A Global Scan of How the Issue of Nutrient Loading & HABs is Being Addressed

Etienne Foulon, Alain N. Rousseau

Spring 2019 - BREE/VT EPSCoR/International Joint Commission meeting to discuss the Missisquoi Bay Water Quality Reference

Wednesday, May 8th 2019, 8:30 a.m. - 3:30 p.m.
Roy Room on St. Michael's College campus

Lake Champlain Basin Program
NEIWPCC New England Interstate Water Pollution Control Commission
BREE Basin Resilience to Extreme Events in the Lake Champlain Basin
Vermont EPSCoR
Organisme de bassin versant de la baie Missisquoi
International Joint Commission

Context & Objective

Nutrient loading & harmful algal blooms

Worldwide literature review

For the International Joint Commission

Inform and support recommendations in Missisquoi Bay Lake Champlain and Lake Memphremagog

Nutrient loading & harmful algal blooms

Worldwide problem

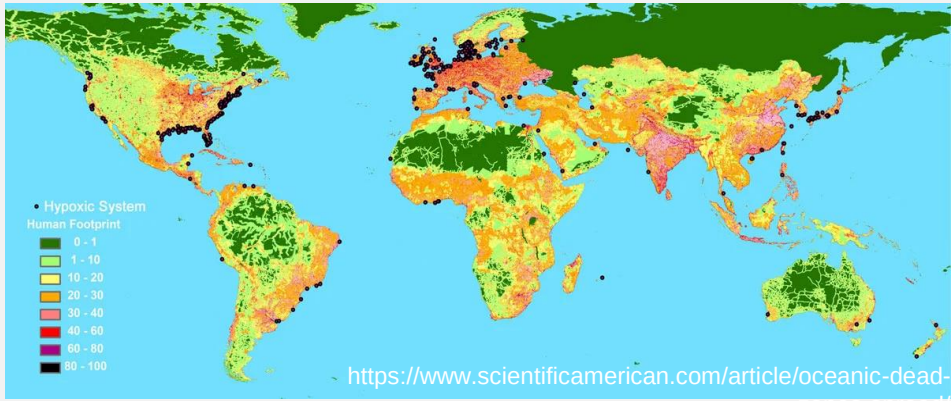
World coastal zones

At least 816 areas experiencing some form of eutrophication or nutrient over-enrichment

Of these, 481 hypoxic areas

Greenhalgh and Selman, 2011

Oceanic dead zones (*Biello*, 2008)



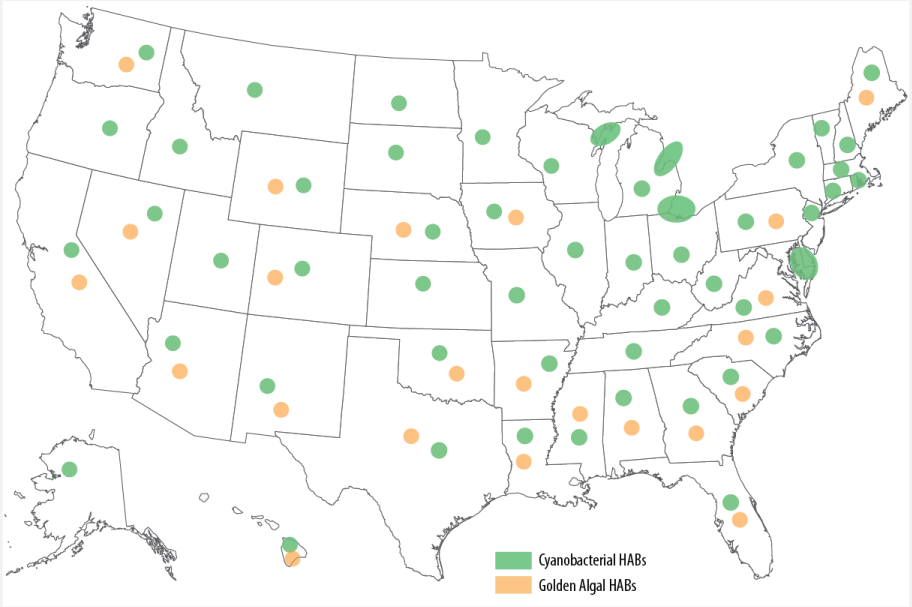
Nutrient loading & harmful algal blooms

Worldwide problem

United States of America

50 states affected by HABs

Cyanobacteria (blue-green algae)
Primnesium parvum (golden algae)



Generalized distribution of selected freshwater HABs in the U.S. extracted from (*CRS*, 2018)

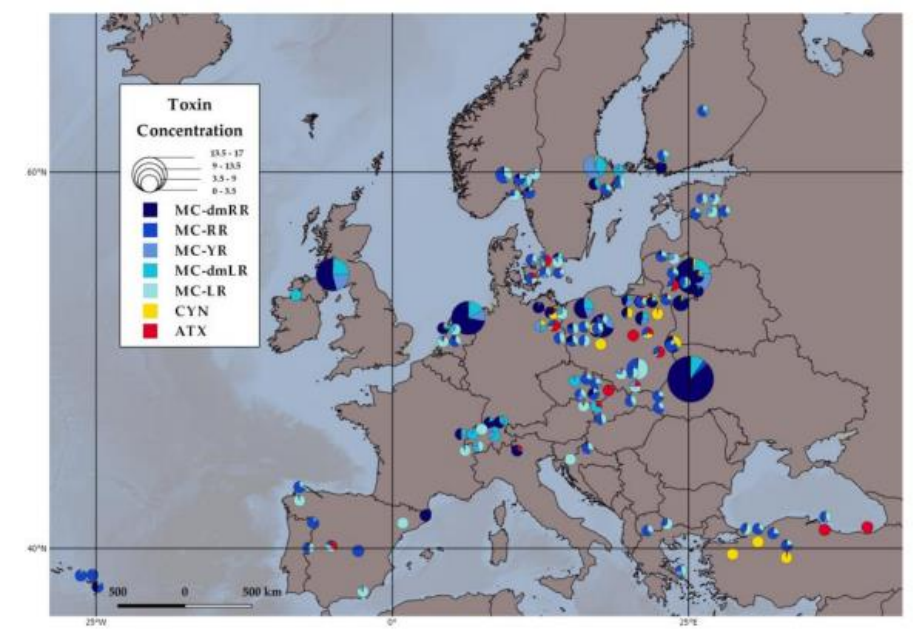
Nutrient loading & harmful algal blooms

Worldwide problem

<u>Europe</u>

Widespread problem mostly due to nitrates pollution

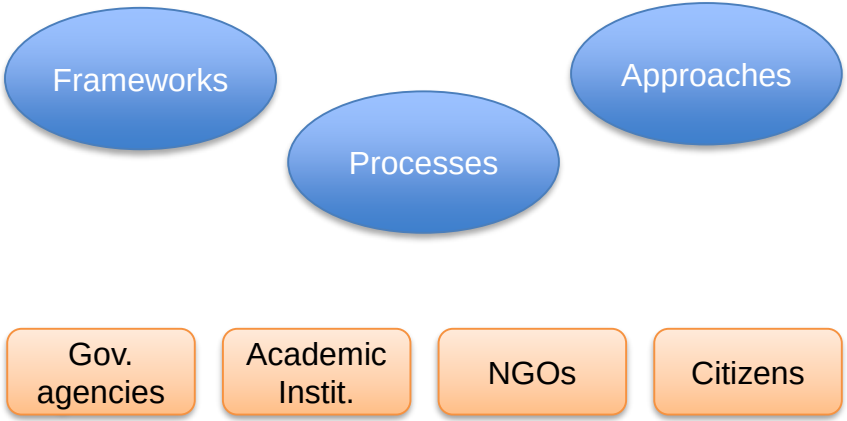
Motivation behind European-wide lake assessment (369) of toxins



Toxin concentrations in the 137 lakes used in the statistical analyses (Mantzouki et al., 2018)

Nutrient loading & harmful algal blooms

Worldwide literature review



Nutrient loading & harmful algal blooms

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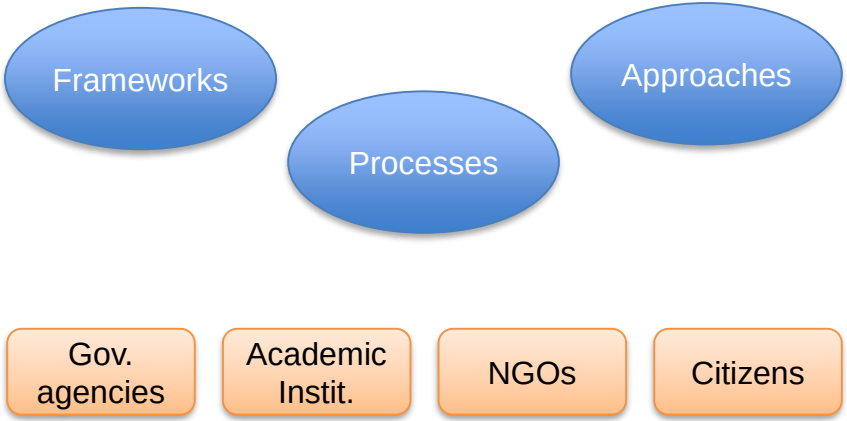
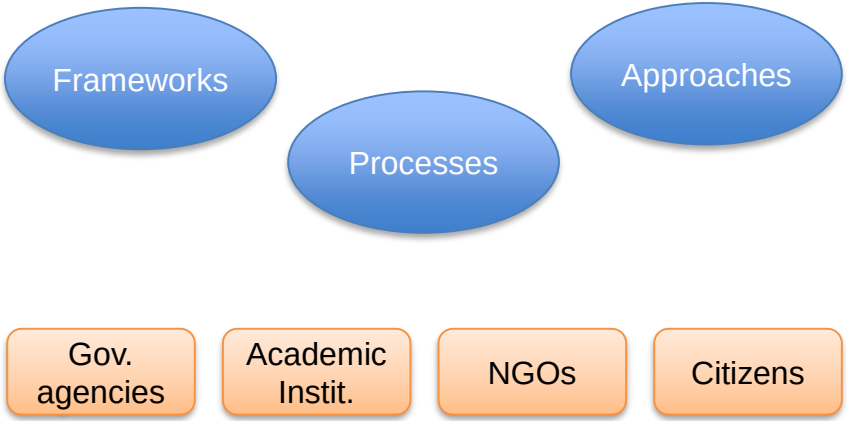


Guiding the review

When was the problem noticed?

Nutrient loading & harmful algal blooms

Worldwide literature review



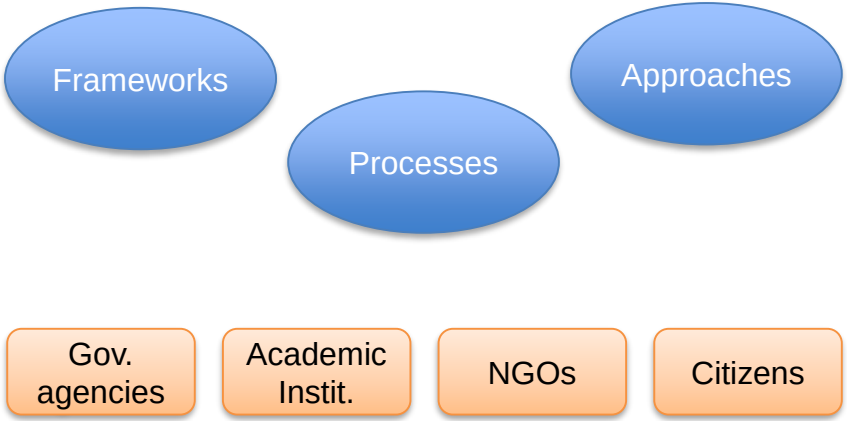
Guiding the review

When was the problem noticed?

What research was done to determine whether or not there was a problem to be addressed?

Nutrient loading & harmful algal blooms

Worldwide literature review



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Which mitigation approaches were used to address the problem?

Nutrient loading & harmful algal blooms

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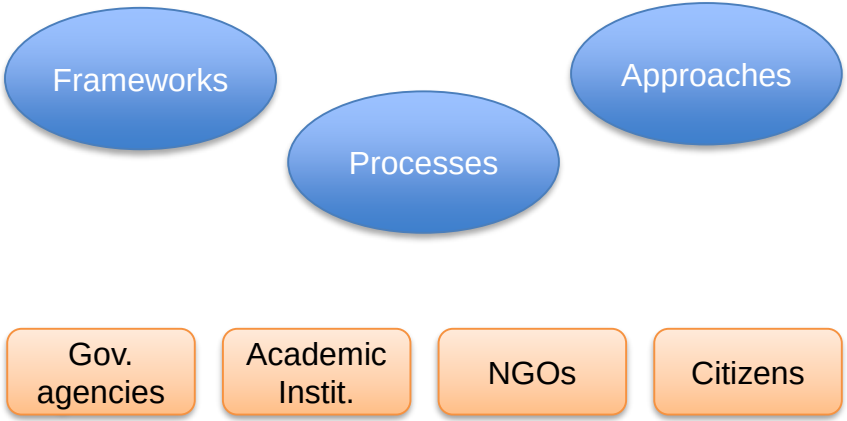

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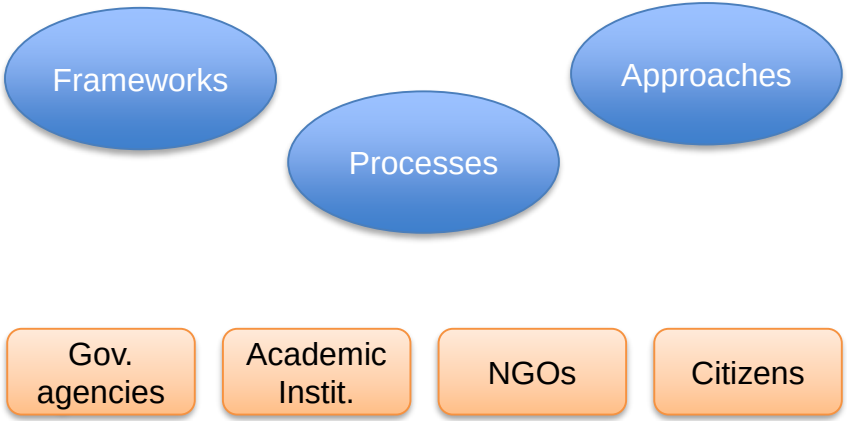

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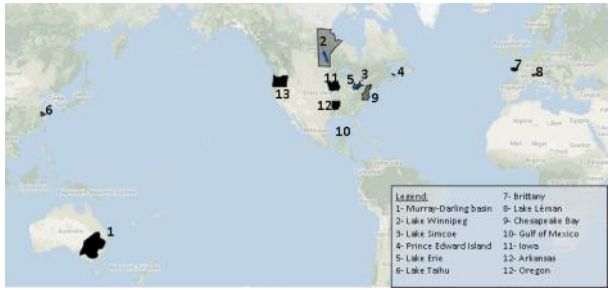
How long have these approaches been in use?

Have they been successful?
How was “success” determined?

Nutrient loading & harmful algal blooms

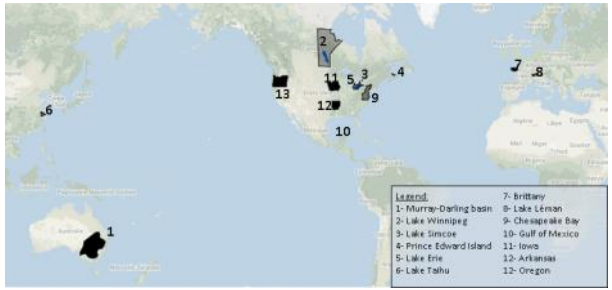


Issues faced across 12 case studies

- Harmful blooms, limited recreation, P internal loading, massive fish kills, drinking water shutdown

Material & Method

Nutrient loading & harmful algal blooms



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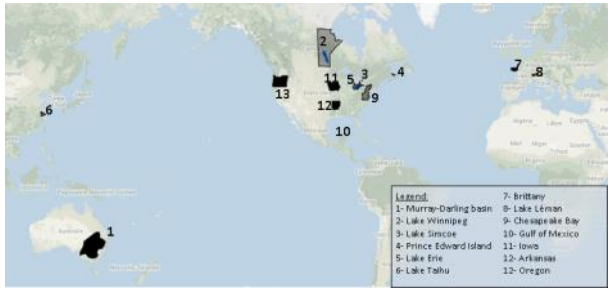

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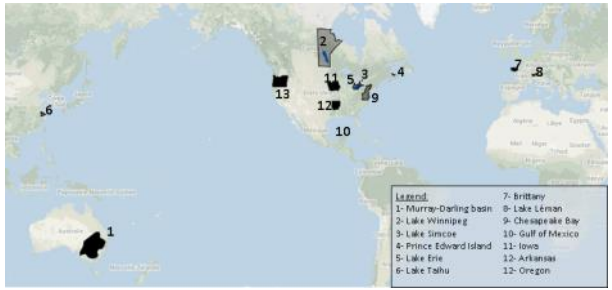

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Risk management and mitigation

- Nutrient management plans (farm), drinking water protection plans, early warning systems, algae surveillance program, cyanotoxin testing

INRS

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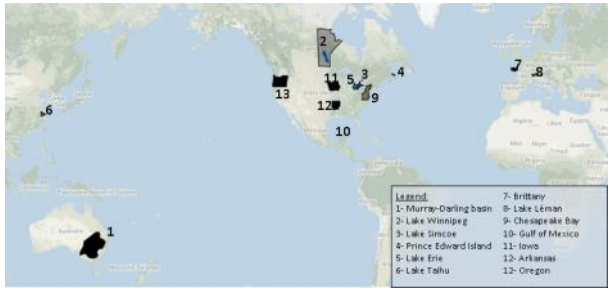

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Outreach, engagement, and educational activities

- BMP guidance documents, educational programs, community engagement activities, technical seminar, opinion surveys

INRS


1
2
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Legend:
1- Murray-Darling basin
2- Lake Winnipeg
3- Lake Simcoe
4- Prince Edward Island
5- Lake Erie
6- Lake Taihu
7- Brittany
8- Lake Léman
9- Chesapeake Bay
10- Gulf of Mexico
11- Iowa
12- Arkansas
12- Oregon

Summary of lessons learned – five themes

Approaches and their specificities

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Engaging with all stakeholders and building trust

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Thinking BMPs through

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Thinking BMPs through

Ensuring performance

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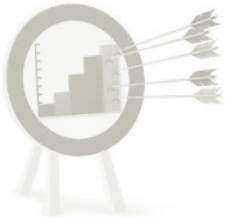

Ensuring performance

Governance and leadership

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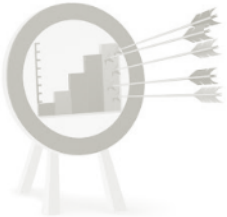
Thinking BMPs through



Ensuring performance

Governance and leadership

Supplemented by a separate review to ensure enough cases captured to allow some generalisation

Results

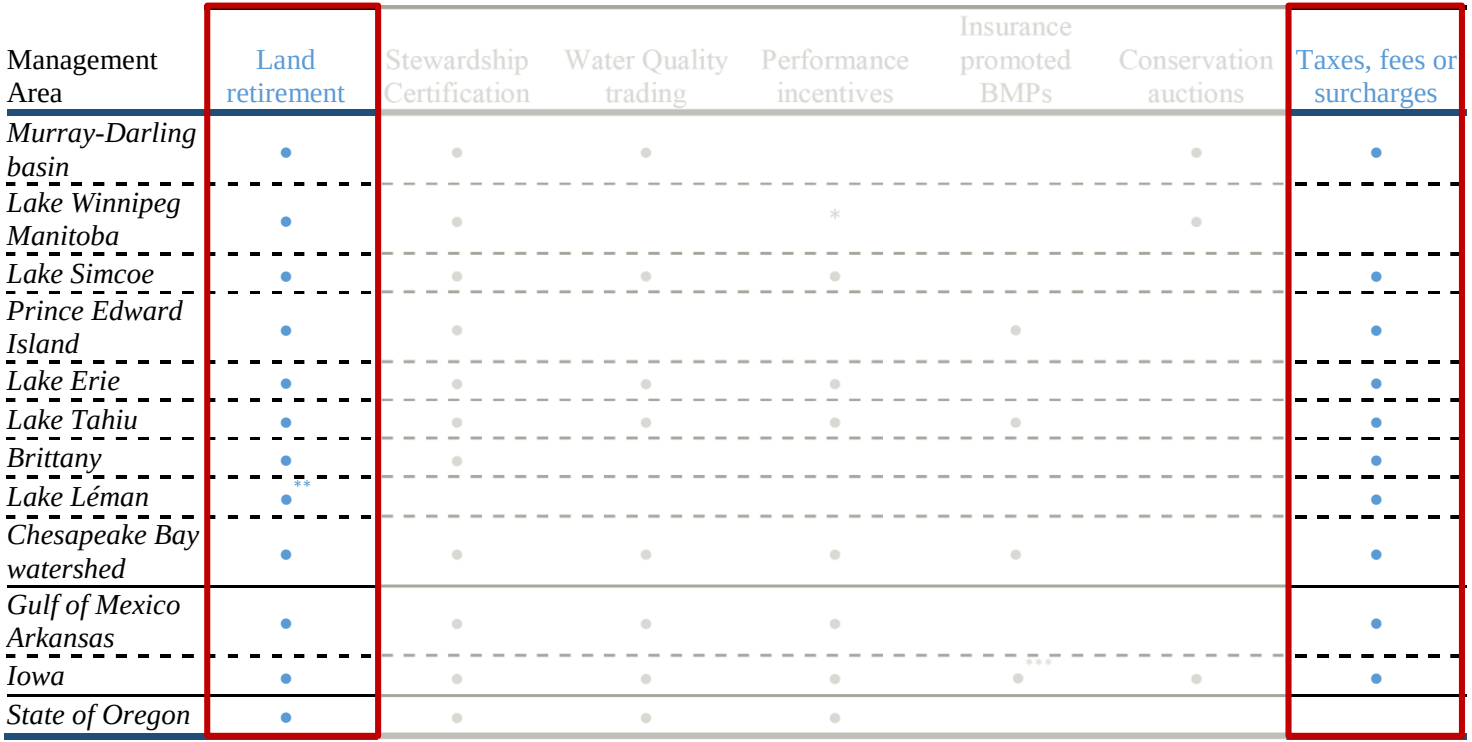
Results

Incentive based approaches

Management Area	Land retirement	Stewardship Certification	Water Quality trading	Performance incentives	Insurance promoted BMPs	Conservation auctions	Taxes, fees or surcharges
Murray-Darling basin	•	•	•			•	•
Lake Winnipeg Manitoba	•	•		*		•	
Lake Simcoe	•	•	•	•			•
Prince Edward Island	•	•			•		•
Lake Erie	•	•	•	•			•
Lake Tahiu	•	•	•	•	•		•
Brittany	•	•					•
Lake Léman	•**						•
Chesapeake Bay watershed	•	•	•	•	•		•
Gulf of Mexico Arkansas	•	•	•	•			•
Iowa	•	•	•	•	•***	•	•
State of Oregon	•	•	•	•			

Results

Incentive based approaches



Results

Incentive based approaches

Management Area	Land retirement	Taxes, fees or surcharges
Murray-Darling basin	•	•
Lake Winnipeg Manitoba	•	
Lake Simcoe	•	•
Prince Edward Island	•	•
Lake Erie	•	•
Lake Tahiu	•	•
Brittany	•	•
Lake Léman	•**	•
Chesapeake Bay watershed	•	•
Gulf of Mexico Arkansas	•	•
Iowa	•	•
State of Oregon	•	

Overall program homogeneity

Land retirement

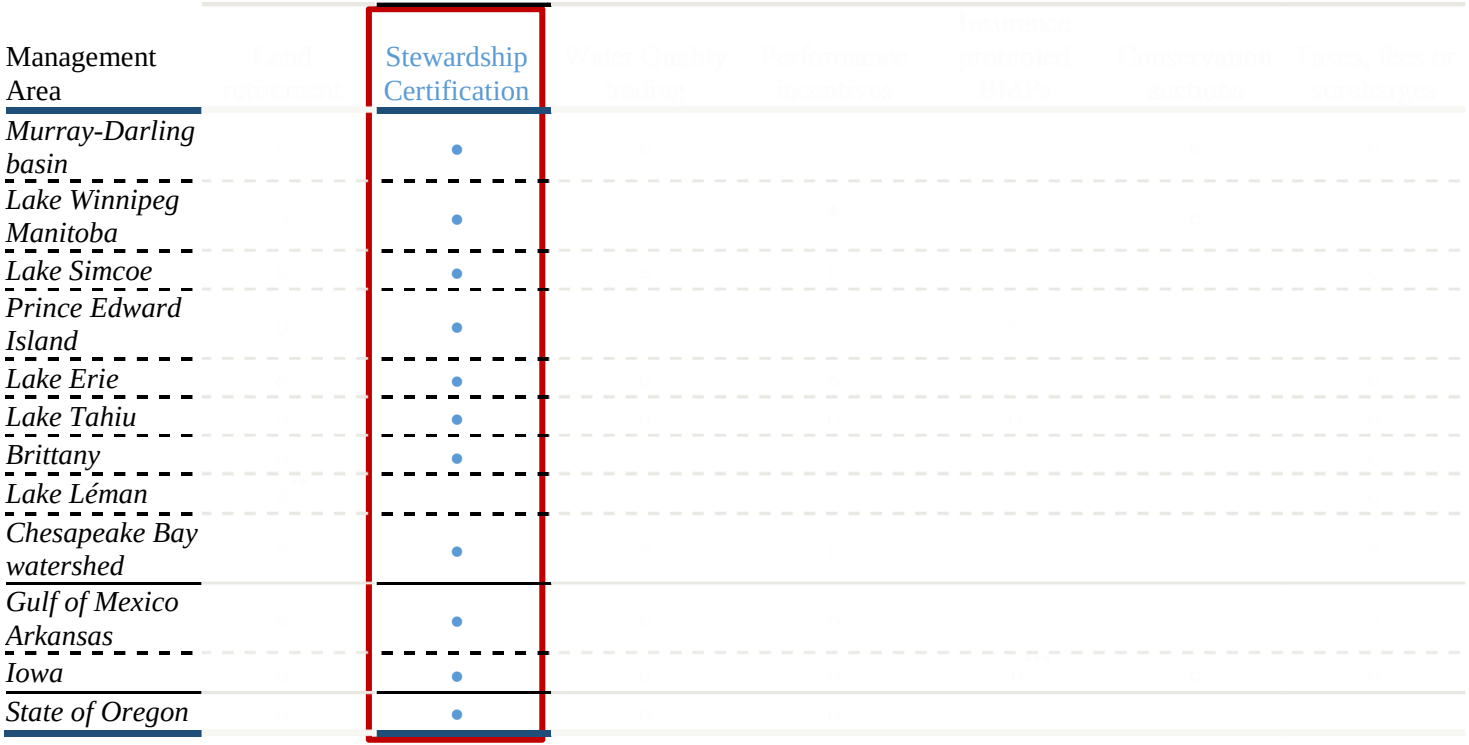
Compensate landowners for "retiring" sensitive areas relative to their contribution to water quality degradation

Taxes, fees or surcharges

Examples including **tax credits** as incentives to implement BMPs or conservation strategies, or **levy pollution** related taxes to incentivise pollution-reducing approaches (or the use of less pollutants, quantitatively speaking)

Results

Incentive based approaches



Results

Incentive based approaches

Management Area	Stewardship Certification
Murray-Darling basin	•
Lake Winnipeg Manitoba	•
Lake Simcoe	•
Prince Edward Island	•
Lake Erie	•
Lake Tahiu	•
Brittany	•
Lake Léman	•
Chesapeake Bay watershed	•
Gulf of Mexico Arkansas	•
Iowa	•
State of Oregon	•

Same overall philosophy

Willingness to improve the environment, peer pressure (inclination to implement your neighbour-proven practices), and of course on market value increase.

False sense of homogeneity

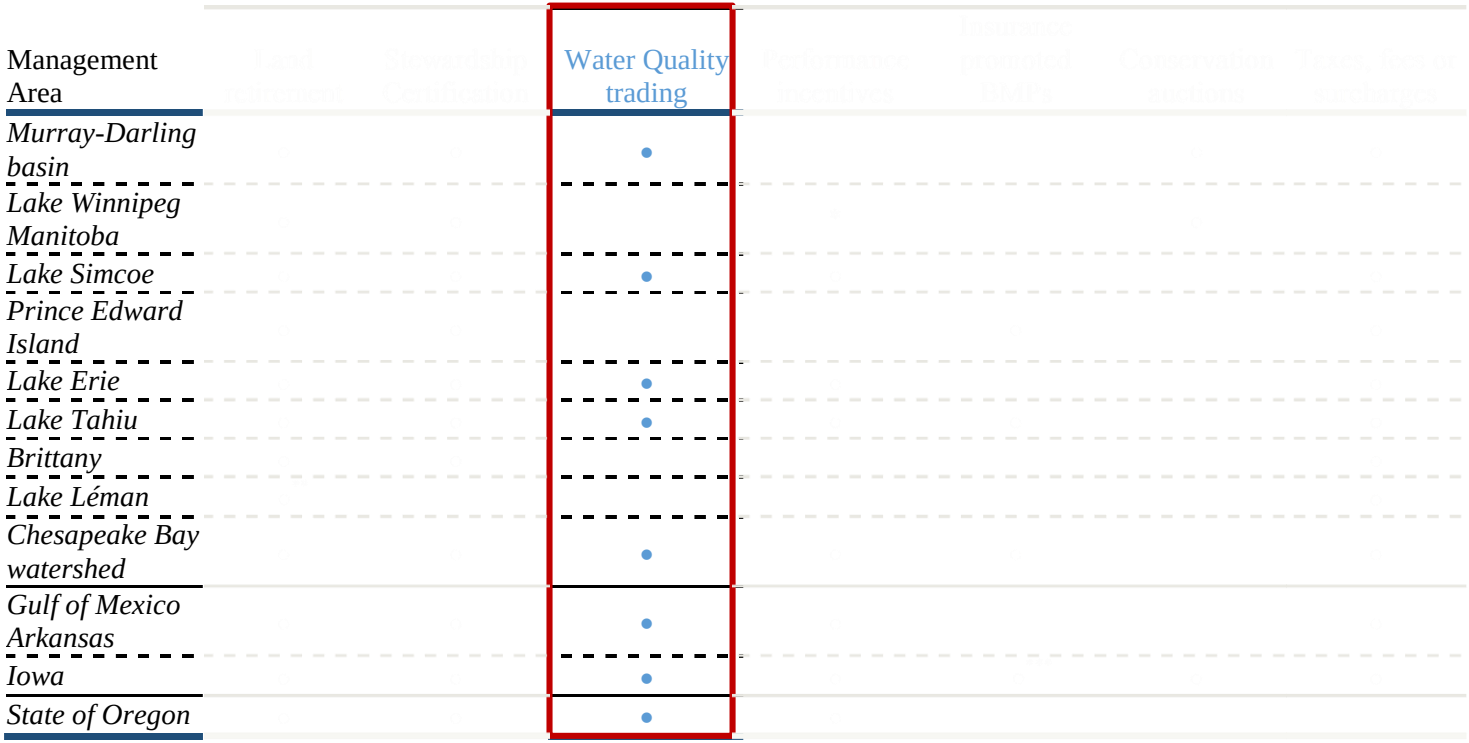
- *4R Nutrient Stewardship Certification Program*

  Encourage series of BMPs using the **Right source** of nutrients at the **Right rate** and **Right time** in the **Right place**
- *Forest and tree farm certifications*
- *Lake friendly certification*

  Offered to municipalities around Lake Winnipeg
- *Biological farm certification*

Results

Incentive based approaches



Results

Incentive based approaches

Management Area	Water Quality trading
Murray-Darling basin	•
Lake Winnipeg Manitoba	
Lake Simcoe	•
Prince Edward Island	
Lake Erie	•
Lake Tahiu	•
Brittany	
Lake Léman	
Chesapeake Bay watershed	•
Gulf of Mexico	•
Arkansas	
Iowa	•
State of Oregon	•

Principle

Promote **trades** (mostly source to NPS) between pollutant source treatments ➔ voluntary and surplus pollutant reduction, **lower cost**

Overall usage (Selman & al., 2009)

57 WQT programs worldwide

- 26 active
- 21 under consideration
- 10 inactive or completed pilot program with no plan for future trades

Majority in the USA, **only six elsewhere**

Results

Incentive based approaches

Management Area	Performance incentives
Murray-Darling basin	
Lake Winnipeg Manitoba	*
Lake Simcoe	•
Prince Edward Island	
Lake Erie	•
Lake Tahiu	•
Brittany	
Lake Léman	
Chesapeake Bay watershed	•
Gulf of Mexico	
Arkansas	•
Iowa	•
State of Oregon	•

Incentive based approaches

Management Area	Principle	Performance incentives
Murray-Darling basin	payments/incentives proportional to actual measured performance or to the level of environmental benefits arising from a technical approach	
Lake Winnipeg Manitoba		*
Lake Simcoe		•
Prince Edward Island		
Lake Erie		•
Lake Tahiu		•
Brittany		
Lake Léman		
Chesapeake Bay watershed		•
Gulf of Mexico Arkansas		•
Iowa		•
State of Oregon		•

Rethinking the procurement of means

Incentivising results

The Delta Institute proposing to shift towards pay for performance programs (*Fisher et al.*, 2016)

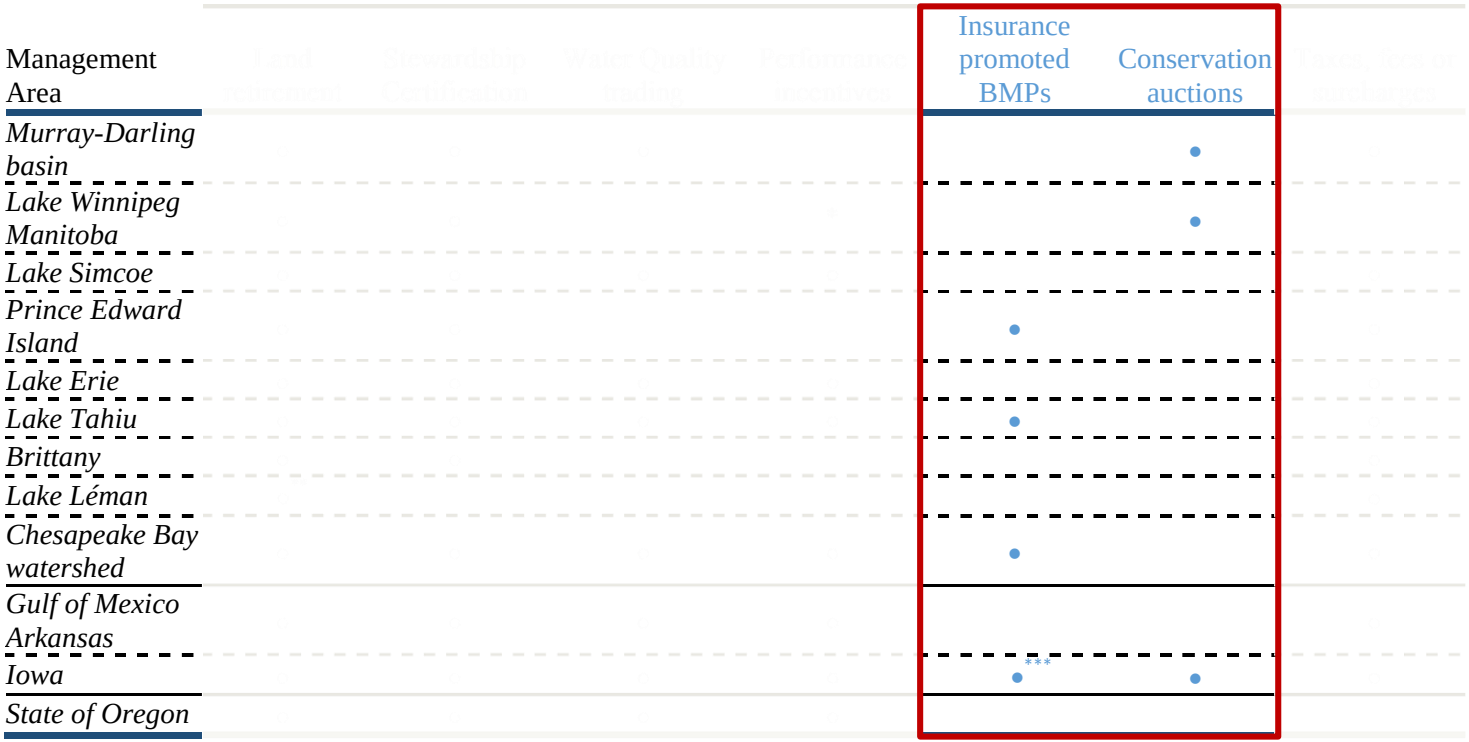
The USDA proposing similar programs (*NRCS*, 2017)

Innovative progress payments

In Finland specific BMPs required the years following enrollment in the conservation program to keep payments coming

Results

Incentive based approaches



Results

Incentive based approaches

Management Area	Innovative approaches	Insurance promoted BMPs	Conservation auctions
Murray-Darling basin	**BMP insurance** guarantees economic losses endured due to BMPs. Control parcel with no BMP. beyond a loss of more than 5% (deductible), losses refunded to the policy holders **Hindrance:** high transaction cost imposed by private insurance companies		●
Lake Winnipeg Manitoba			●
Lake Simcoe			
Prince Edward Island		●	
Lake Erie			
Lake Tahiu		●	
Brittany	**Conservation auctions** **reverse auctions**, bidders (farmers or private land owners) submitting bids indicating their willingness to accept incentives for a BMP **Hindrance:** low participation **Plus**: efficient in broader environmental schemes		
Lake Léman			
Chesapeake Bay watershed		●	
Gulf of Mexico			
Arkansas			
Iowa		●	●
State of Oregon			

Nutrient loads and algal blooms

Worldwide literature review

Innovative and diverse approaches being implemented

But…

- In-depth review needed to make recommendations adapted to the contexts of Lake Memphremagog and Missisquoi Bay-Lake Champlain

Nutrient loads and algal blooms

Worldwide literature review

- National water quality standards not stringent enough to prevent HABs.

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- Cost-benefit analyses increasing the use of more or less sustainable technical solutions (algaecide, Phoslock™).
- Climate change synergy in all likelihood increasing HABs frequencies and areas.

Nutrient loads and algal blooms

Worldwide literature review

There are not any actual success stories related to remediation of HABs, simply management stories.

Institut national
de la recherche
scientifique

Merci pour votre attention

Issues addressed across case studies

				Addressed Issues				
Country	State/Prov	Management Area	Dominant nutrient source	HABs	Limited recreation	Internal Loading	Massive fish kills	Drinking supply shutdown
Australia	Multi	*Murray-Darling basin*	Agriculture	•	•		•	•*
Canada	MB	*Lake Winnipeg*	Multiple/Upstream jurisdictions	•	•	•	•	**
Canada	ON	*Lake Simcoe*	Agriculture/Atmosphere/Urban	•	•	•		
Canada	PEI	*Prince Edward Island*	Agriculture				•***	
Canada-USA		*Lake Erie*	Agriculture-Urban	•	•	•	•	•
China		*Lake Tahiu*	Agriculture-Urban	•	•	•		•
France		*Brittany*	Agriculture	•	•		•	
France-Switzerland		*Lake Léman*	Natural/WWTP outlet	•	****•			
USA	MD-VA	*Chesapeake Bay*	Agriculture/Urban	•	•	•	•	
USA		*Gulf of Mexico*	Agriculture	•	•	•	•	
USA	IA	*State of Iowa*	Agriculture/WWTP	•			•	•
USA	AR	*State of Arkansas*	Agriculture/Urban	•	•		•	
USA	OR	*State of Oregon*	Multiple/Climate change	•	•			*****•

Regulatory approaches

	Regulatory Approaches					
Management Area	Setting reduction targets*	Stormwater management	Wastewater management	Ban on winter manure spreading	Wetland no-net loss policy	Numeric nutrient criteria**
Murray-Darling basin	•	•				•
Lake Winnipeg Manitoba	•		•	•	•	•
Lake Simcoe	•	•	•		•	•
Prince Edward Island	•				•	
Lake Erie	•	•	•	•		•
Lake Taihu	•**	•	•		•	•**
Brittany	•	•	•	•	•	•
Lake Léman	•	•	•	•	•	•
Chesapeake Bay watershed	•	•	•	•	***	
Gulf of Mexico Arkansas	•	•	•			
Iowa	•	•	•	•		
State of Oregon	•			•		

Risk management and mitigation approaches

	Risk mitigation approaches				
Management Area	Nutrient management plan (farm)	Drinking water protection plans*	Early warning system	Algae surveillance program	Cyanotoxin testing**
Murray-Darling basin	•	***	•	•	•
Lake Winnipeg Manitoba	•	•		•	•
Lake Simcoe	•	•		•	
Prince Edward Island	•	•			•****
Lake Erie	•	•	•	•	•
Lake Taihu	*				•
Brittany	•	•		•	•
Lake Léman	•	•	•	•	
Chesapeake Bay watershed	•	•	•	•	•
Gulf of Mexico	N.A.	N.A.	•	•	•
Arkansas	•	•			
Iowa	•	•		•	•
State of Oregon	•	•		•	•