Partners in Project Green

A Program of Toronto and Region Conservation Authority

Using Native, Salt-Tolerant Plants to Restore Impacted Soils

June 04, 2024

- Use the Q&A feature to submit questions to the presenter
- Submit tech issues or chat with fellow attendees through the Chat feature
- Recording, slides and additional information will be available after the webinar

We respectfully acknowledge that we are situated on the Traditional Territories and Treaty Lands, in particular those of the Mississauga Nation, as well as the Anishinaabe of the Williams Treaty First Nations, the Huron Wendat, and the Haudenosaunee.

As stewards of land and water resources within the Greater Toronto Region, Toronto and Region Conservation Authority appreciates and respects the history and diversity of the land and is grateful to have the opportunity to work and meet on this territory.

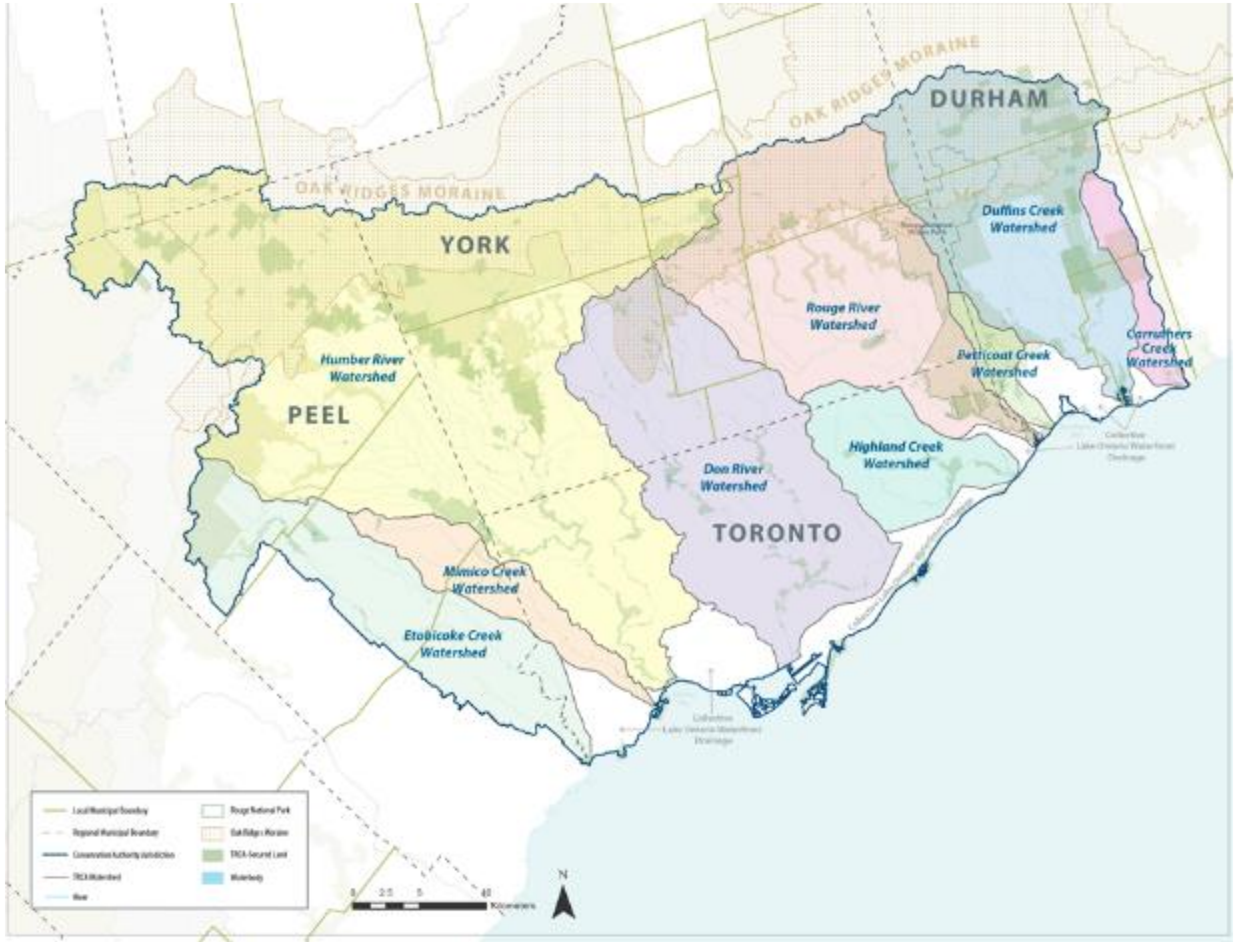
Partners in Project Green

A Program of Toronto and Region Conservation Authority

Our Story

- Toronto Region Conservation Authority's Partners in Project Green (PPG) was launched in 2008 in collaboration with Toronto Pearson

- PPG is open to any business, municipality or individual who operates within the Greater Toronto Area (GTA) in the Regions of Peel, York and Durham and the City of Toronto



Agenda

Time	Item
2:00 PM	PPG Updates & Speaker Introductions
2:05 PM	Using Native Salt-Tolerant Plants to Restore Impacted Soils
2:35 PM	Making MTO Less Salty
2:40 PM	Salt Management Best Practices
2:45 PM	Q&A

Corporate Flood and Heat Risk Management

- Partnered with TRCA's Sustainable Technologies Evaluation Program & Ecosystem and Climate Science, to educate and empower ICI/MURB sector to take action to build climate resilience.

- Resource Hub: Free Videos and accessible resources on flood and heat risks, tools and actions to address them including utilizing Green Infrastructure (GI) and Low Impact Development (LID) techniques.

- Partnered with Credit Valley Conservation to deliver their Greening Corporate Grounds program to qualifying businesses in the City of Mississauga (within TRCA's Jurisdiction).

Image credit: "Stormwater management pools on University Blvd" by UBC News is marked with CC BY-NC 2.0.

Scan Me!

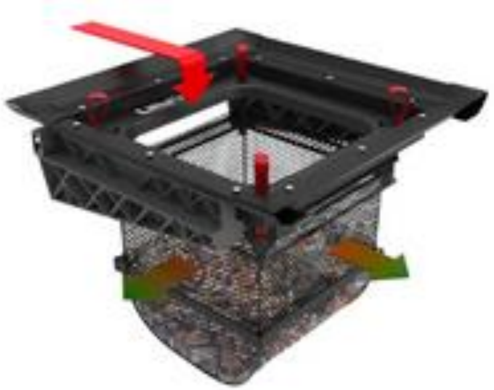
Exclusive Offer for PPG Members

Catch on-site litter before they enter our freshwater with these catch basin inserts!

PPG is collaborating with **EnviroPod™** to bring an exclusive offer to our members.

PPG members receive 10% off on **LittaTrap™**:

- Easily fits in most storm drains
- Simple maintenance



Learn more

Speaker Introductions

Dr. Lyndsay Cartwright, Sr. Research Analyst, TRCA

Toronto and Region Conservation Authority

In addition to Dr. Cartwright's work with the Ecosystem and Climate Science team at Toronto and Region Conservation Authority, she is also an Adjunct Professor at Queen's University, Trent University, University of Waterloo, and University of Toronto.

She is interested in applied ecological research related to current threats to biodiversity and the environment within the Toronto Region.

Dr. Barb Zeeb, Professor & Canada Research Chair, RMC

For 20 years, Dr. Zeeb has studied how to remediate metal-, organochlorine-, petroleum hydrocarbon-, and salt-impacted sites in collaboration with government agencies and contaminated site owners.

Dr. Zeeb is cross-appointed to the School of Environmental Studies and an Adjunct Professor in the Department of Biology at Queen’s University in Kingston, Ontario. As of May 2023, she is also the President of the International Phytotechnology Society.

Lauren Nawroth, Master of Environmental Studies, Queen's University

Lauren's thesis explored phytoremediation of saline soils using Canadian native grasses, specifically halophytes (salt tolerant plants). Coupled with a Bachelor of Science (Honours) majoring in Chemistry, Lauren hopes to pursue a career in environmental consulting.

Paula Berketo, Principal Landscape Architect, Ministry of Transportation

Ontario
MINISTRY OF TRANSPORTATION

Paula is a full member of the Ontario Association of Landscape Architects.

Since 2010, she has been guiding the Ministry with all aspects of planting, soils, tree preservation, native plants, and vegetative cover. This includes the selection of native seeds and plants that can survive and thrive in challenging conditions, including high volumes of salt, and if possible, remediate those difficult situations.

Daniel Filippi, Research Scientist, TRCA

Sustainable Technologies EVALUATION PROGRAM

Daniel Filippi is a Research Scientist with TRCA's Sustainable Technologies Evaluation Program (STEP).

He has over 10 years' experience in the environmental field and has developed several flood and climate change-related training programs/courses educating homeowners, government staff, consultants and ICI/MUR owners on the importance of adopting appropriate Low Impact Developments (LID) and SWM BMPs.

Using Native Salt-Tolerant Plants to Restore Impacted Soils

Acknowledgements

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Toronto Pearson

407 ETR Express Toll Route

McMaster University

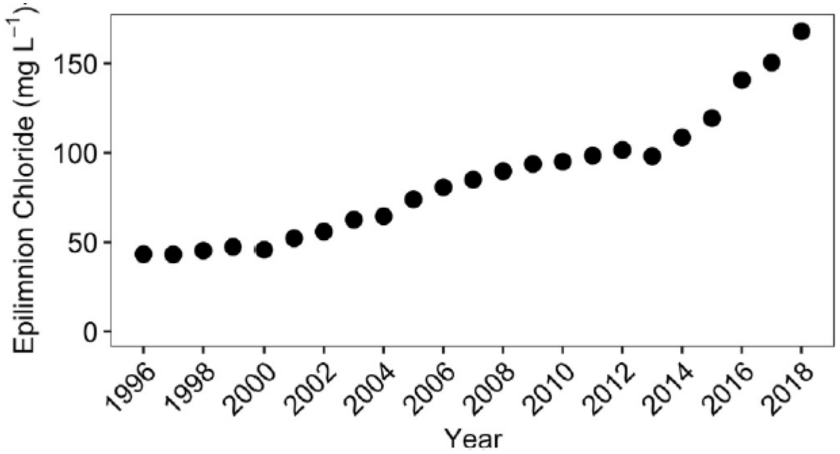
Ontario

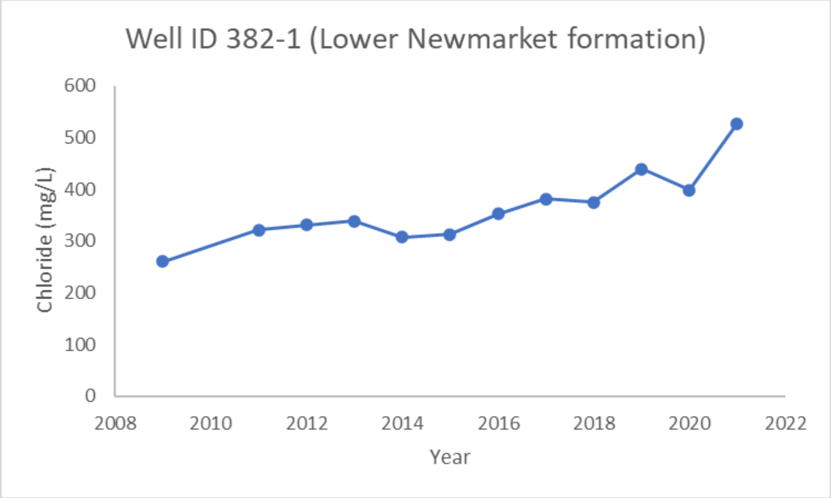
TERRERA

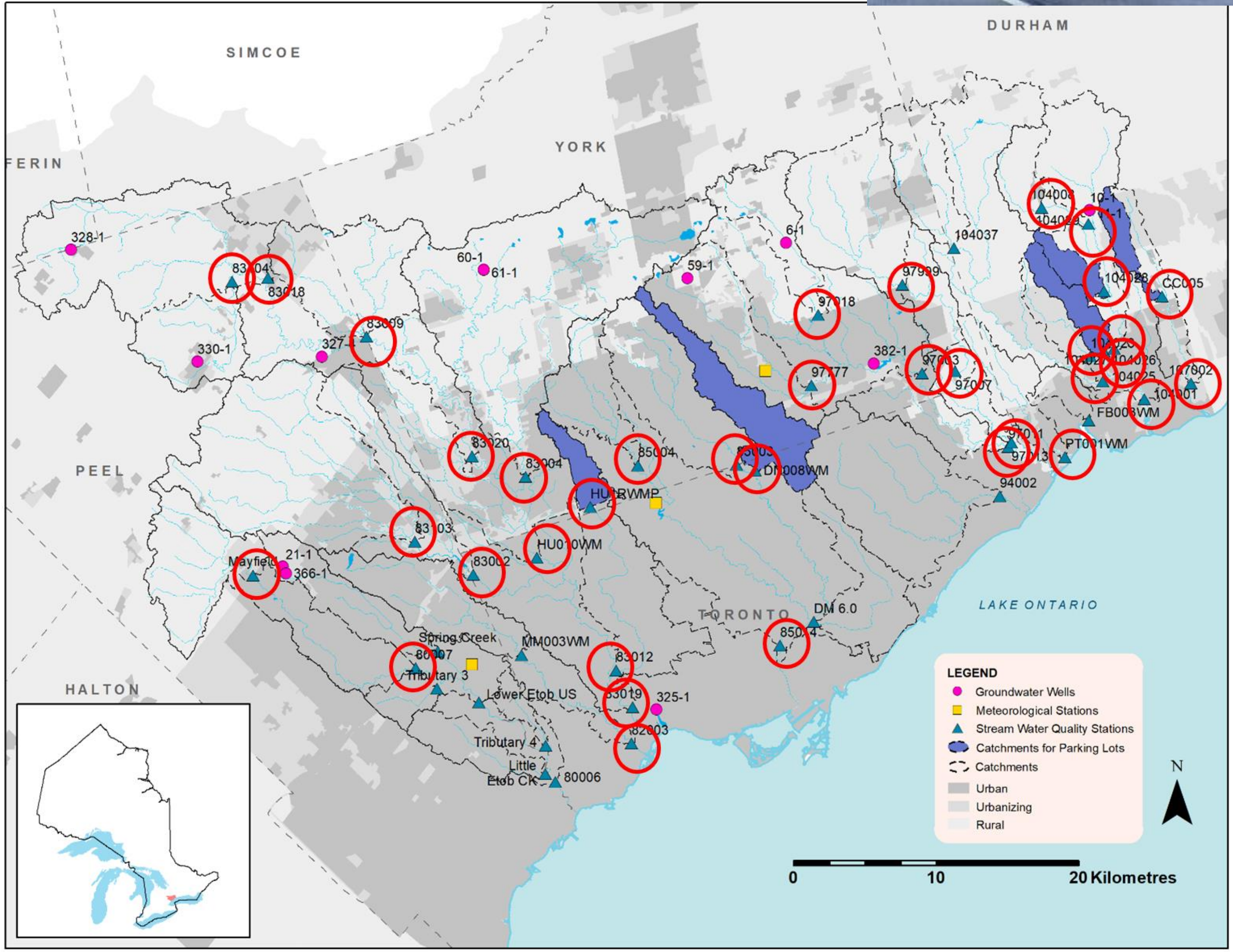
Queen's UNIVERSITY

Chloride levels in freshwater continue to rise

Lake Wilcox

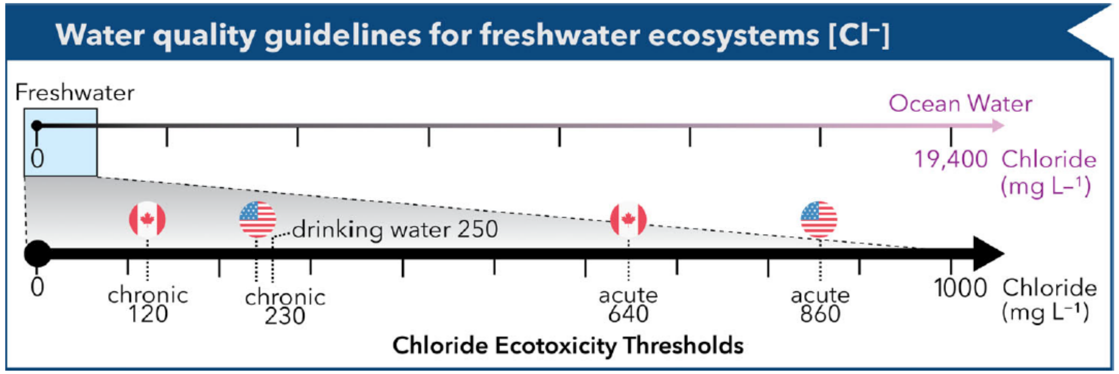


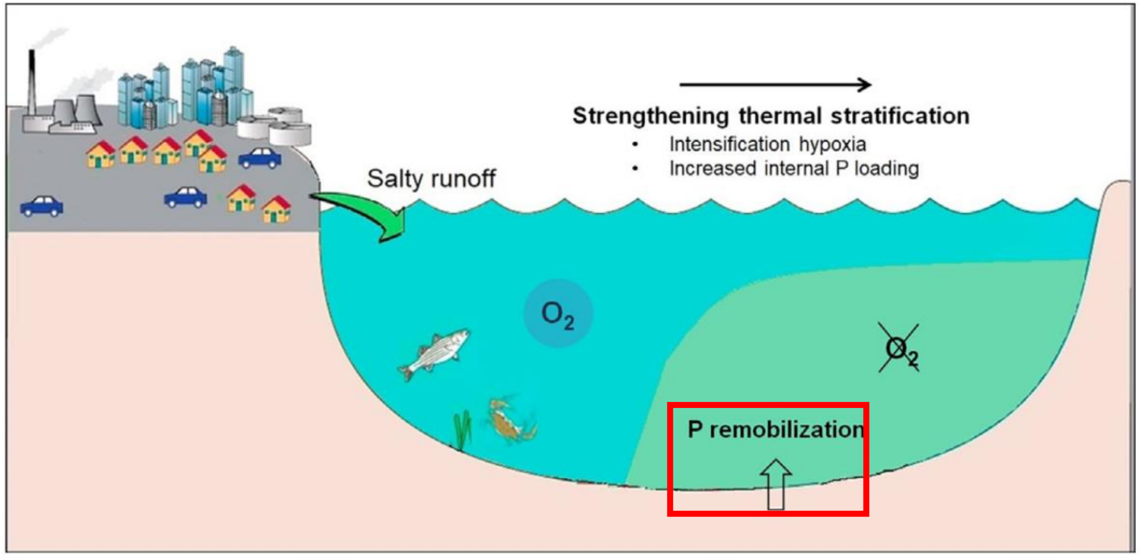


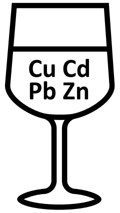


Radosavljevic et al. (2022), TRCA (2021), Cartwright et al. (2023)

Moving towards, or already exceeding, thresholds to protect aquatic life & human well-being

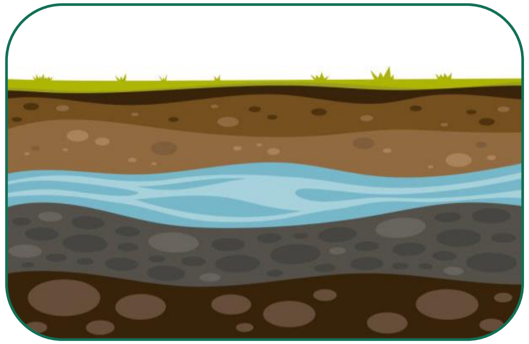




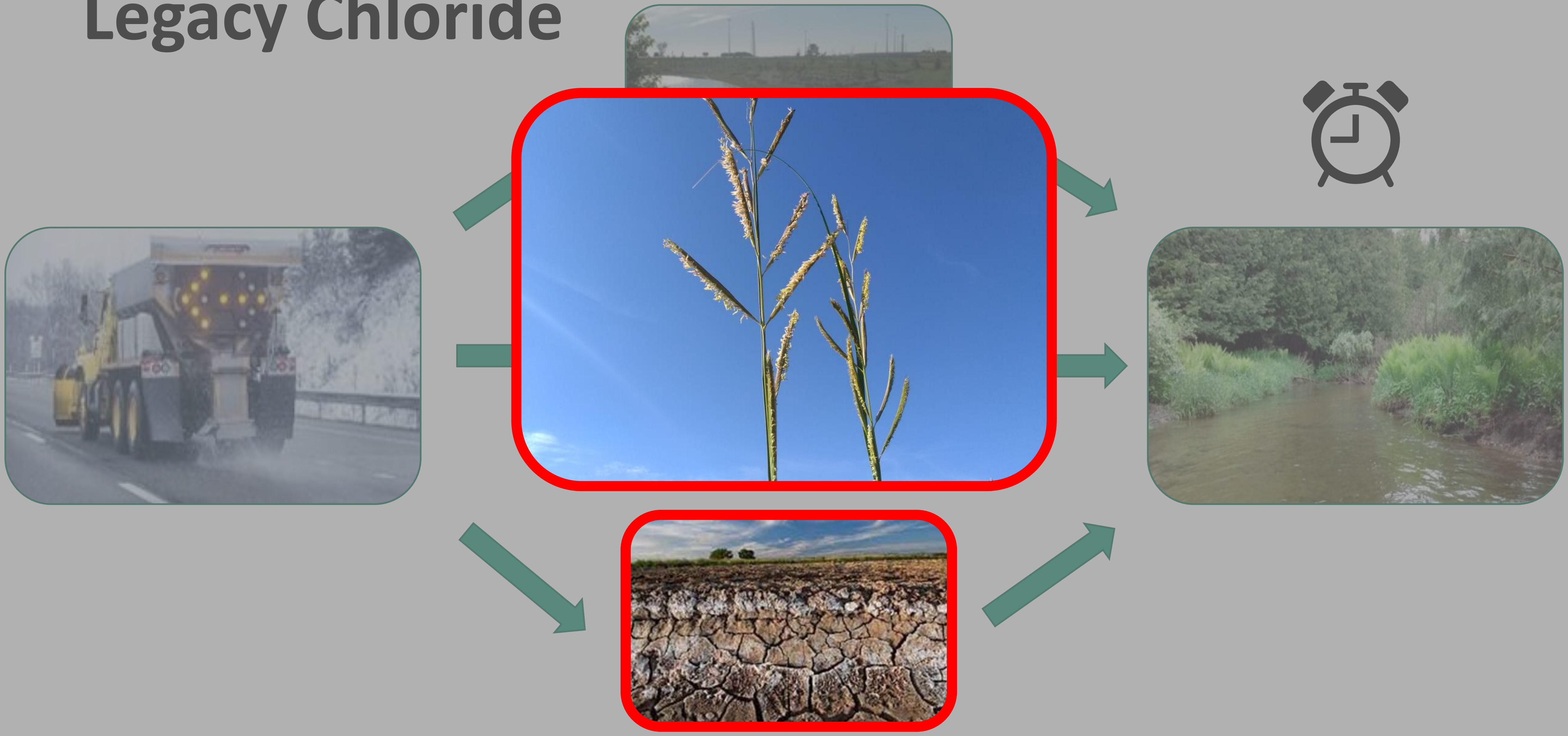


Dugan & Arnott (2022), Lawson & Phan (2022), Radosavljevic et al. (2022)

Legacy Chloride



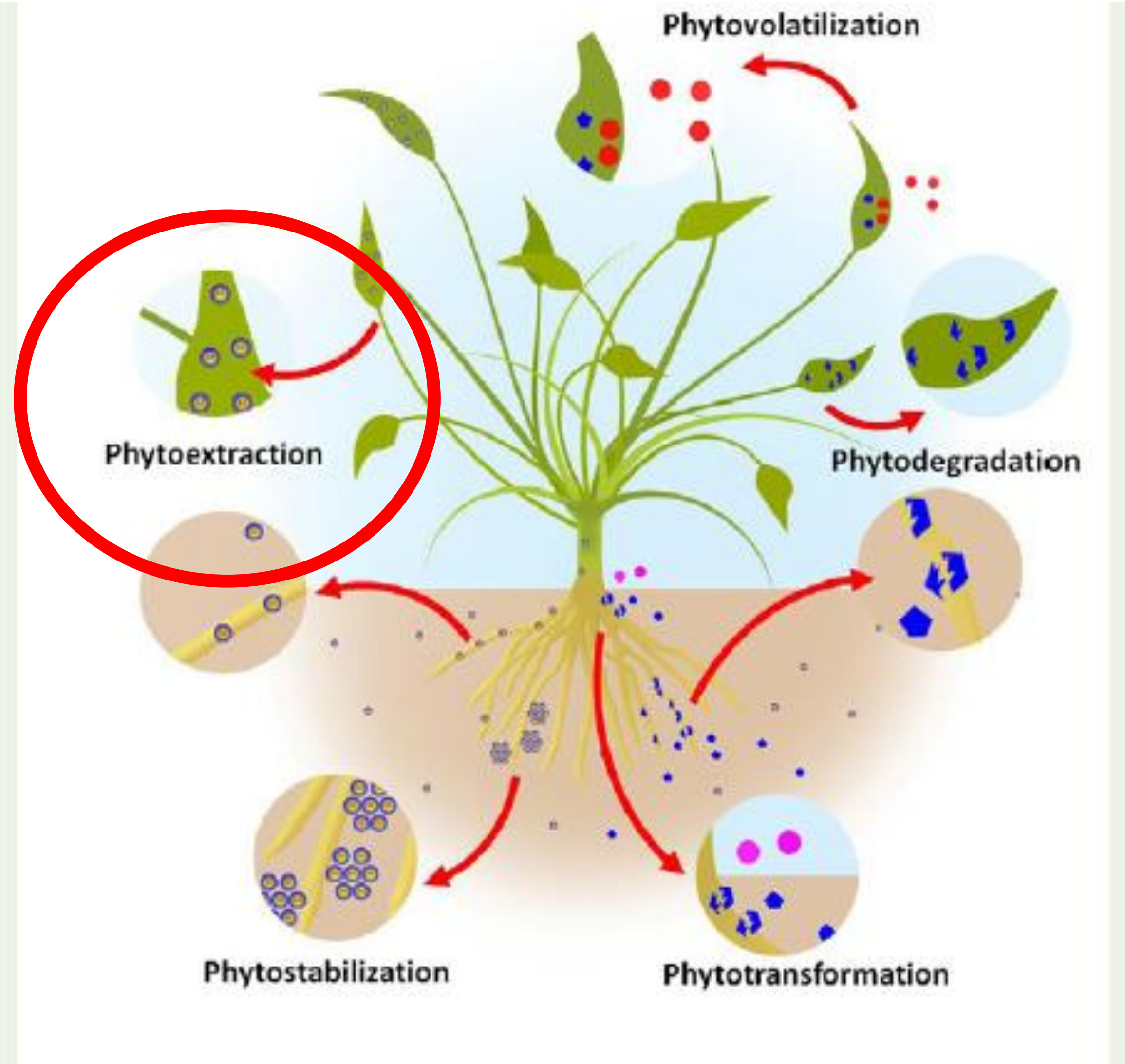
Legacy Chloride



Phytoremediation

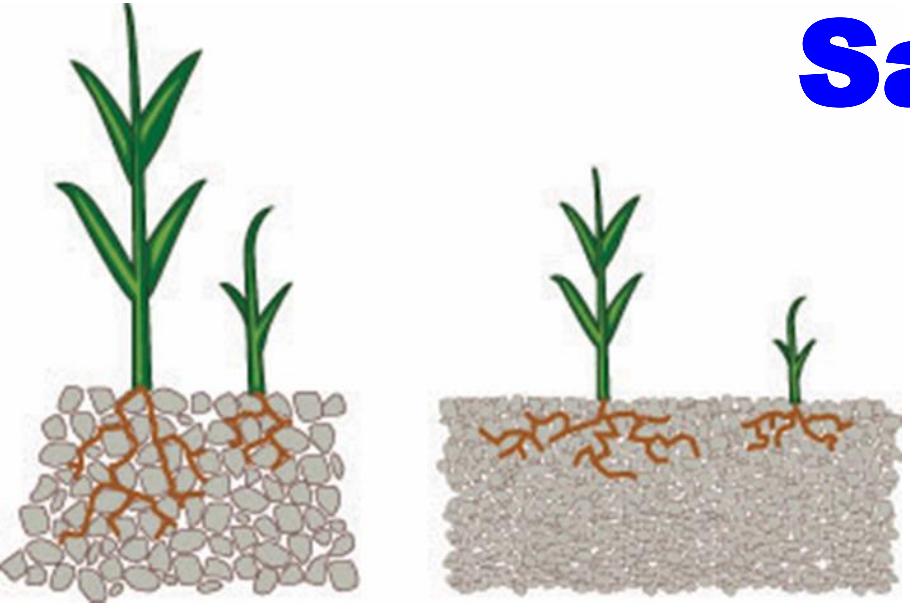
- using plants to remediate contaminated environments

Phytoextraction = contaminants taken up by roots, translocated to shoots and sequestered (usually in plant vacuoles)



https://www.opensciencepublications.com/fulltextarticles/JPSR-2349-2805-2-135.html

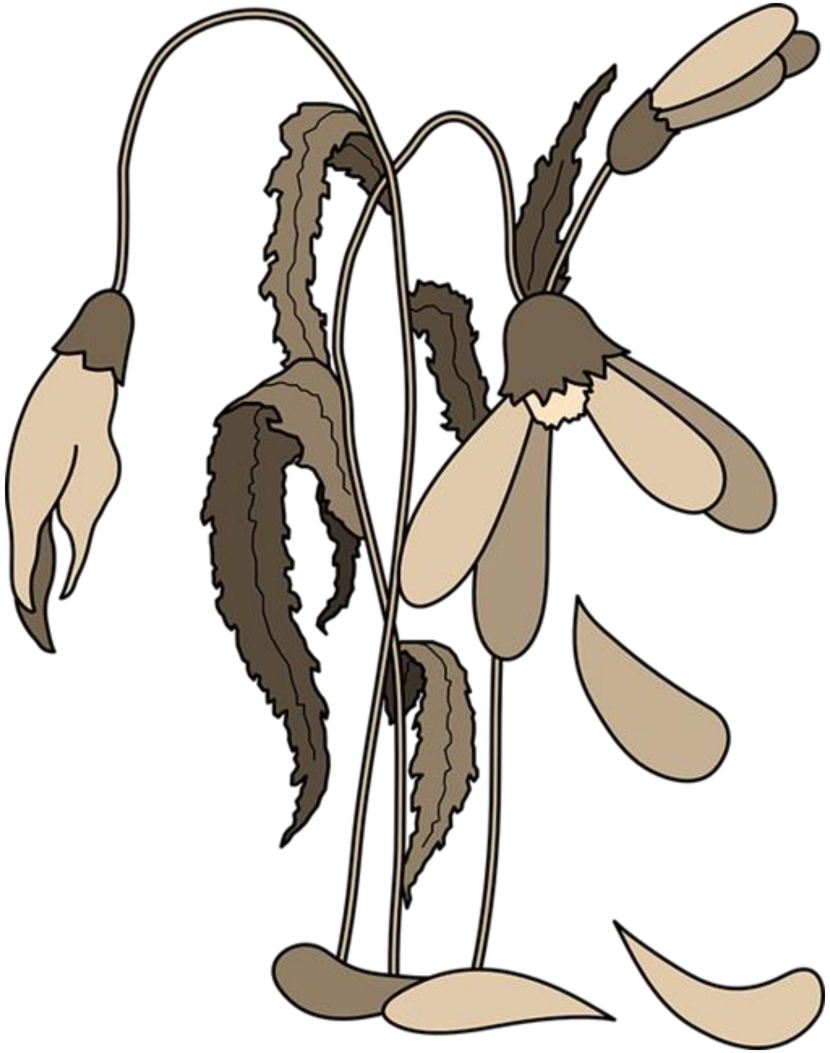
Salinity Stress



(University of Georgia, 2019)

(FAO, 2002)

- poor soil structure
- osmotic stress in plants, microbes & soil invertebrates
  - → artificial drought
- Ion toxicity in plants



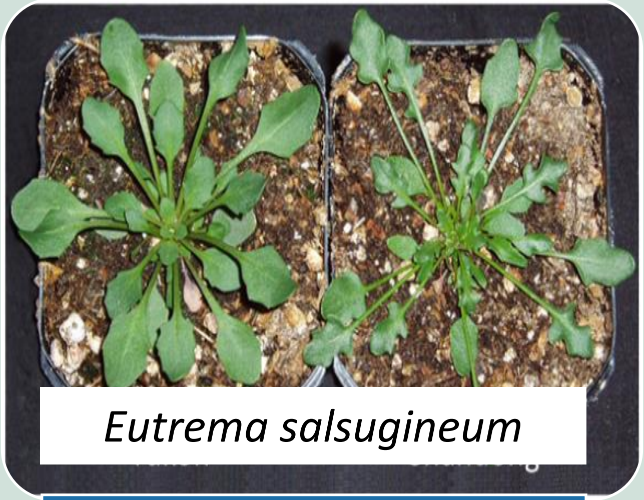
Poll #1: What are halophytes?

Halophytes are plants that:

a) cannot tolerate salt in soil
b) can tolerate, and in some cases extract salt from soil
c) need high amounts of moisture in soil
d) need high amounts of nutrients

Halophytes

Excluder



Eutrema salsugineum

Prevent salts from entering roots

Accumulator

Salicornia maritima

Sequester harmful salts in central vacuole

Recretohalophyte

Distichlis spicata

Excrete salt through glands on leaf surfaces

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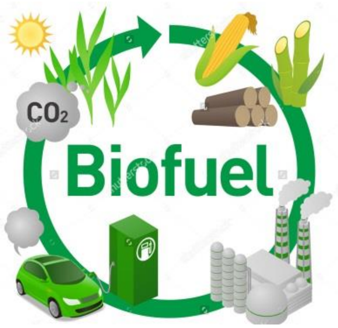
Accumulator Halophytes



1) Plant Halophytes

- many accumulators identified
- select native species
- many dryland & some semi-aquatic

2) Grow

- ions taken up by plant
- sequestered in central cell vacuoles

3) Harvest

- labour intensive
- soil left undisturbed
- some species can tolerate multiple harvests/season

4) Repurpose Biomass

- compost
- feed & fodder
- pyrolysis to biochar
- produce biofuels

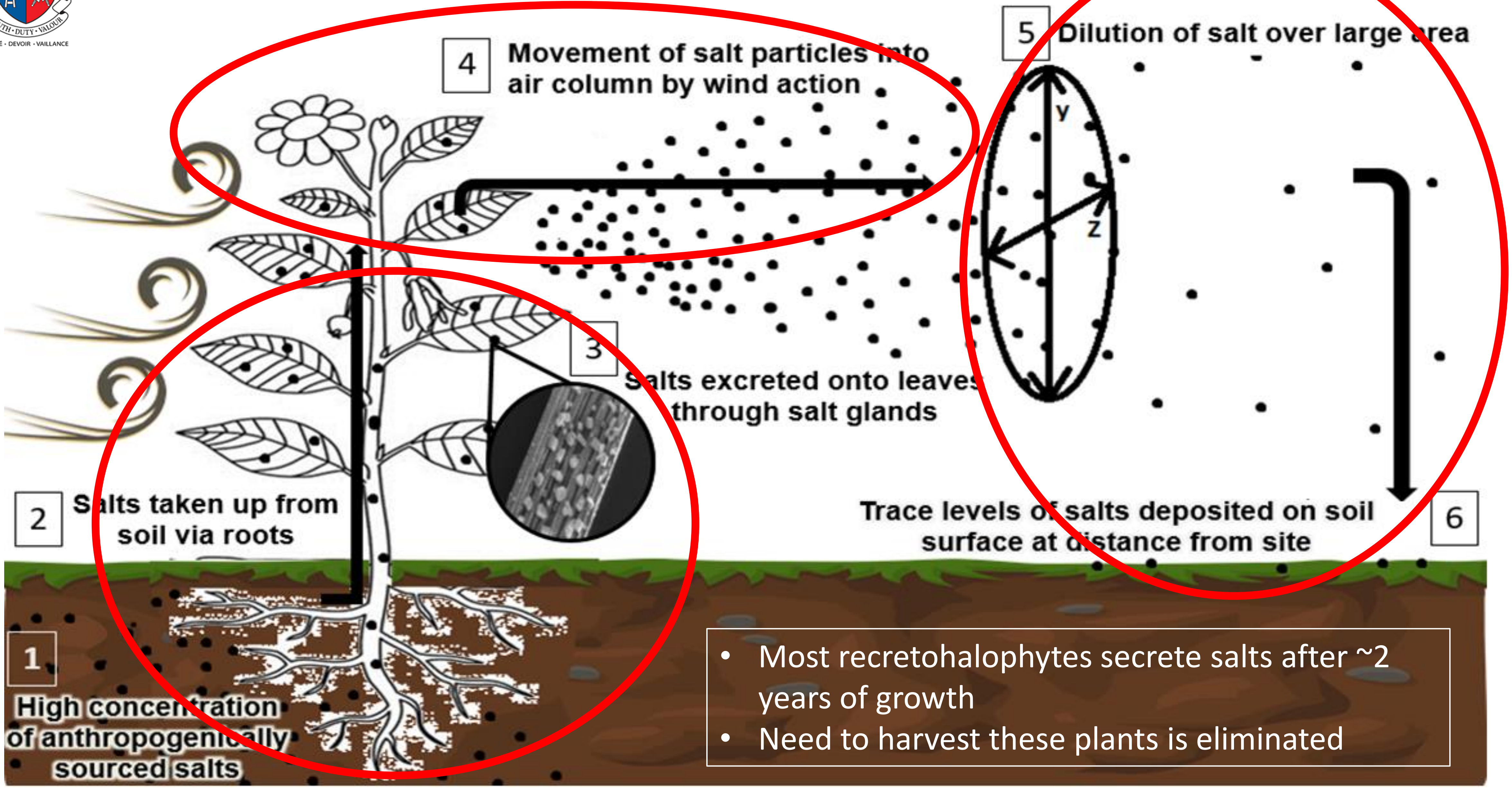
Recretohalophytes

Armeria maritima
(sea thrift)

Distichlis spicata
(inland saltgrass)

Sporobolus michauxianus
(prairie cordgrass)

Haloconduction



- Most recretohalophytes secrete salts after ~2 years of growth
- Need to harvest these plants is eliminated

Selected Species for Remediation

Side Oats Grama
Bouteloua curtipendula

Prairie Cordgrass
Sporobolus michauxianus

Switchgrass
Panicum virgatum

Sand Dropseed
Sporobolus cryptandrus

Excretors

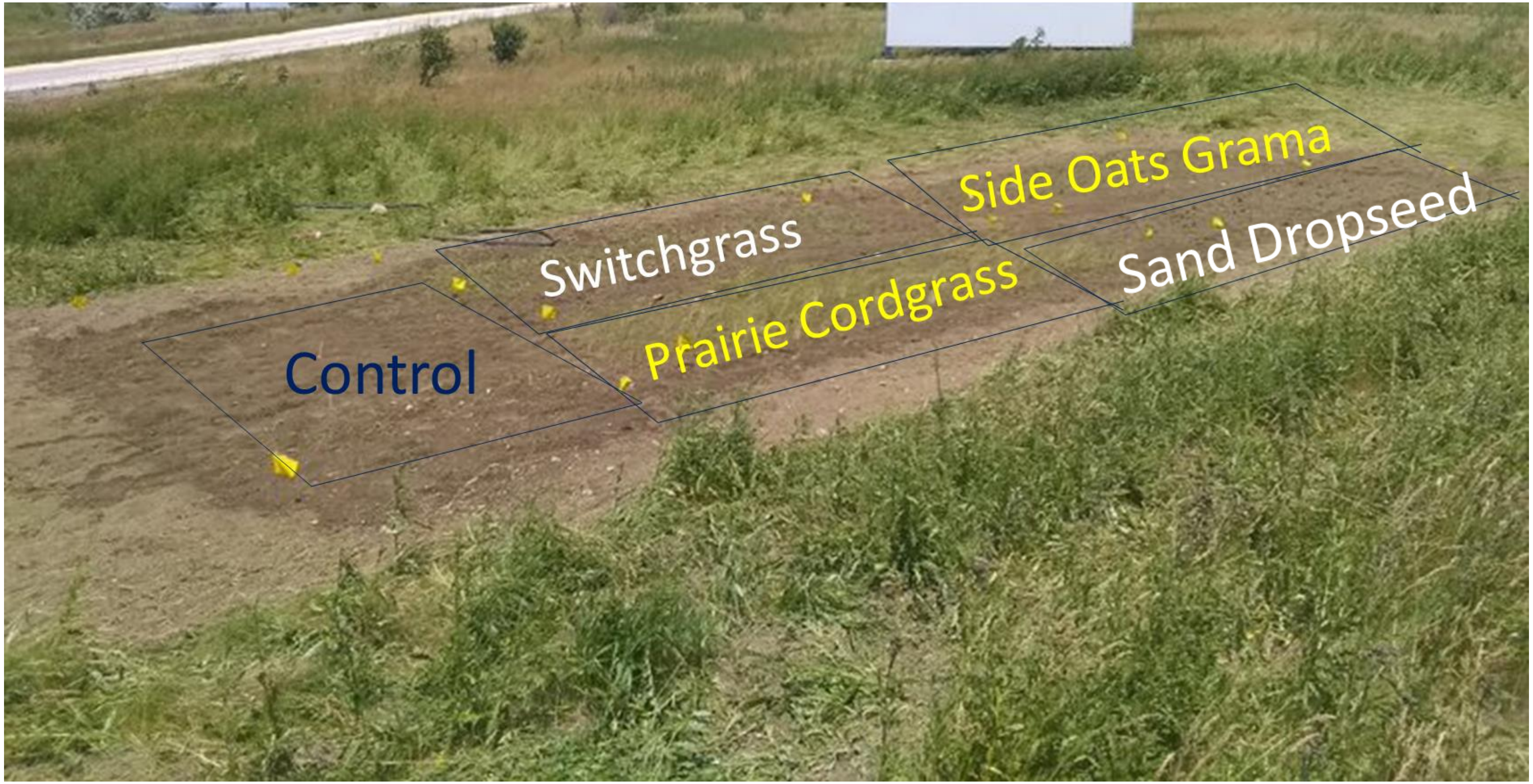
Accumulators

Experimental Plots

Established background:
Cl^- levels = 20 mg/kg

In plot:
Cl^- levels = mean 365 mg/kg

Experimental Plots



Halophyte Type

Excretor

Accumulator

Halophyte Type

Excretor

Accumulator


Prairie Cordgrass
Switchgrass
Side Oats Grama
Sand Dropseed
July 21st, 2022


August 18, 2022
Prairie
Cordgrass
Switchgrass
Side Oats Grama
Sand
Dropseed

End of Season

Halophyte Type

Excretor

Accumulator

Regrowth of harvested material

June 1, 2023

Regrowth of Switchgrass

Un-harvested Switchgrass

Halophyte Type

Excretor

Accumulator

Halophyte Type

Excretor

Accumulator

Halophyte Type

Excretor

Accumulator

Phytoremediation timelines (2023)

	Species	Literature biomass production g DW /m^2	Observed biomass production g DW/m^2	Average Chloride uptake mg/m^2	Cl^- (mg) in top 15 cm of specific species plot	Years for Remediation
Excretor	**Prairie Cordgrass**					
Excretor	**Side Oats Grama**					
Accumulator	**Switchgrass**					
Accumulator	**Sand Dropseed**					

Phytoremediation timelines (2023)

Species	Literature biomass production g DW /m^2	Observed biomass production g DW/m^2	Average Chloride uptake mg/m^2	Cl^- (mg) in top 15 cm of specific species plot	Years for Remediation
Prairie Cordgrass	1,000				
Side Oats Grama	1,100				
Switchgrass	1,500				
Sand Dropseed	25				

Excretor

Accumulator

Phytoremediation timelines (2023)

Species	Literature biomass production g DW /m^2	Observed biomass production g DW/m^2	Average Chloride uptake mg/m^2	Cl^- (mg) in top 15 cm of specific species plot	Years for Remediation
Prairie Cordgrass	1,000	8,904			
Side Oats Grama	1,100	454.3			
Switchgrass	1,500	7,568			
Sand Dropseed	25	-			

Excretor

Accumulator

Phytoremediation timelines (2023)

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Prairie Cordgrass	1,000	8,904	41,052		
Side Oats Grama	1,100	454.3	1,317		
Switchgrass	1,500	7,568	16,967		
Sand Dropseed	25	-	12,124		

Excretor

Accumulator

Phytoremediation timelines (2023)

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Side Oats Grama	1,100	454.3	1,317	14,040	
Switchgrass	1,500	7,568	16,967	15,600	
Sand Dropseed	25	-	12,124	93,600 (2022)	

Excretor

Accumulator

Phytoremediation timelines (2023)

	Species	Literature biomass production g DW /m^2	Observed biomass production g DW/m^2	Average Chloride uptake mg/m^2	Cl^- (mg) in top 15 cm of specific species plot	Years for Remediation
Excretor	**Prairie Cordgrass**	1,000	8,904	41,052	40,950	1.9 years
Excretor	**Side Oats Grama**	1,100	454.3	1,317	14,040	13.3 years
Accumulator	**Switchgrass**	1,500	7,568	16,967	15,600	2.3 years
Accumulator	**Sand Dropseed**	25	-	12,124 (2022)	93,600 (2022)	3.5 years (2022)

Polling Question #2

If there was signage available to show your organization is using native *halophytes* to help remove salt from soils (similar to pollinator garden signs), would your organization consider displaying this for the public?

a) Yes*
b) No
c) Maybe*

*We will reach out to you after the webinar to discuss further

Polling Question #3

Would your organization be interested in trialing planting halophytes on your land to inform the development of guidelines/checklists for landowners?

a) Yes*
b) No
c) Maybe*

*We will reach out to you after the webinar to discuss further

Polling Question #4

Would your organization be interested in hosting a community halophyte planting event on your land?

a) Yes*
b) No
c) Maybe*

*We will reach out to you after the webinar to discuss further

Why Is the Ministry of Transportation So Salty and What Can Be Done ?

Using Native Salt-Tolerant Plants to Restore Salt-Impacted Soils

Ministry of Transportation – Principal Landscape Architect

Paula Berketo,B.L.A., O.A.L.A.

June 2024

Ontario

MTO & Salt

- MTO is salty.
- At times, very salty
- Sodium, magnesium, calcium
- Reduced amounts in past decade
- Greatly affects green infrastructure
- Plants, soil, turf
- Runoff
- Sensitive water bodies

Native Grasses Are Magic

- MTO seed mixes recently changed
- OPSS 803 – Vegetative Cover revised to have a variety of native grasses (done in 2023) Switchgrass, Big and Little Bluestem, Canada Wild Rye, Indian Grass, Smooth Aster, Milkweed, Sweet OxEye.
- Surprised by halophytes
- Results of study provide much hope
- Look forward to second phase of study results

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Salt Management Best Practices

Presented by: Daniel Filippi

June 4th, 2024

The water component of STEP is a collaborative of:

Toronto and Region Conservation Authority

Credit Valley Conservation
inspired by nature

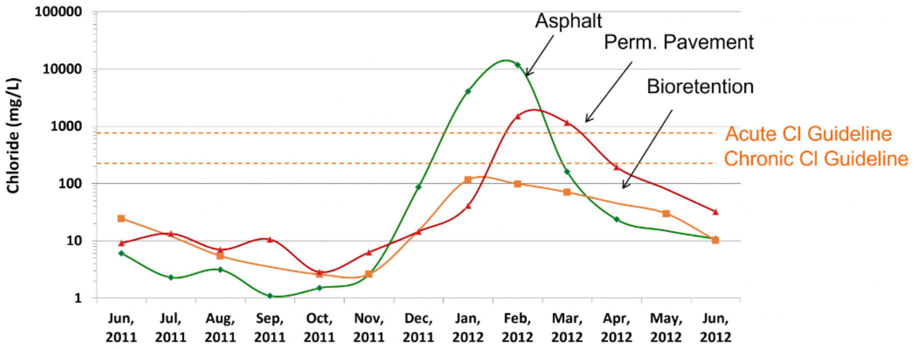
Lake Simcoe Region conservation authority

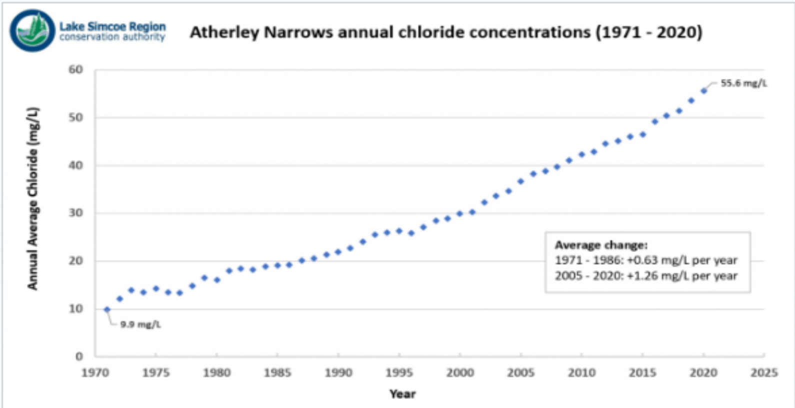
STEP Wiki Guidance

Sustainable Technologies EVALUATION PROGRAM

Salt

Contents [hide]





A graph showing increasing average levels of chloride found in Atherley Narrows, (a rural sampling location, between Lake Couchiching and Lake Simcoe), over the past few decades, due in part to increased use of rock salt in parking lots, roadways and commercial and residential properties. From 2005 - 2020 the amount of chloride increase per year has doubled when compared to 1971 - 1986 (1.26 mg/L per yr. vs. 0.63 mg/L per yr.) (LSRCA, 2021). It is estimated that by 2120 the average level of chloride within the the Lake Simcoe watershed will exceed the 120mg/L guideline set by CWQG. (LSRCA, 2018)[1]

Overview [edit]

Between 5 and 7 million tonnes of salt is applied every year in Canada for winter maintenance of roads and other paved surfaces, making it one of the most ubiquitous contaminants in urban environments. Canadians spend over $1 billion in winter maintenance costs to clear snow/ice on public and private roads, parking lots and sidewalks, this includes the use and application of greater than 5 million tonnes of rock salt for both deicing and anti-icing operations (Hossain et al., 2015)[2]. While the use of salt is essential to ensure public safety, there is a growing concern regarding the large quantities of salt (mainly chloride ions), being released to the environment.

$NaCl^-$ is the most common de-icer applied for winter maintenance, comprised of 40% sodium and 60% chloride. Sodium chloride rock salt is often treated with liquid $MgCl_2$ and $CaCl_2$ to reduce the effective temperature range of salts. Liquid brines comprised of $NaCl^-$, $MgCl_2$ and $CaCl_2$ or a combination of these products are increasingly being used on roads for anti-icing to help reduce the amount of rock salt used and lower overall operations costs.

Impacts on the Environment, Human Health and Built Infrastructure [edit]

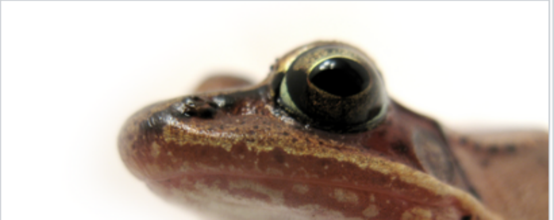
While salt is needed to keep roads safe in the winter, it is highly corrosive and toxic to freshwater wildlife at relatively low concentrations. Some of the impacts of salt on infrastructure, human health and the environment include the following:

Freshwater wildlife [edit]

Just as we depend on air with the right makeup of oxygen, freshwater species – like fish, frogs, mussels, salamanders and zooplankton – need water with the right balance of chloride to survive. Having adapted to low levels of chloride in their habitats, increased levels begin to disrupt their basic functions – such as regulating their water content (osmoregulation) and breathing. Studies have shown widespread effects of salt on ecosystems at all trophic levels from biofilms to fish species. Specific effects vary based on exposure concentrations, and may include reductions in fecundity, size, shape, growth and abundance (Hintz and Relyea, 2019)[3]

Vegetation [edit]

Salt affects vegetation in various ways. Salt in soil water generally makes it more difficult for roots to take up water. This phenomenon mimics drought conditions for the plant and underlies the recommendation for salt tolerant plants in LID practices. If passing traffic sprays salty water onto plants it can reduce cold hardiness in buds and new twigs. These then become more susceptible to freezing, mortality or deformation. In high enough concentrations, sodium and chloride can also be directly toxic to plants. In some species the ions are absorbed by the plant and build up in the leaves causing them to die.

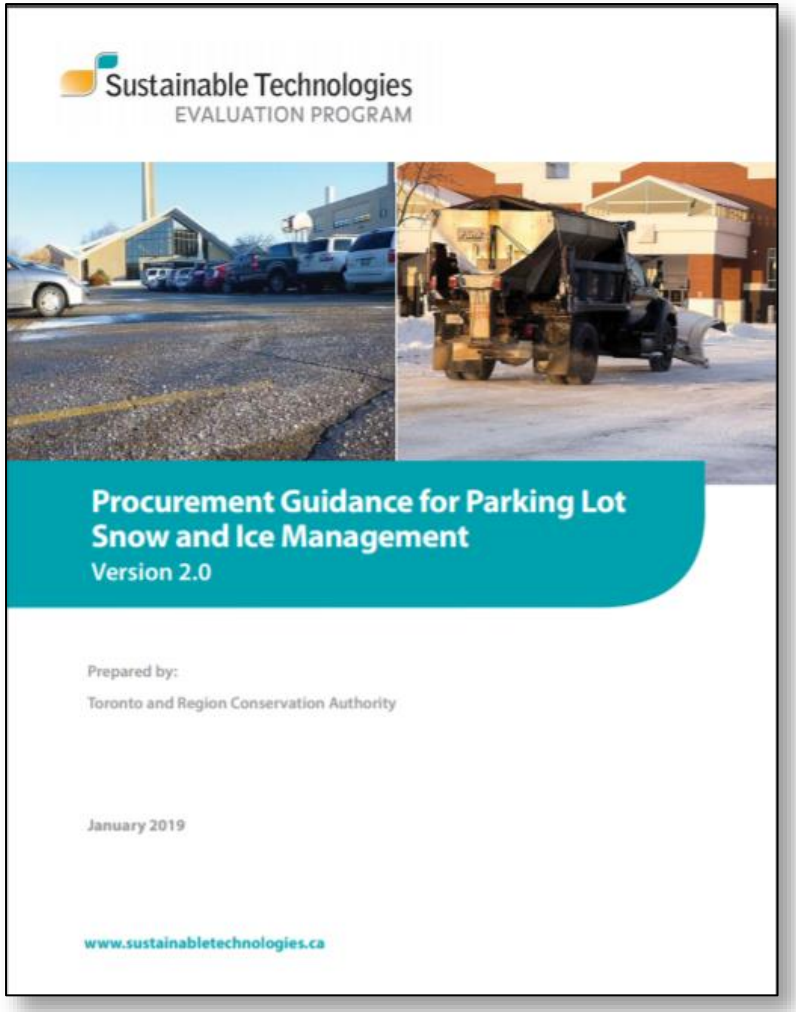


Soils [edit]

Dissolved sodium ions may replace calcium and magnesium ions in soil minerals, with negative effects on soil structure, hydraulic properties and fertility. Salt can also cause trace metals to be leached from the soil and into groundwater (e.g. Norrström and Bergstedt, 2001[5]; Norrström, 2005[6]). Excess salt (chloride) in soils can also result in decreased hydraulic conductivity, which can lead to increased occurrences of surface runoff, erosion and

Procurement Guidance

- Focus on **parking lot** snow and ice management
- Emphasis on practices that **optimize salt use**
- Describes key practices and potential to reduce salt
- Estimates of expected impact of practice specification on contract price
- Sample contract wording

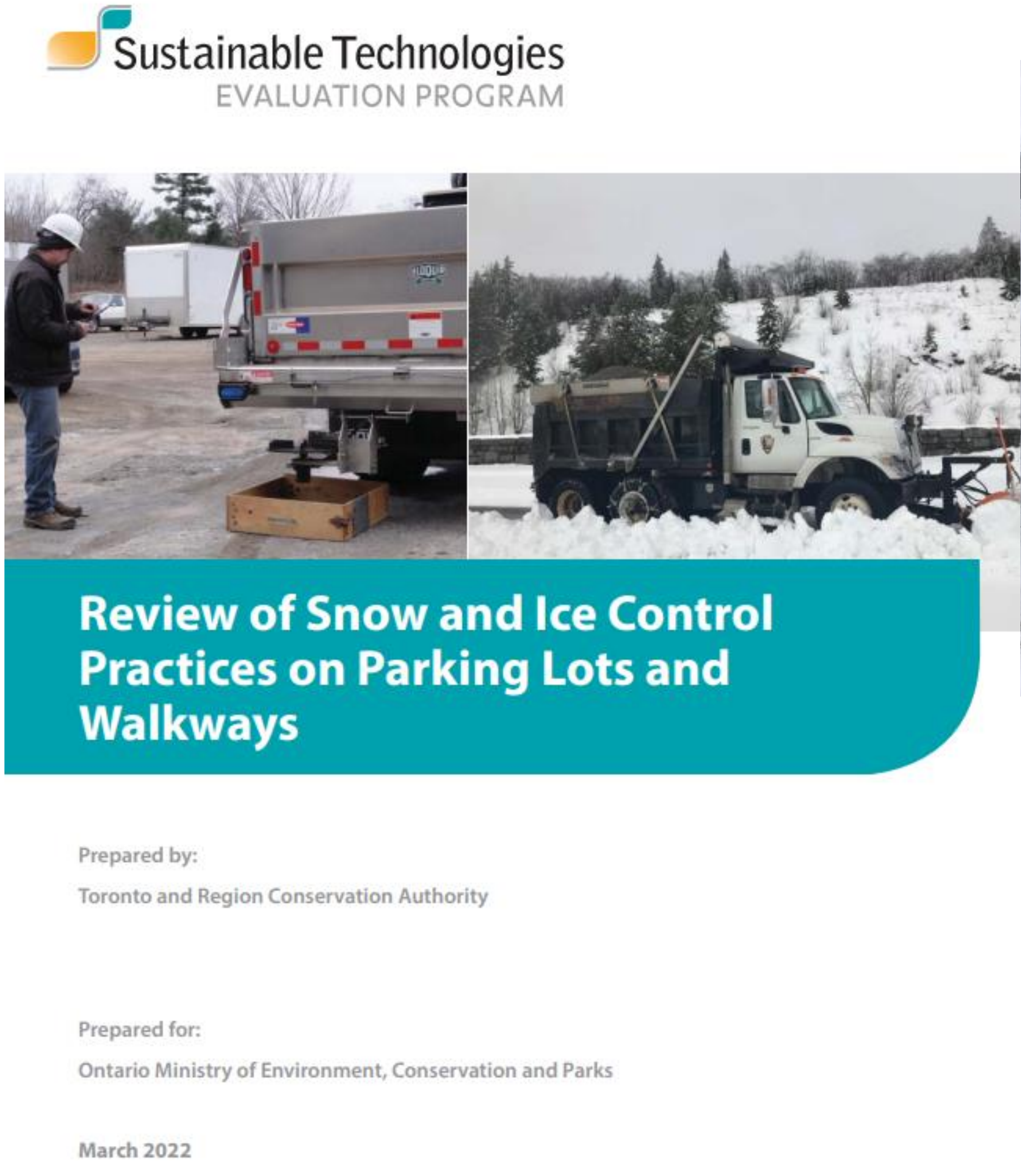


Procurement Guidance v2.0
www.sustainabletechologies.ca

BMPs for Snow & Ice Control on Parking Lots & Walkways

- Characterizes state of practice through surveys of contractors, municipalities and property owners
- Synthesizes key insights from research and guidelines on application rates and snow and ice BMPs
- Practices addressed include:
- Alternative materials
    - Pre-treated and pre-wetted salt
    - Direct Liquid Application (DLA)
    - ‘Chemical plowing’
    - Decision making tools (e.g., Maintenance Decision Support Systems - MDSS)
    - Salt storage
    - Staff training
    - Property manager best practices
    - And others like alternative surface courses
- Case study summaries in Appendix

STEPS’s BMP Document from Across Ontario & Beyond (2022)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Review of Snow and Ice Control Practices on Parking Lots and Walkways

Prepared by:

Toronto and Region Conservation Authority

Prepared for:

Ontario Ministry of Environment, Conservation and Parks

March 2022

Alternatives to Chloride

- Several low chloride organic liquids evaluated
- Effective in reducing salt
- In some contexts, salt alternatives may increase nutrient load to waterways
- Nutrient impacts on streams less likely on roads drained by ditches

1. Alternatives to Salt
2. Alternatives to Sand
3. Evaluation of Organic Anti-Icing

Resources & Contact

STEP website:
[Winter Salt Management]

STEP LID Planning and Design Guide wiki website:

1. Salt
2. Source Water Protection

Contact
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Daniel.Filippi@trca.ca

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Winter Salt Management

Winter salts are usually defined as the chloride salts of sodium, calcium, magnesium, and potassium, which are the four most common chemicals used for winter maintenance. Every winter, more than 5 million tonnes of salt are applied to roads, parking lots, and sidewalks across Canada[1]. Salt is used to control snow and ice, making winter driving safer and more efficient. It is used extensively in Canada because it is effective, relatively easy to transport and use, and low in cost.

The environmental impact of winter salt use in Canada has been documented in several studies, including a comprehensive five-year scientific assessment completed in 2001 by Environment Canada. This assessment concluded that salt is entering the environment in quantities that may pose immediate or long term environmental risks. Elevated concentrations of chloride salts may cause adverse effects to aquatic life, terrestrial vegetation, soil structure, and drinking water.

The economic impacts of winter salt use include corrosion damage to roads, bridges, parking garages, and underground utilities, as well as the costs of implementing corrosion protection measures. Salt corrosion also affects motor vehicles, especially brake linings, frames, and bumpers. When these factors are fully accounted for, the costs of winter salt use become considerably larger.

Over the last decade, there have been significant advances in winter maintenance technology and practice. From the development of low chloride alternatives to the conventional salt, to improved equipment and application techniques, to advances in our ability to monitor weather and pavement conditions, winter maintenance practitioners now possess more tools to safely and effectively control snow and ice using less salt.

Select a project on the right side bar for more information about STEP's work in road salt management.

Photo Credit: Todd Klassy via Compfight cc

[1] Environment Canada. 2004. Best Management Practices for Salt Use on Private Roads, Parking Lots and Sidewalks, page 1.

Featured Projects

- » Review of Snow and Ice Control Practices on Parking Lots and Walkways
- » Evaluation of Organic Anti-icing Materials for Winter Maintenance
- » Specifying Salt Management Best Practices in Parking Lot Winter Maintenance Contracts
- » SAVE Program
- » Snow and Ice Control for Parking Lots and Sidewalks (SICOPS)
- » Chloride in Toronto Area Streams
- » Alternatives to Salt: What else melts snow and ice?

Guidelines

- » Code of Practice for the Environmental Management of Road Salts
- » TAC Syntheses of Best Practices

Canadian Water Quality Guidelines for the Protection of Aquatic Life: Chloride
380 KB PDF

Minnesota Pollution Control Agency's Winter Parking Lot and Sidewalk Maintenance Manual

www.sustainabletechnologies.ca

Implementation and Resources

- Reduction of salt is key
- Working on guidelines (common locations to plant, easy testing of soil, maintenance)
- No one-size-fits-all solution
- https://partnersinprojectgreen.com/what-are-halophytes/
  - Information on halophytes
  - Halophyte species
  - Nurseries supplying halophytes
- https://wiki.sustainabletechnologies.ca/wiki/Plant_lists
  - Plant lists based on soil moisture, shade-tolerance
  - Select tall grasses (for halophytes)
  - Species best used with different LID best management practices (salt, pollution, drought and compaction tolerant)

Q & A

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