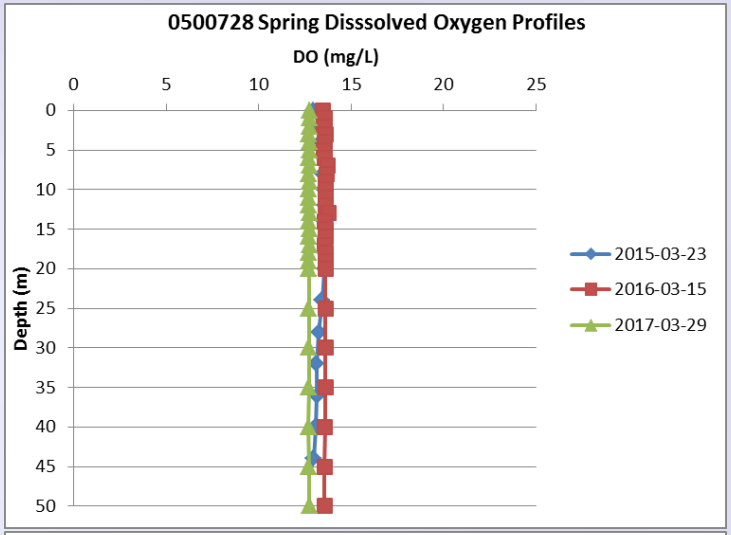


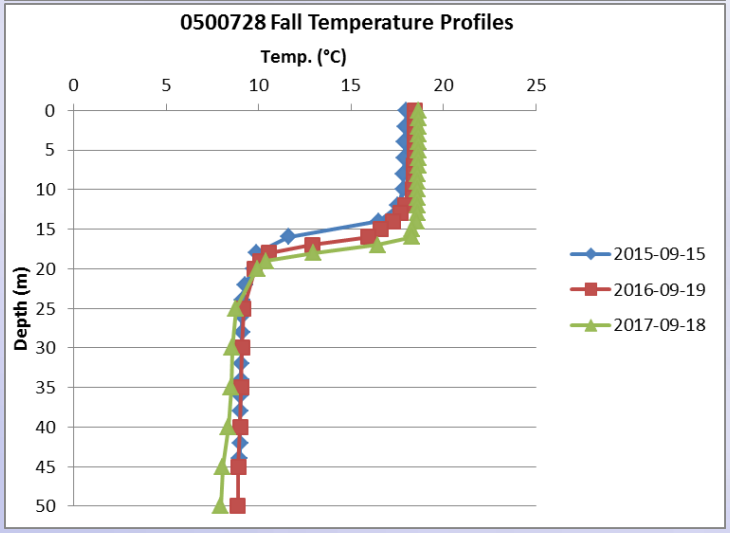
- OLWQS provide important seasonal data, which MoE would not otherwise have
- OLWQS data evaluated with spring/fall data look at seasonal and yearly trends
- **OLWQS efforts are greatly appreciated!**

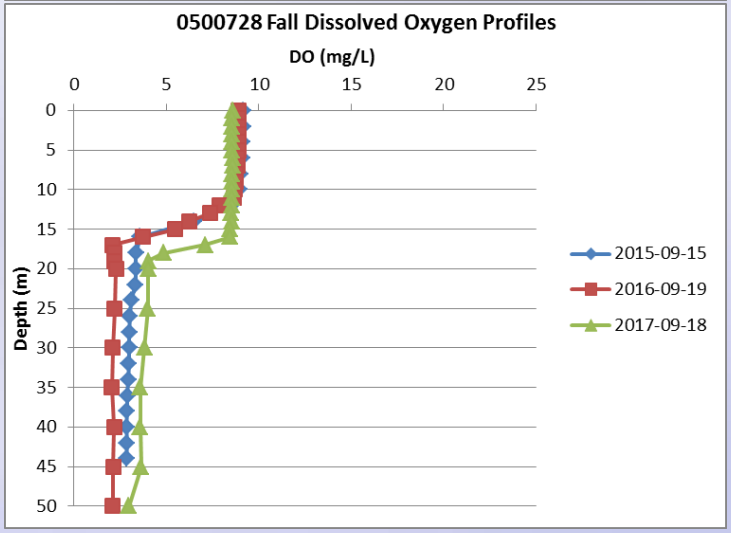
North Basin Vertical Profiles:

Temperature & Dissolved Oxygen (Spring vs. Fall)



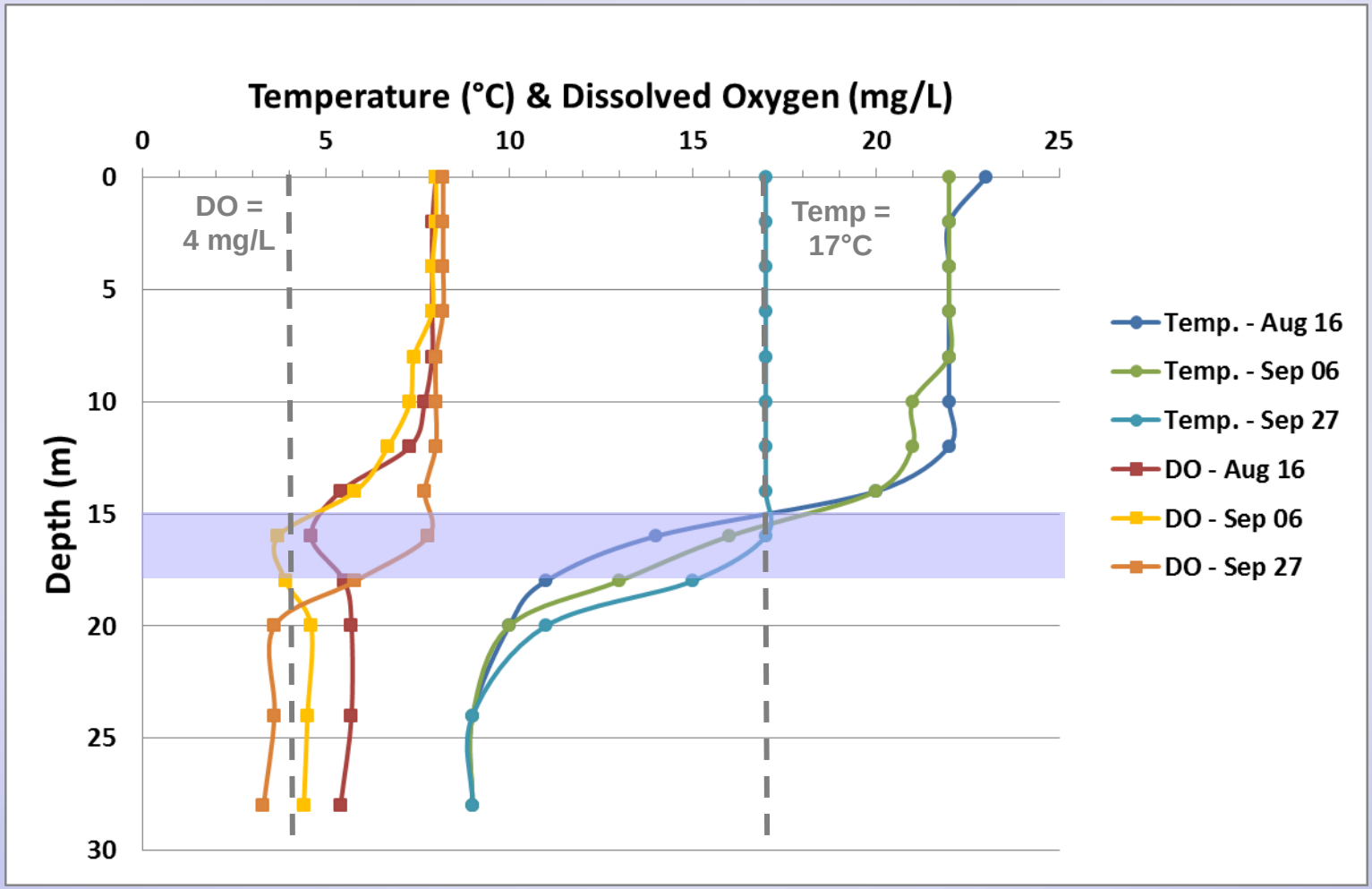






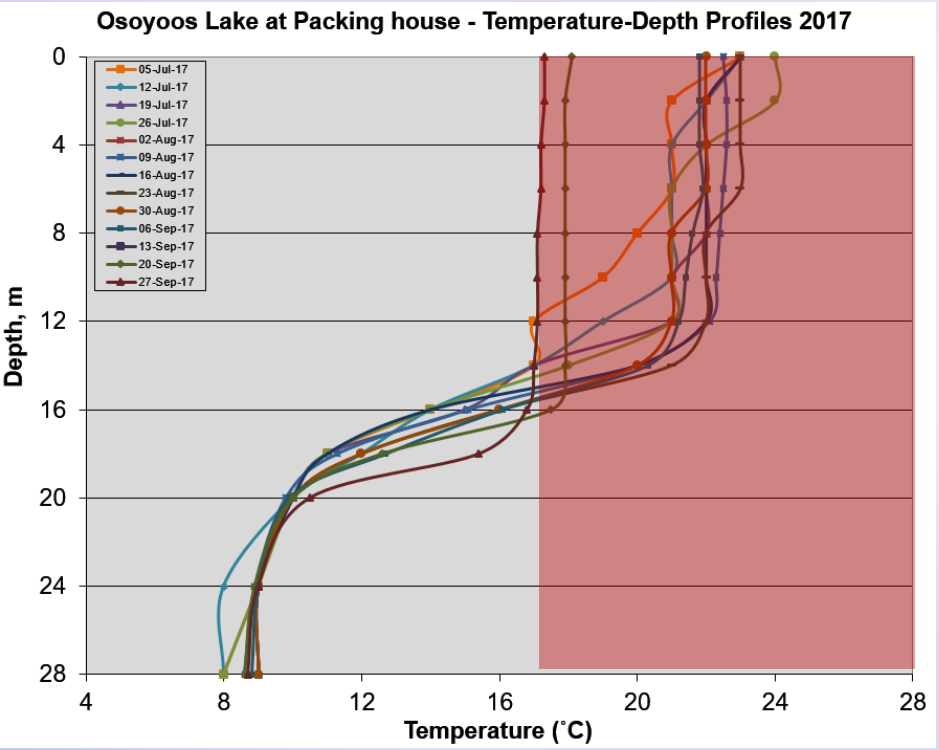
Vertical Profiles from OLWQS:

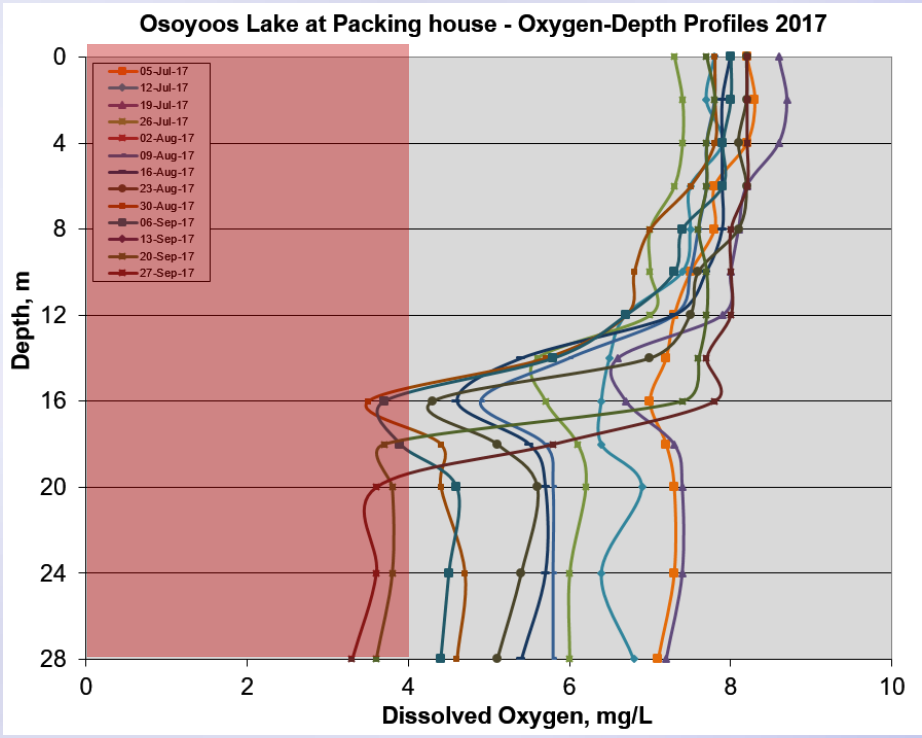
2017 Temperature & Dissolved Oxygen from the North Basin



Vertical Profiles from OLWQS:

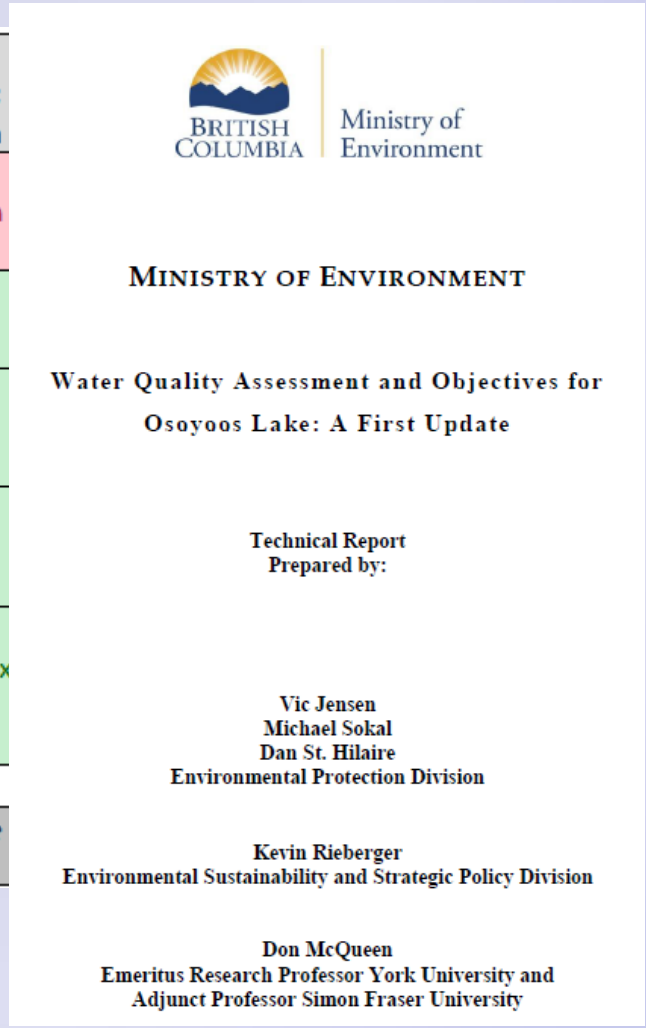
2017 Temperature & Dissolved Oxygen from the North Basin





Water Quality Objectives

Variable	Objective Value	Timing	2015 Attainment North Basin
Dissolved oxygen	> 5.8 mg/L @ 15 m depth	on August 15th	4.62 mg/L (sampled on Aug 19)
Total phosphorus	< 15 µg/L	Spring (February - March)	8.00 µg/L
Phytoplankton chlorophyll-*a*	< 4.0 µg/L	Seasonal mean (May to September)	2.96 µg/L
Secchi depth	> 3.5 m	Seasonal mean (May to September)	4.80 m
Cyanobacteria biomass	< 700 mm^3/m^3 mean; < 2000 mm^3/m^3 max.	Seasonal mean (May to September); max value anytime	mean = 443 mm^3/m^3; max = 1364 mm^3/m^3
Legend =	Met objective	Did not meet objective	*No objective or no data*


BRITISH COLUMBIA Ministry of Environment

MINISTRY OF ENVIRONMENT

Water Quality Assessment and Objectives for Osoyoos Lake: A First Update

Technical Report
Prepared by:

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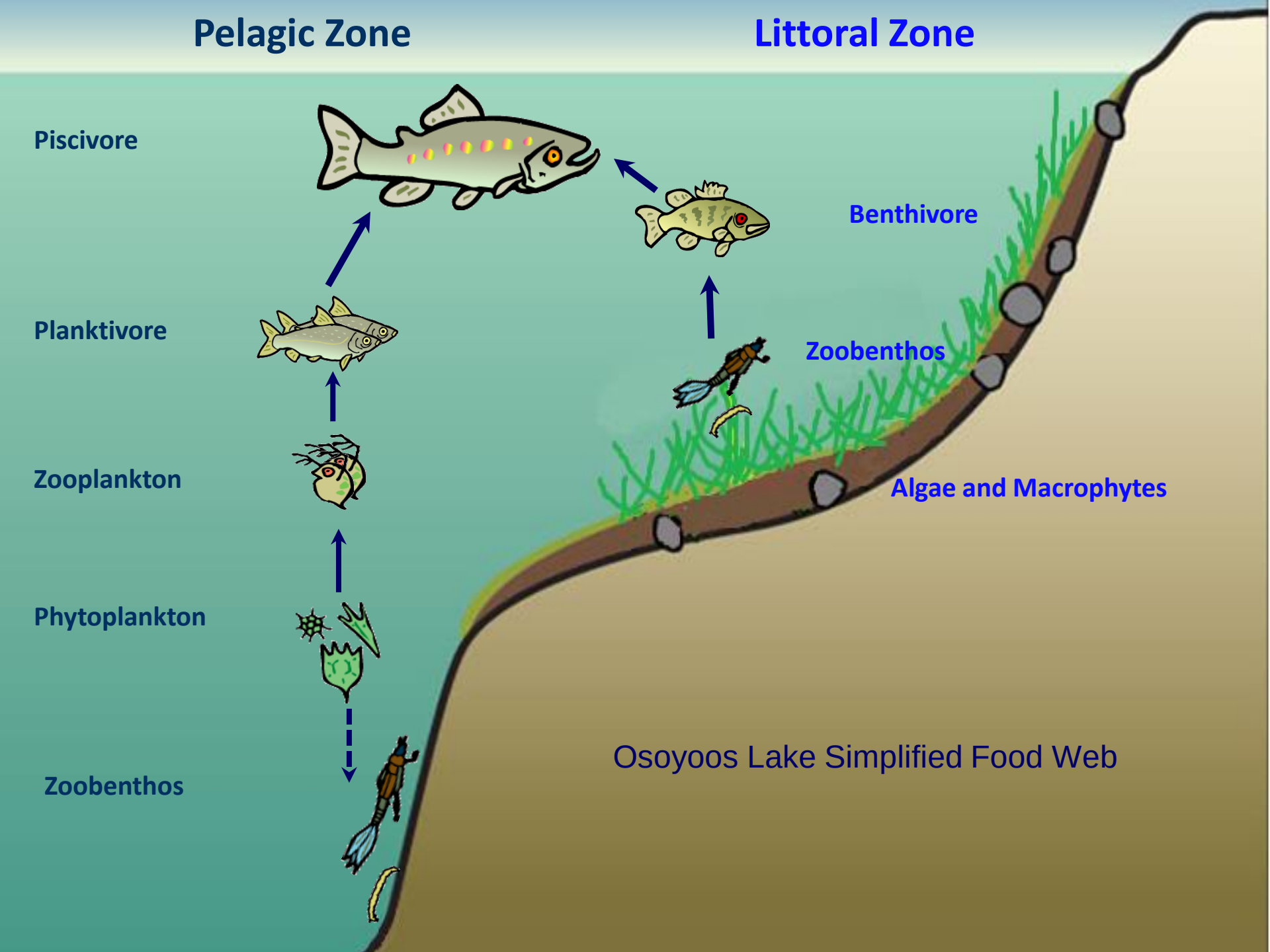
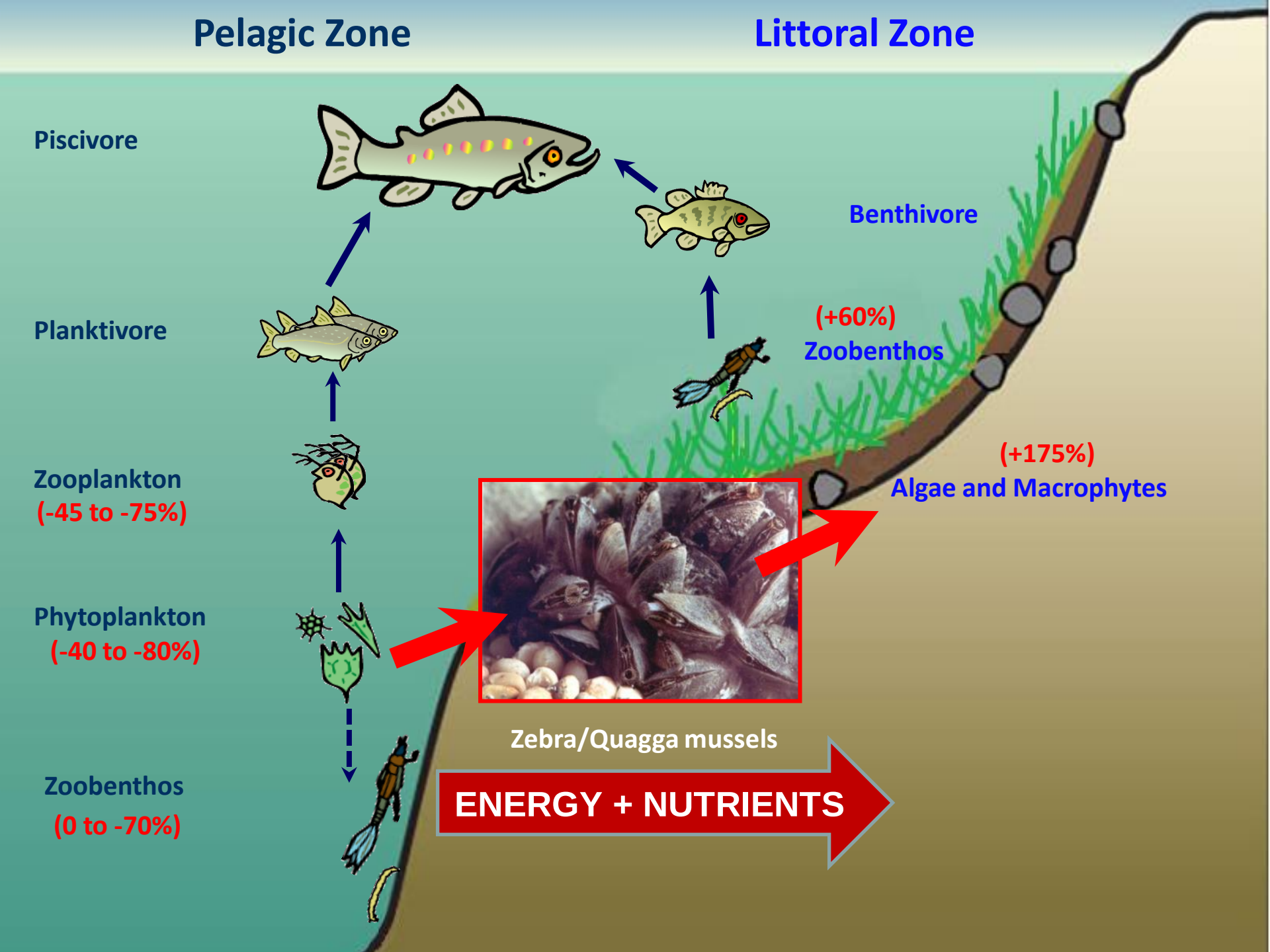
Don McQueen
Emeritus Research Professor York University and
Adjunct Professor Simon Fraser University

- Water Quality Objectives established in 2011
- WQO attainment sampled in 2015
- Next WQO attainment sampling in 2020
- **OLWQS data provides valuable information between attainment years**

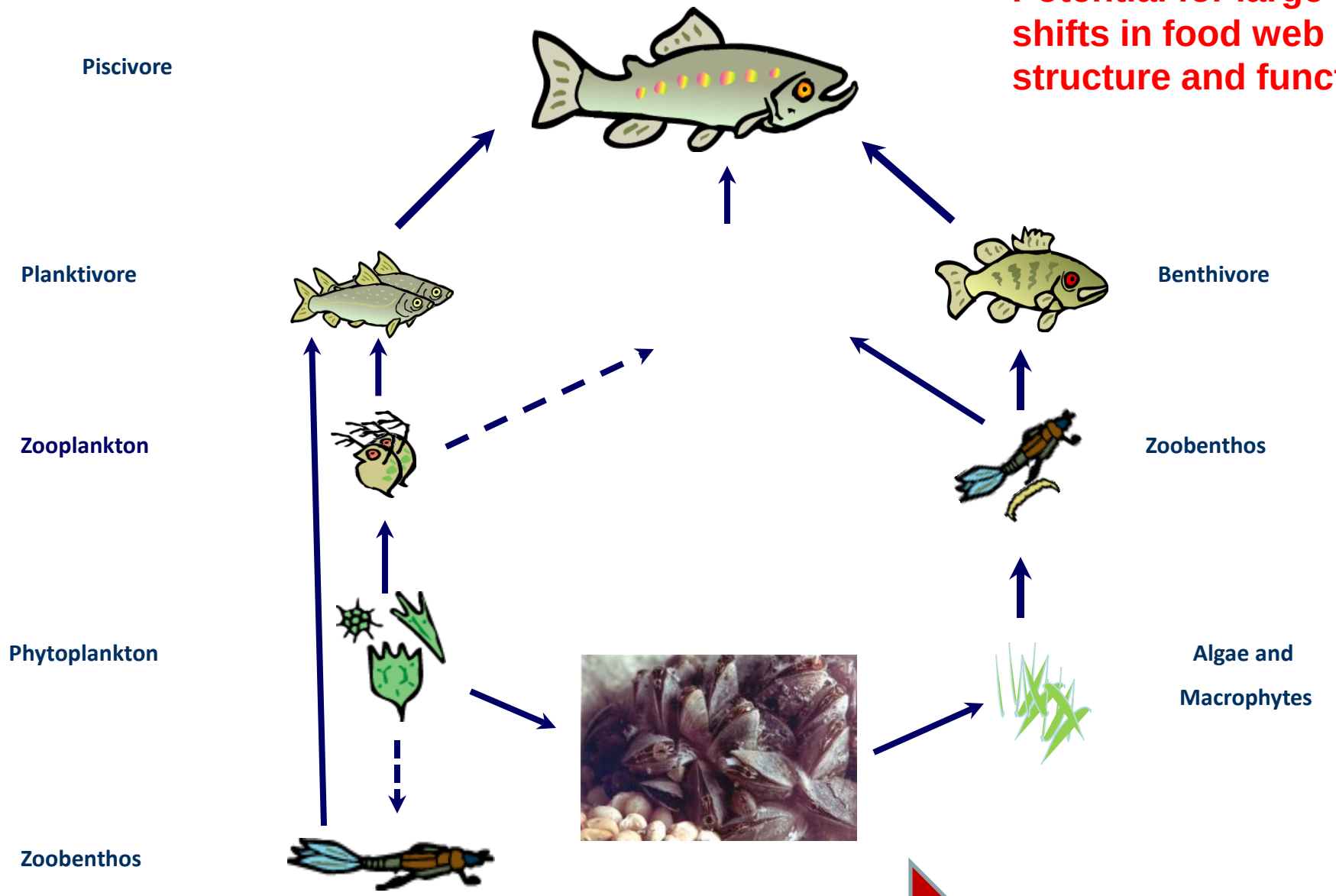
Continued Monitoring & Future Issues

- ENV to continue spring/fall monitoring of Osoyoos Lake
  - It is important to understand current water quality conditions, as well as determining long-term climatic variability and its effects on lake water quality.
- Continue OLWQS sampling to add missing seasonal data
  - Consider adding May sampling date; Consider removing North End and/or White Sands sites; Consider decreasing sampling to every 2 weeks
- Efforts are still needed to reduce non-point sources of nutrients in the watershed
- Emerging issues (EDCs, PPCPs, other organic chemicals)
- Invasive zebra & quagga mussels – ENV to continue sampling for mussel veligers
  - In addition to major infrastructure, recreational, and economic impacts, invasive mussels could have major ecological impacts…


Pelagic Zone
Littoral Zone
Piscivore
Benthivore
Planktivore
Zoobenthos
Zooplankton
Algae and Macrophytes
Phytoplankton
Zoobenthos
Osoyoos Lake Simplified Food Web

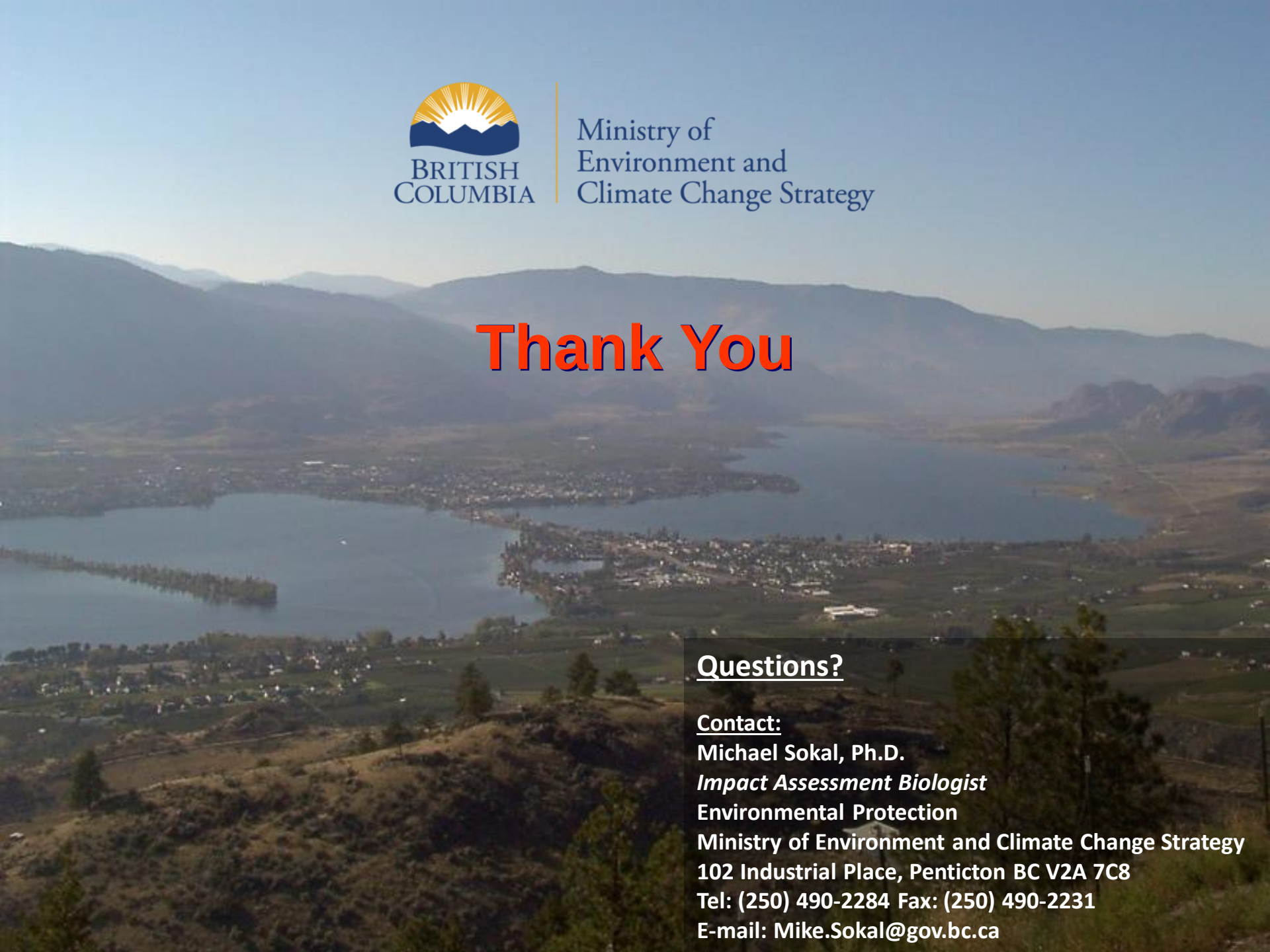

Pelagic Zone
Littoral Zone
Piscivore
Planktivore
Zooplankton
(-45 to -75%)
Phytoplankton
(-40 to -80%)
Zoobenthos
(0 to -70%)
Benthivore
(+60%)
Zoobenthos
(+175%)
Algae and Macrophytes
Zebra/Quagga mussels
ENERGY + NUTRIENTS

Potential for large shifts in food web structure and function



Invasive Mussel Effects on Freshwater Environment

1. Impacts on algae & redistribution of energy/nutrients
   - decline of phytoplankton
   - promotion of toxin producing cyanobacteria (bluegreen algae)
   - increase in macrophyte and benthic algal growth and distribution
2. Cascading impacts to higher trophic levels
3. Effects can be larger in smaller ecosystems
4. Persistence through time: Impacts >20+ years)
5. Overall ecological impact: Very High
6. **On a positive note…they are not here! Let's keep it that way!!**


BRITISH COLUMBIA
Ministry of Environment and Climate Change Strategy
Thank You
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