Restoration For Resilience:

Tidal marsh restoration and coastal flood adaptation in the Fraser River Estuary

DFO-PSF Virtual Knowledge Exchange Workshop
January 31, 2024

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Ducks Unlimited Canada
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Photo: E. Balke

Overview

- Introduction to the Fraser River Estuary
- Challenges for Resilience
- Restoring Resilience
  - Sturgeon Bank Sediment Enhancement Pilot Project
  - The Nature Force

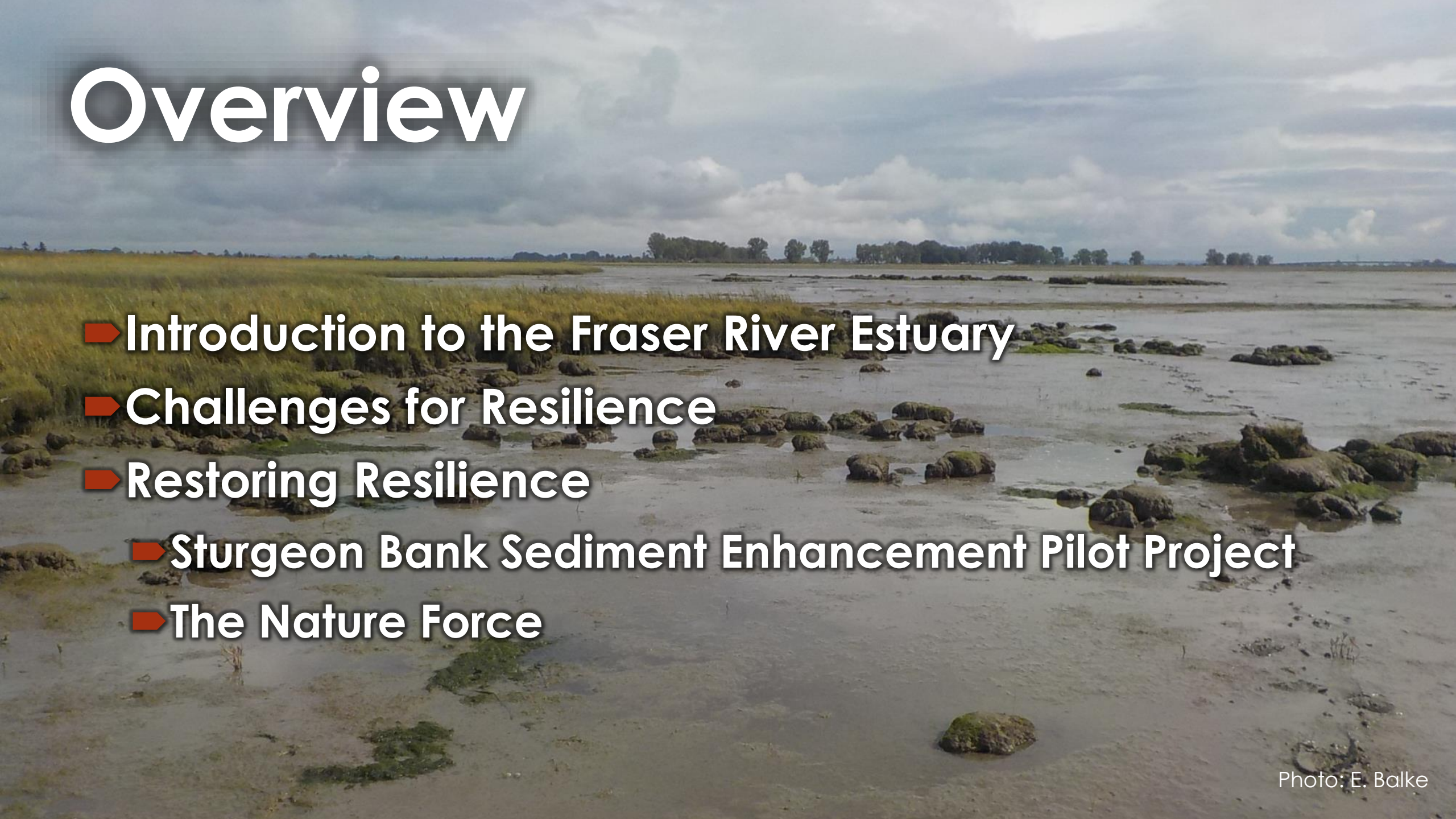
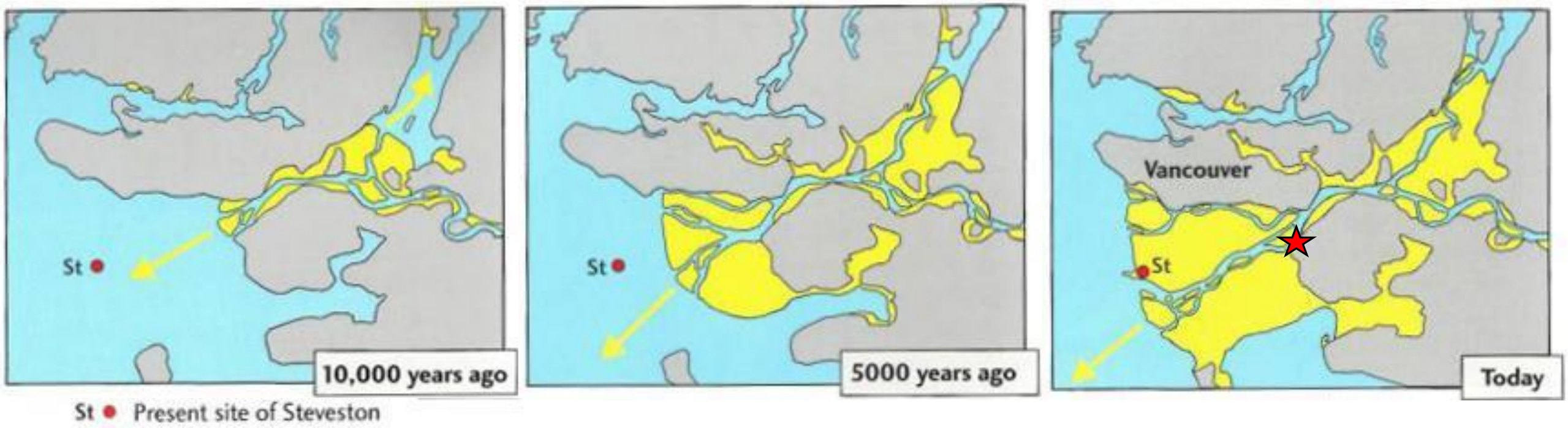


Photo: E. Balke

Formation of the Fraser Delta



Figures: Clague and Turner, 2003

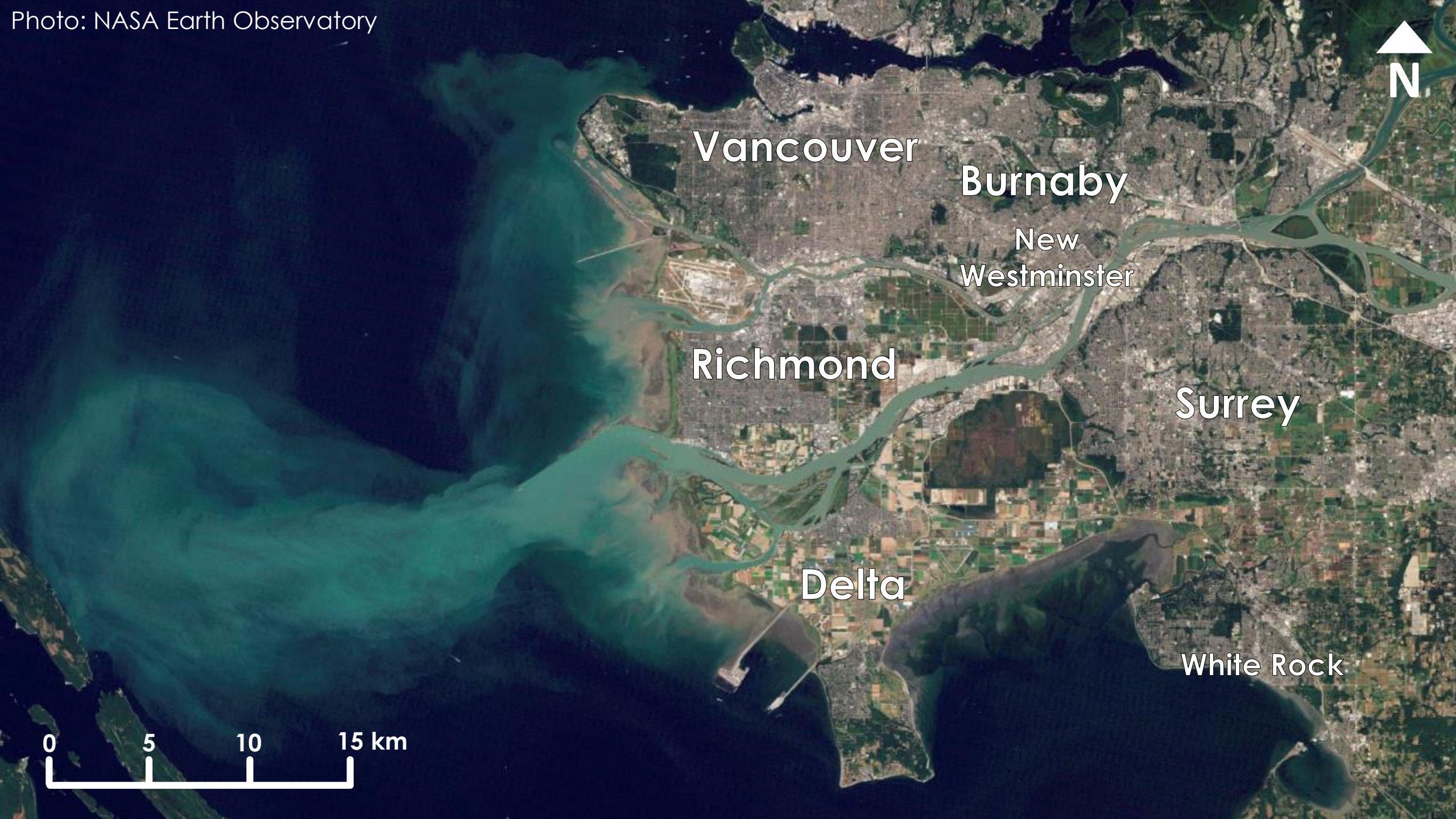


Photo: NASA Earth Observatory
N
Vancouver
Burnaby
New Westminster
Richmond
Surrey
Delta
White Rock
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15 km


Photo: NASA Earth Observatory
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STURGEON BANK
Richmond
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White Rock
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Photo: NASA Earth Observatory
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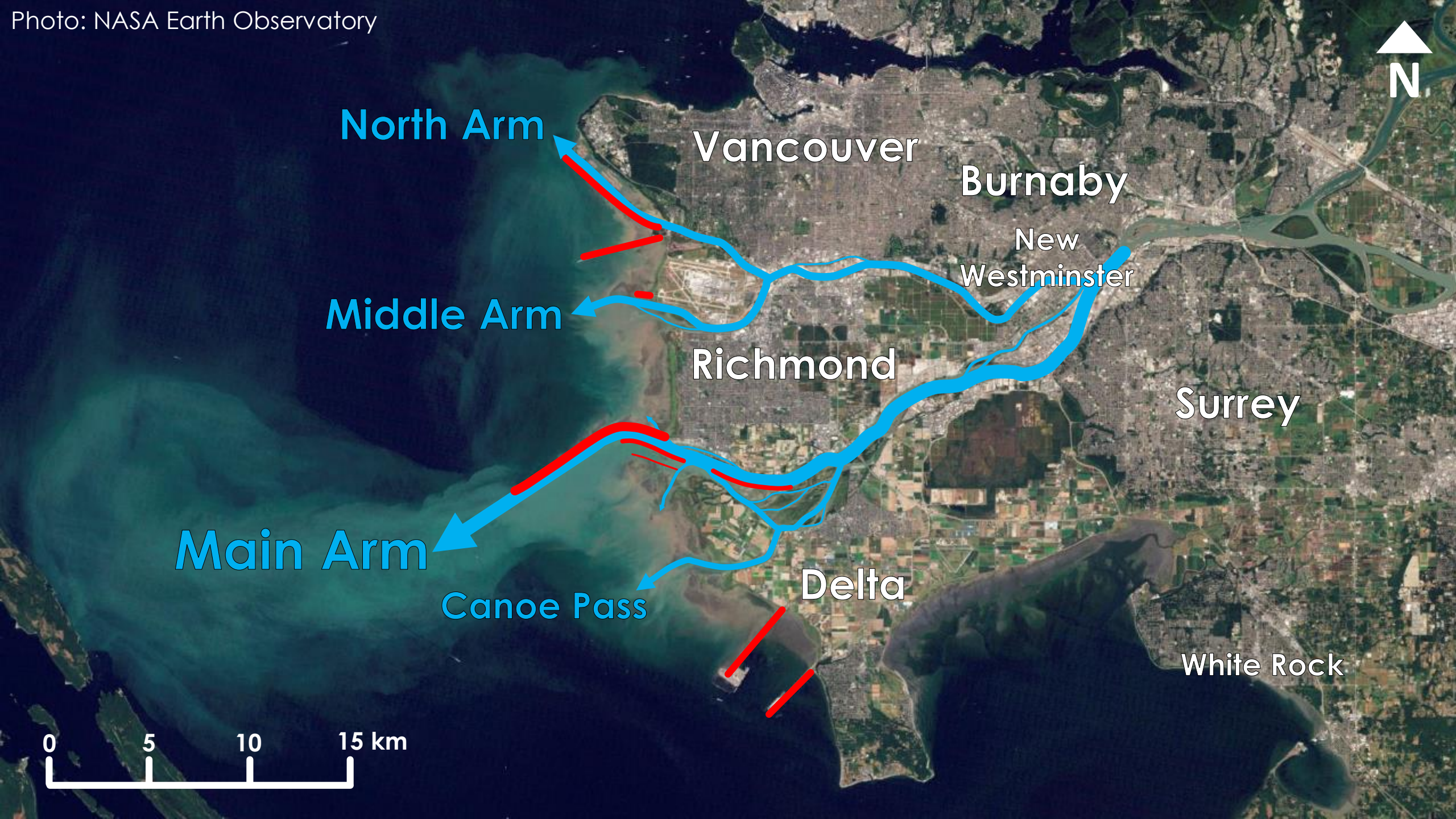
Photo: NASA Earth Observatory
N
North Arm
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Main Arm
Canoe Pass
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Burnaby
New Westminster
Richmond
Surrey
Delta
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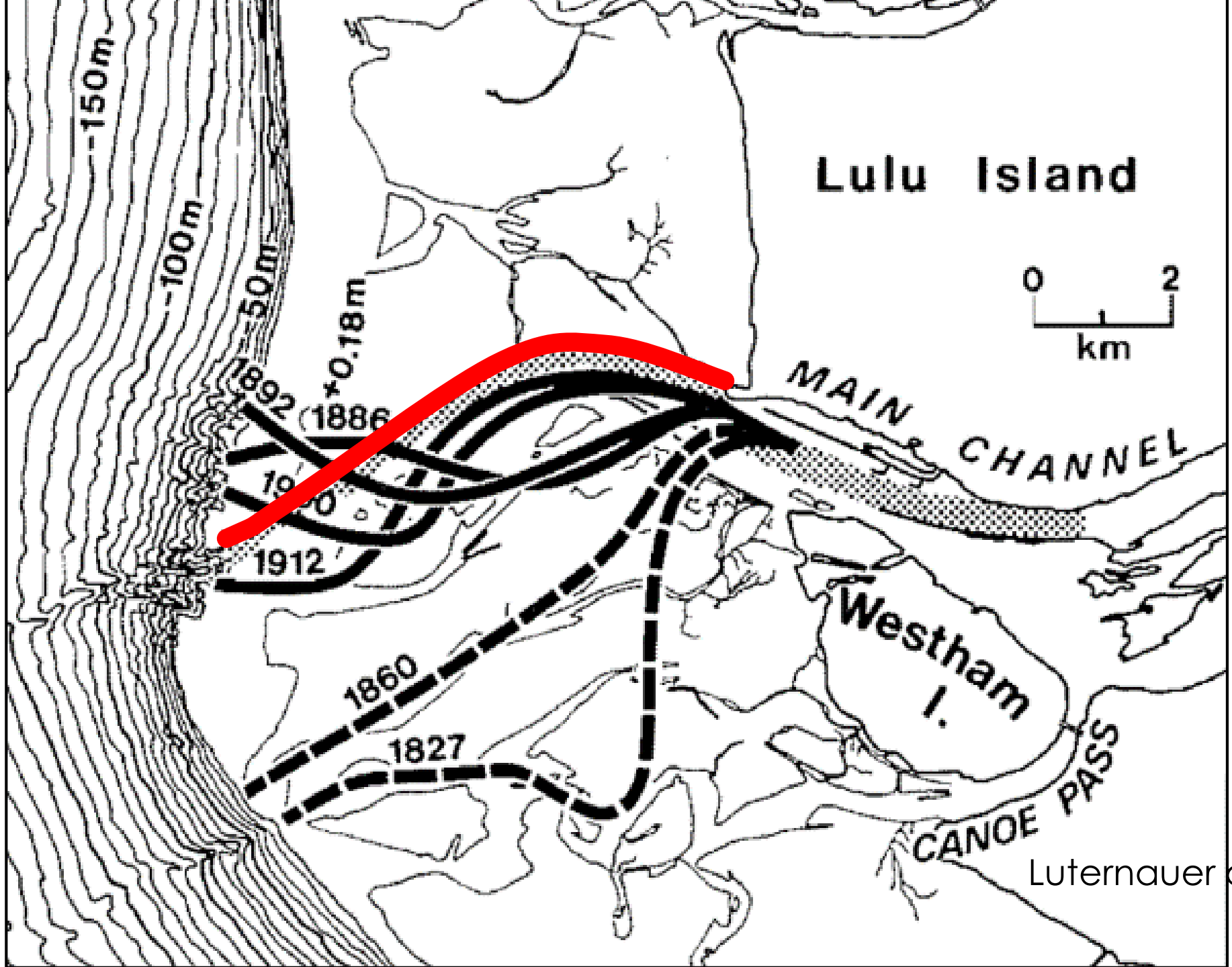
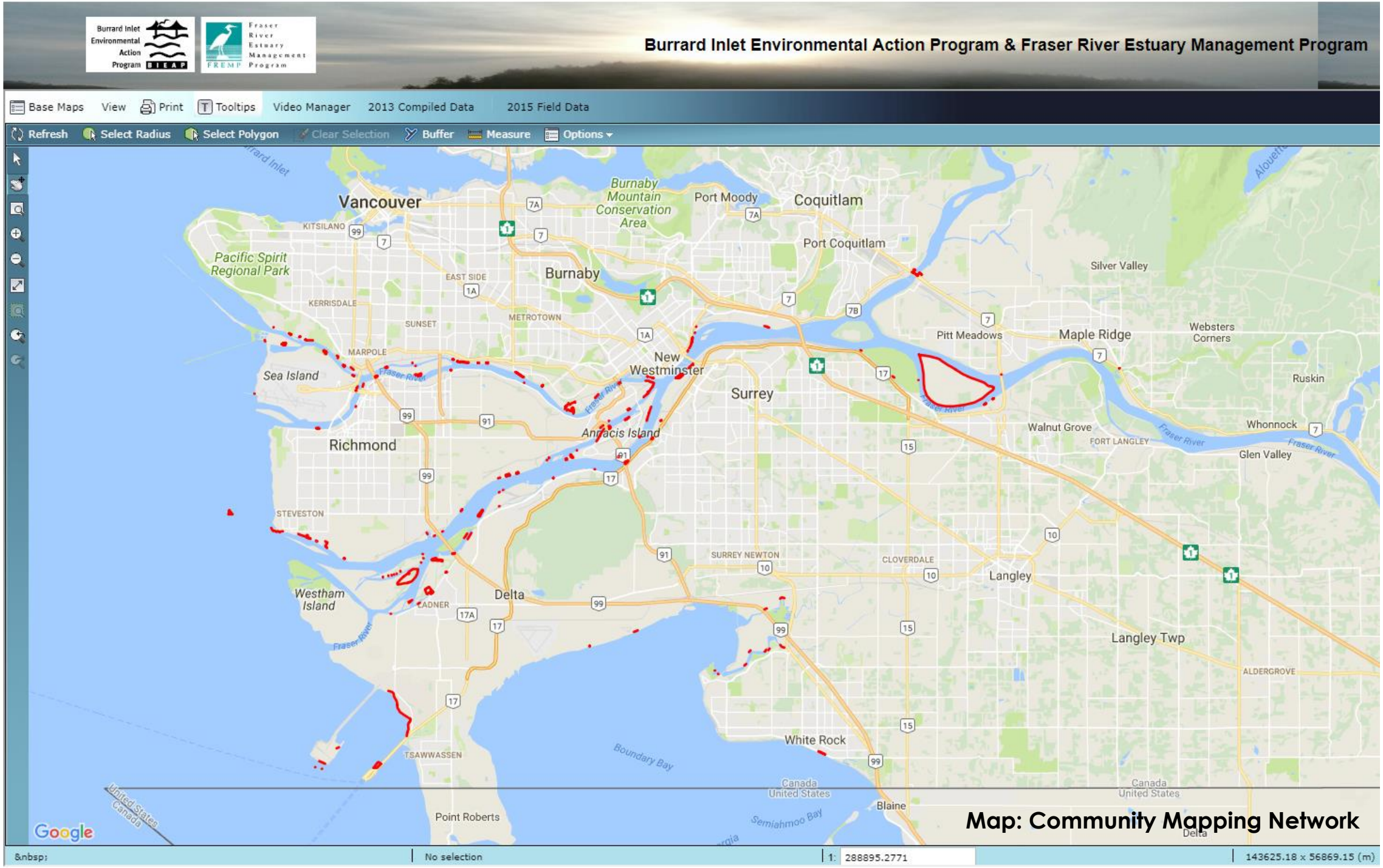


Luternauer and Finn, 1983


FRPD 309
clayton perry photography

Roberts Bank Terminal 2 Expansion

Figure: Port of Vancouver


Burrard Inlet Environmental Action Program & Fraser River Estuary Management Program
Base Maps
View
Print
Tooltips
Video Manager
2013 Compiled Data
2015 Field Data
Refresh
Select Radius
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Clear Selection
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Measure
Options
Vancouver
Burnaby Mountain Conservation Area
Port Moody
Coquitlam
Port Coquitlam
Pacific Spirit Regional Park
Burnaby
Silver Valley
Pitt Meadows
Maple Ridge
Websters Corners
New Westminster
Surrey
Ruskin
Sea Island
Richmond
Annacis Island
Walnut Grove
Whonnock
Glen Valley
FORT LANGLEY
Fraser River
Langley
Langley Twp
Westham Island
Delta
SURREY NEWTON
CLOVERDALE
ALDERGROVE
STEVESTON
TSAWWASSEN
White Rock
Boundary Bay
Point Roberts
Blaine
Canada
United States
Google
Map: Community Mapping Network
No selection
288895.2771
143625.18 x 56869.15 (m)

FACTORS INFLUENCING THE PERSISTENCE OF CREATED TIDAL MARSHES IN THE FRASER RIVER ESTUARY

Ducks Unlimited Canada

MARCH 2022

Daniel Stewart MSc,
Daniel Hennigar BSc,
Robyn Ingham BSc.,
Eric Balke MSc, RPBio

ASARUM

BRITISH COLUMBIA

BCWF
BC WILDLIFE FEDERATION

HEALTHY WATERSHEDS INITIATIVE


Photo: Sean Boyd

Photo: ReifelBirdSanctuary.com

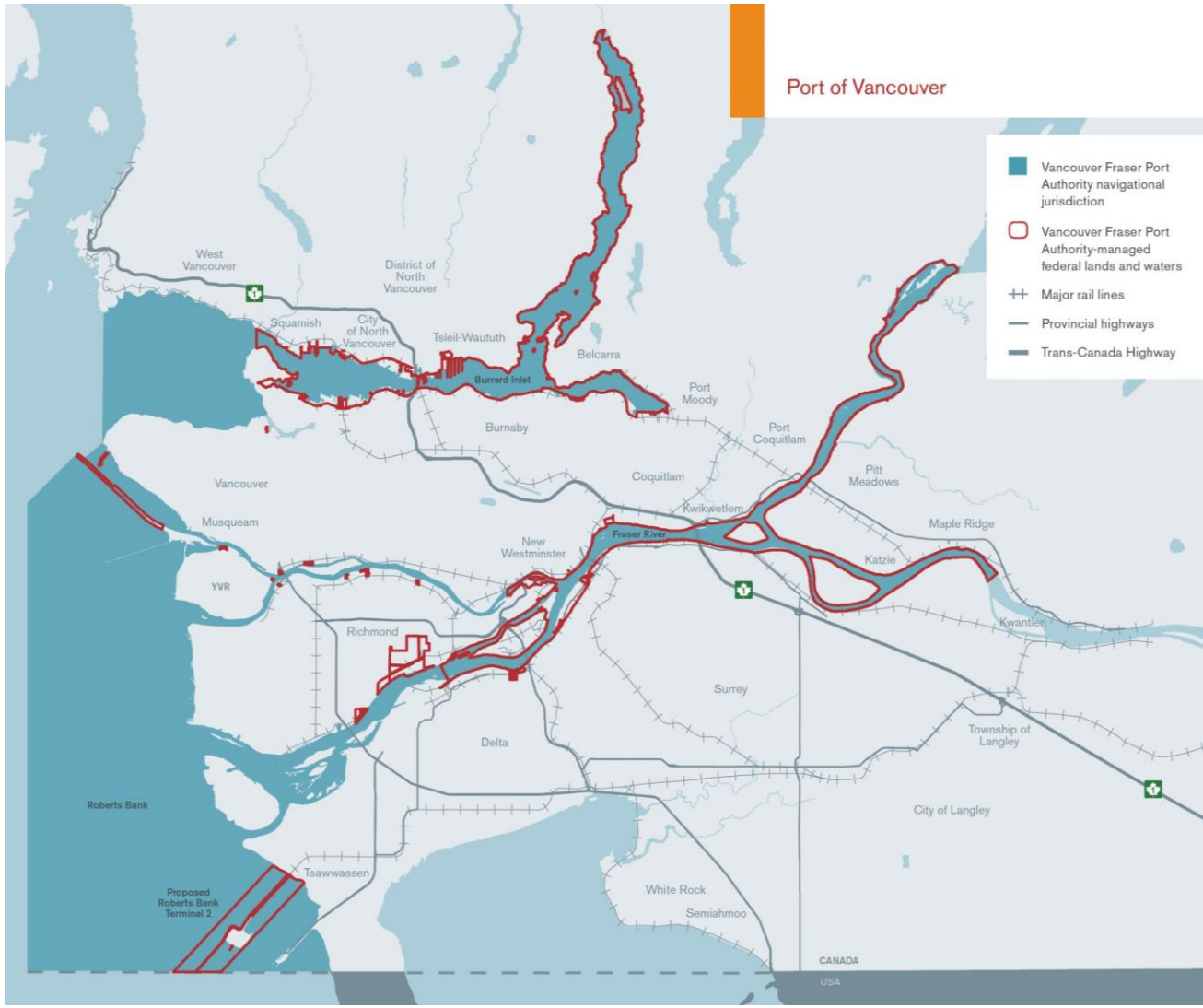
Photo: Pure Landscapes Photography

Photo: E.Balke

Photo: John MacDonald

Fractured Governance

- Fraser River Estuary Management Program (FREMP) terminated in 2013
- Fractured jurisdiction and a lack of coordination between/within agencies
- First Nations largely excluded from historical decision making, and presently overwhelmed by referrals
- No estuary plan for sea-level rise adaptation or ecological resilience



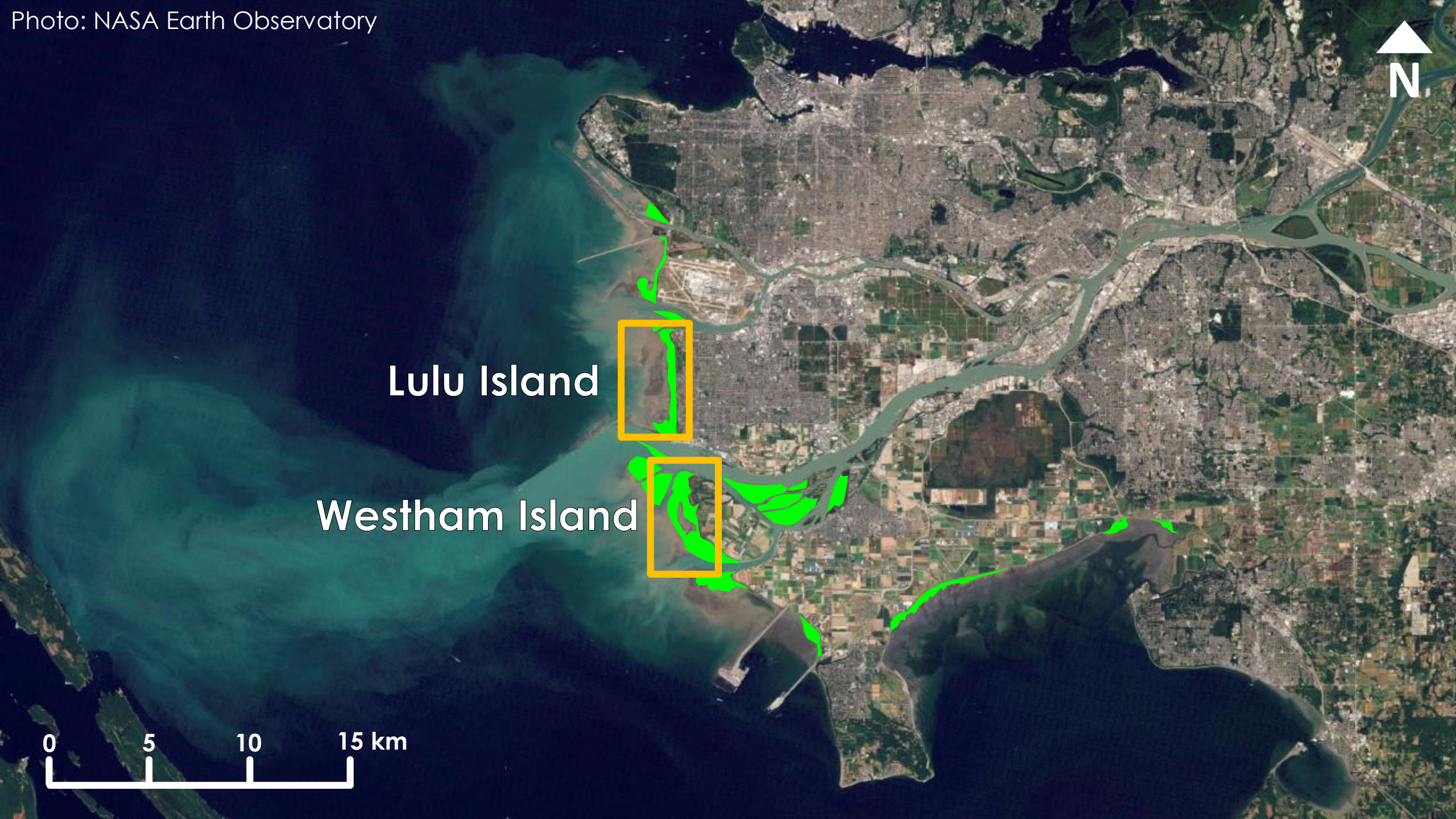


Photo: NASA Earth Observatory
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Lulu Island
Westham Island
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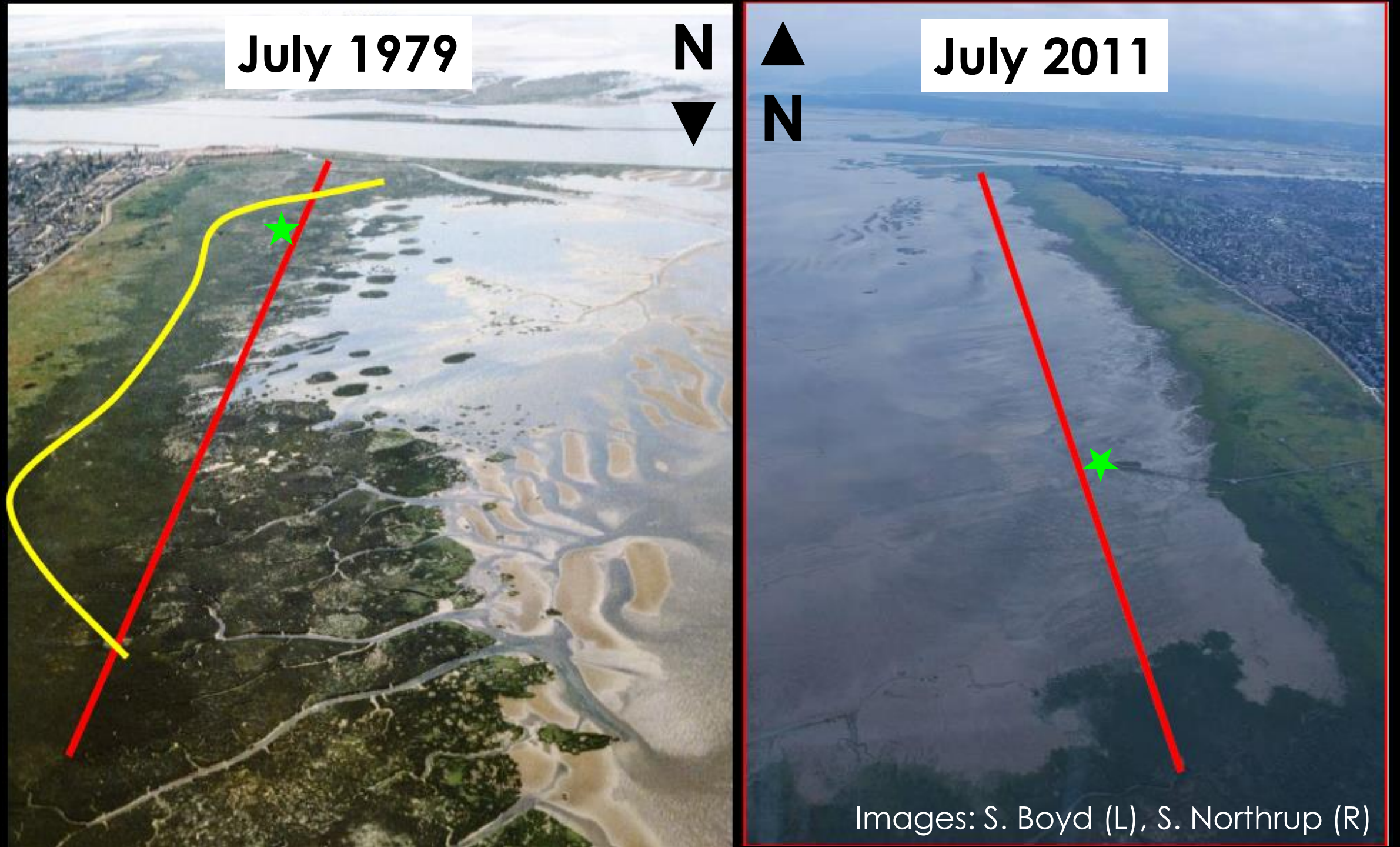
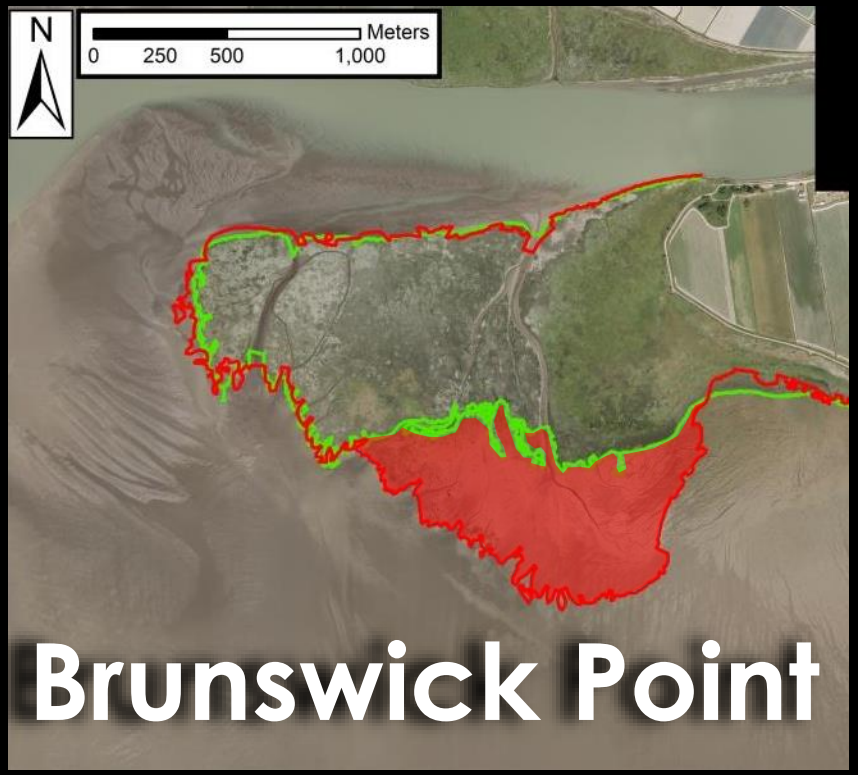

July 1979
N
July 2011
N
Images: S. Boyd (L), S. Northrup (R)


0 250 500 1,000
Meters
N
Sturgeon Bank
>160 ha


0 250 500 1,000
Meters
N
Reifel Bird Sanctuary
DIKE
DIKE
Westham Island
~50 ha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Meters
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Brunswick Point
~50 ha

Sturgeon Bank Marsh Recession Project

1) Understand the Recession
2) Evaluate the Present Environment
3) Experiments

Photo: E. Balke

Understand the Recession

- Satellite imagery analysis
- Air photo analysis
- Plant corm surveys
- Sediment pits

Photo: E. Balke

Present Environment

- Water loggers
- Marsh leading edge mapping
- Elevation measurements/monitoring
- Surveys of adjacent marshes

Photo: E. Balke

Experiments

- Reciprocal Transplant Experiment
- LWD anchoring
- Inundation experiment
- Goose exclosures

Photo: E. Balke

Leading Hypotheses of Marsh Recession

- Sediment deficit (elevation)
- High salinity
- Relative sea-level rise
- Goose herbivory

Photo: E. Balke


Photo: NASA Earth Observatory
N
Vancouver
Richmond
Surrey
Delta
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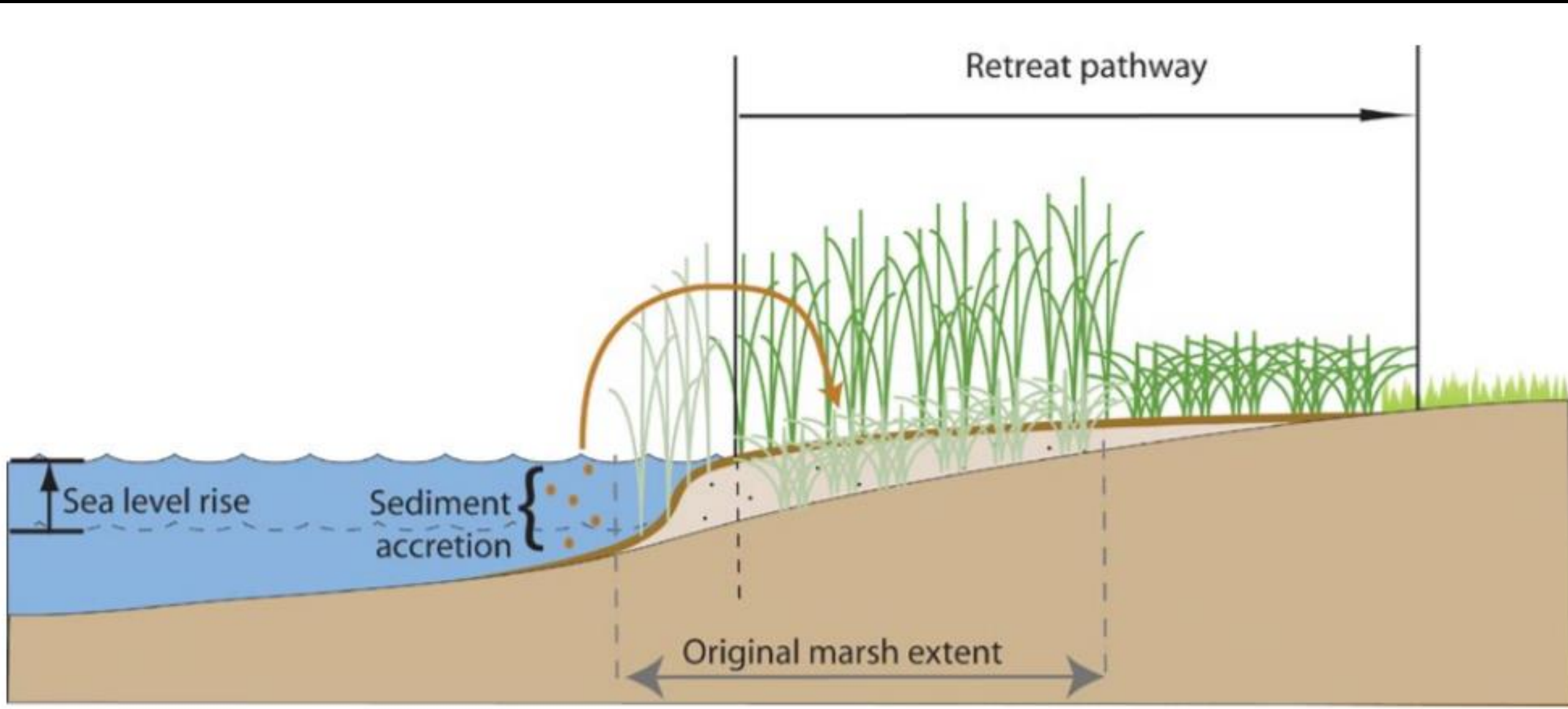
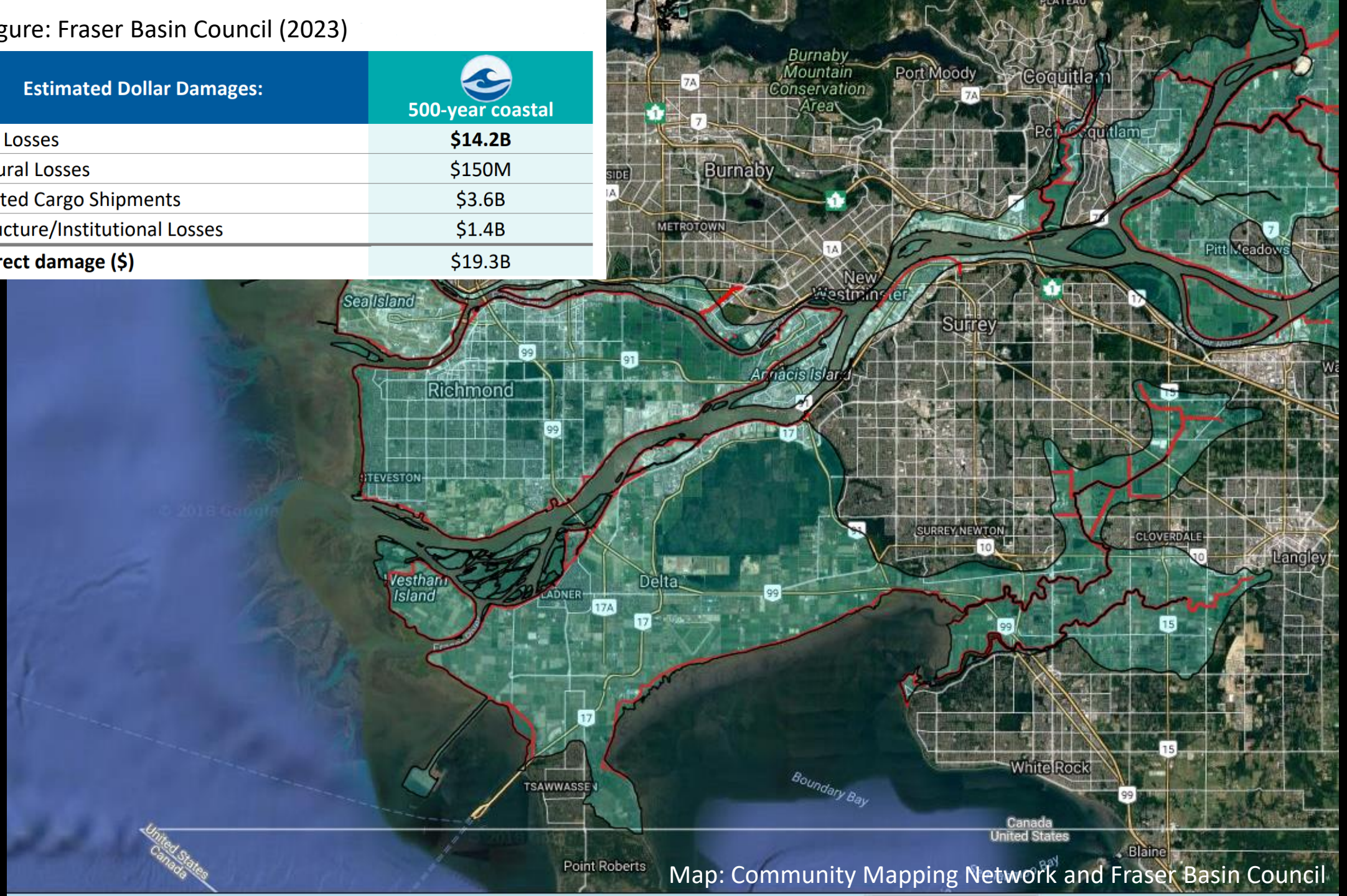


Mitchell M, Bilkovic DM. Embracing dynamic design for climate-resilient living shorelines. J Appl Ecol. 2019;56:1099–1105

Figure: Fraser Basin Council (2023)

Estimated Dollar Damages:	500-year coastal
Building Losses	**$14.2B**
Agricultural Losses	$150M
Interrupted Cargo Shipments	$3.6B
Infrastructure/Institutional Losses	$1.4B
Total direct damage ($)	$19.3B



Map: Community Mapping Network and Fraser Basin Council

Does the Fraser Delta need MARS?

- Largest estuary
- Biophysical processes greatly altered
- Dikes prevent tidal marsh migration
- Extensive marsh recession
- Lack of regional management of goose populations

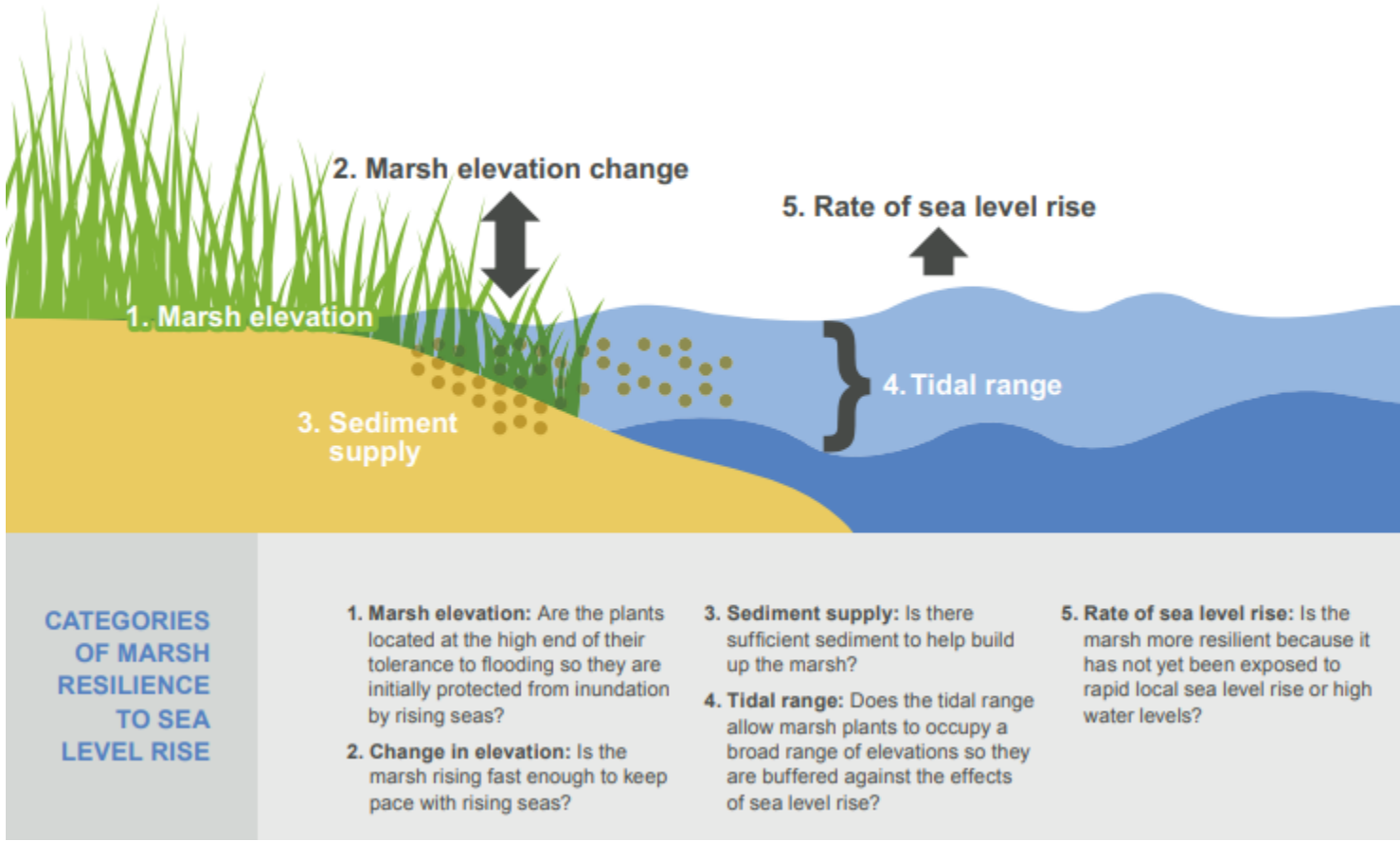


Figure: NERRA.org

Recent Fish Habitat Restoration Projects

- 2017-2022: DFO Coastal Restoration Fund
  - Raincoast Conservation Foundation - Steveston North Jetty Breaches
  - DUC - South Arm Marshes restoration projects
- 2021-2024: DFO/BC BC Salmon Restoration & Innovation Fund
  - Fraser River Estuary Salmon Habitat (FRESH) Restoration Projects
    - RCF - North Arm Jetty Breaches
    - DUC - Sturgeon Bank Sediment Enhancement Pilot Project

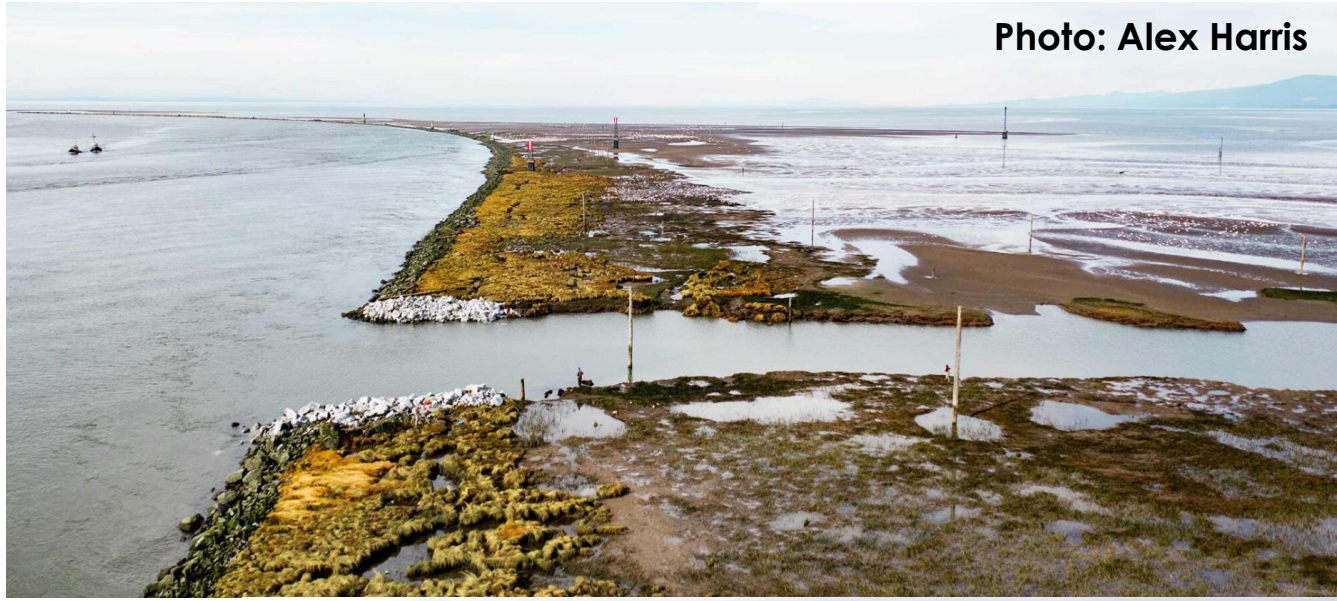
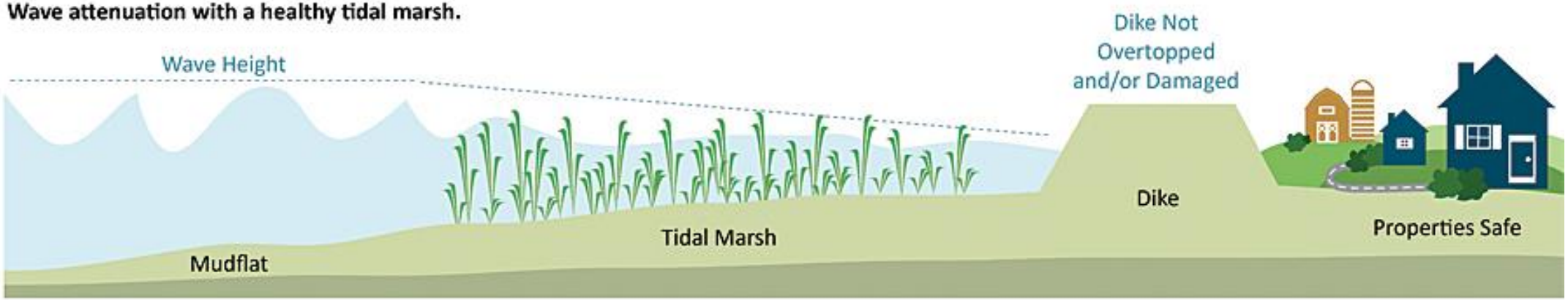


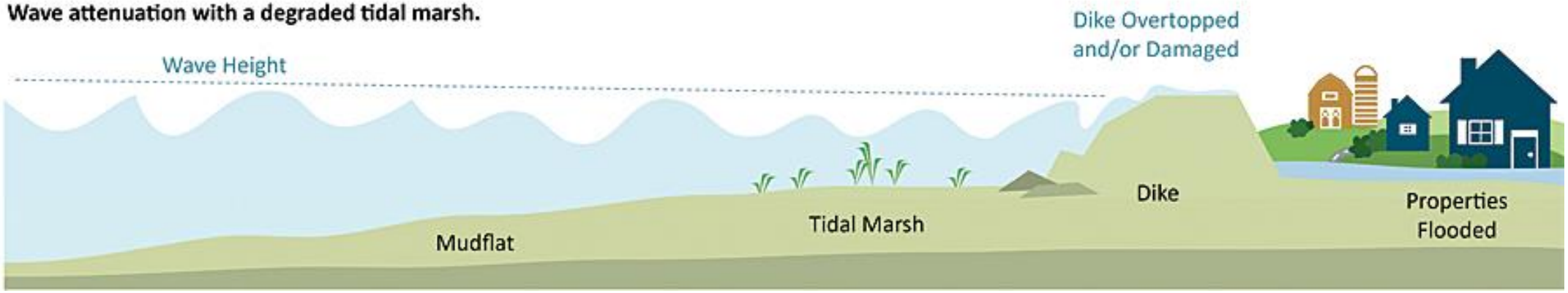
Photo: Alex Harris

Photo: Max Scruton

Wave attenuation with a healthy tidal marsh.



Wave attenuation with a degraded tidal marsh.



Source: Esri ArcNews, "GIS Helps Integrate Coastal Hazard Risk and Sea Level Rise," 2014

Photo: NASA Earth Observatory

N

Vancouver

STURGEON BANK

Rich

BAY

0 5 10 15 km

Quantifying the Problem

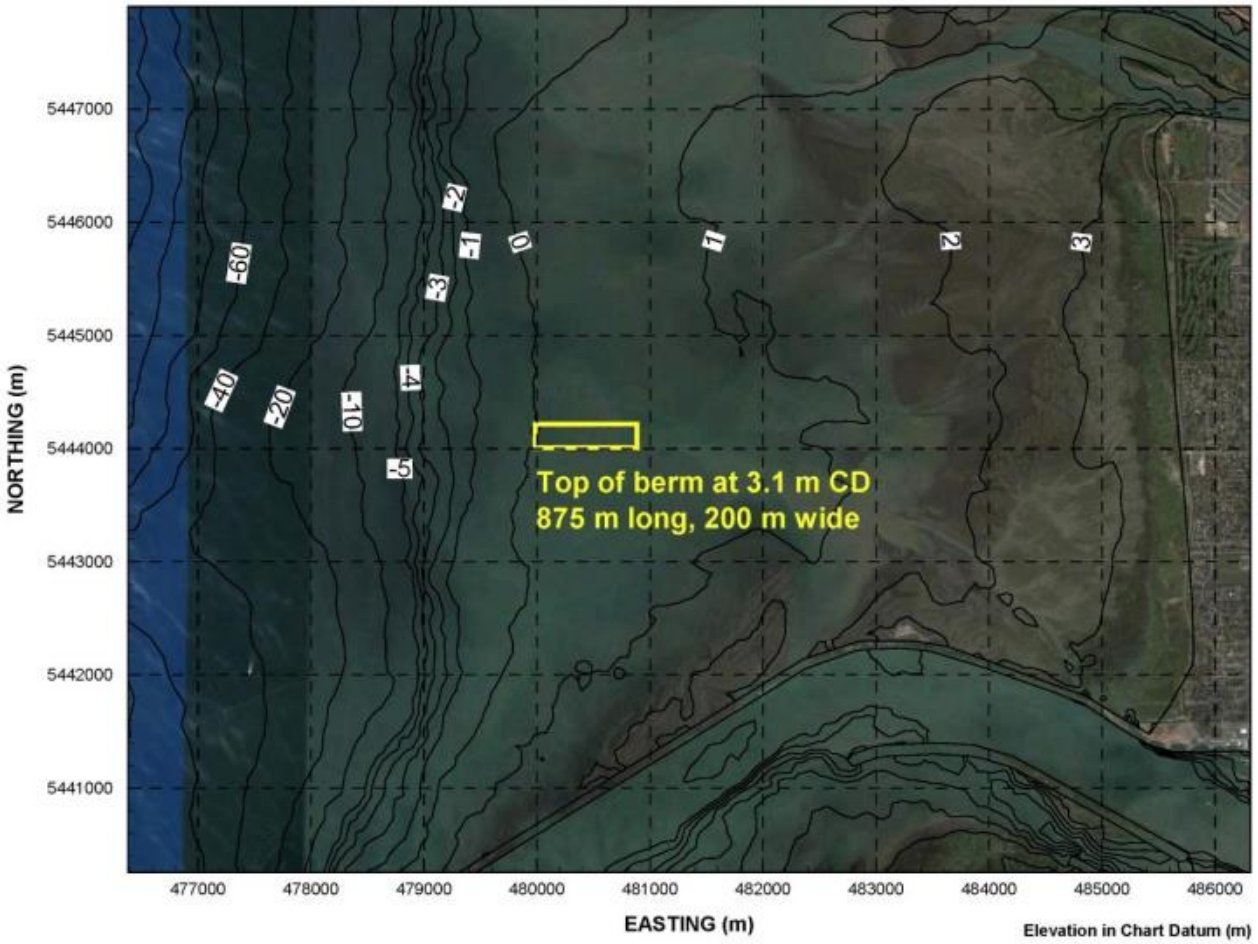
CHALLENGE: INTRODUCE NEW SEDIMENT TO OFFSET RATES OF RELATIVE ELEVATION LOSS

BIG PICTURE STATEMENT OF THE PROBLEM:*

- Historical estimates of sediment inputs (Luternauer and Murray, 1973): **525,000 m^3/yr**
- Quantity of sediment required to accrete the tidal flats by ~3 mm/yr: **500,000 m^3/yr**
- Quantity of sediment required over a 5-year project lifespan: **2,500,000 m^3**
- For context, the volume of sediment that is disposed at sea (Sand Heads + Point Grey): **1,800,000 m^3/year**

IMPRACTICAL TO MECHANICALLY PLACE THE SEDIMENT EVENLY ACROSS THE TIDAL FLATS; SOLUTION IS TO PLACE SEDIMENT IN MOUNDS TO BE REDISTRIBUTED BY NATURAL PROCESSES

*Sediment volume estimates compiled by Hemmera and Golder (2013)


Top of berm at 3.1 m CD
875 m long, 200 m wide
-60
-40
-20
-10
-5
-4
-3
-2
-1
0
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5443000
5442000
5441000
NORTHING (m)
477000
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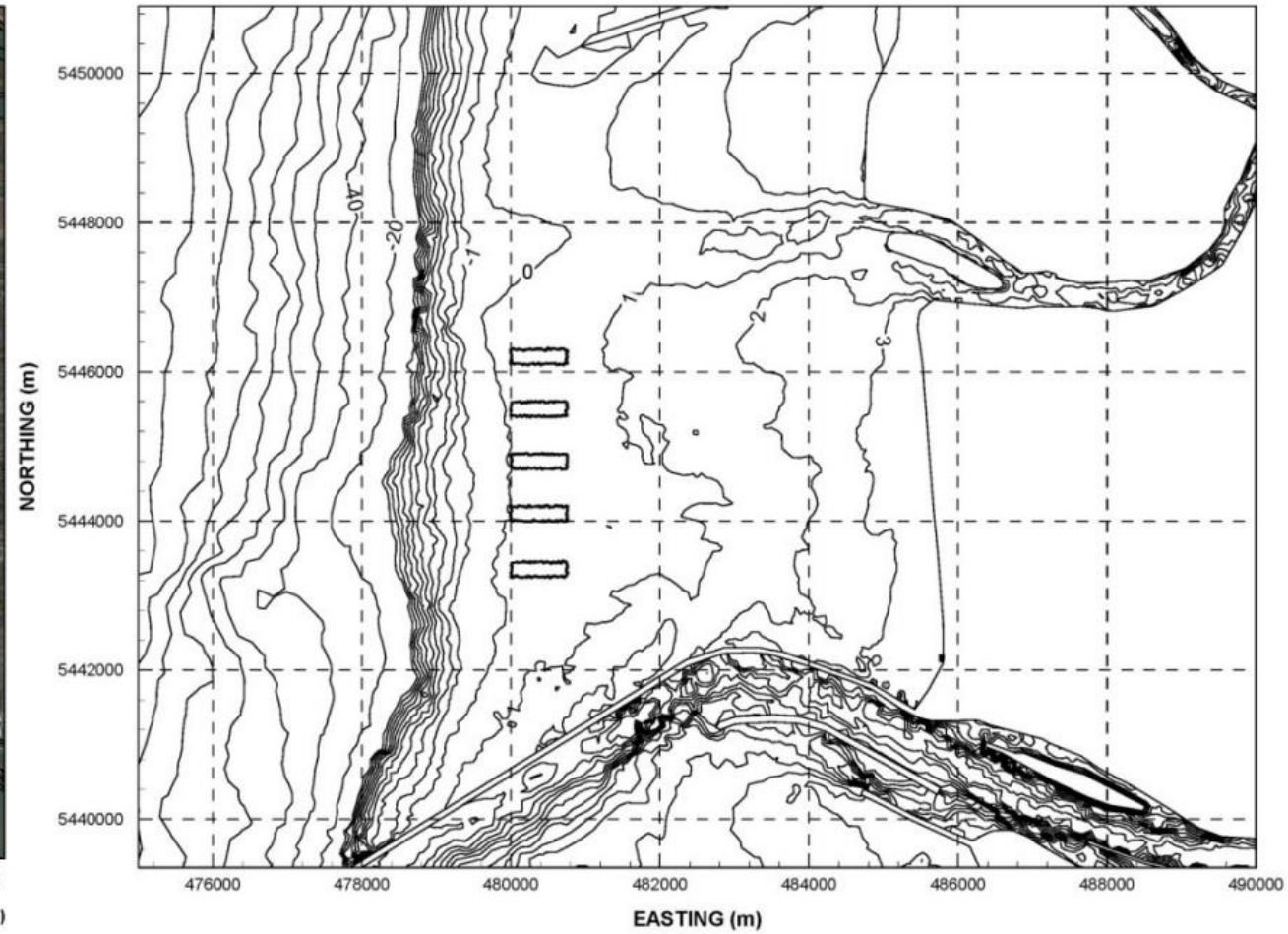
EASTING (m)
Elevation in Chart Datum (m)


-40
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5448000
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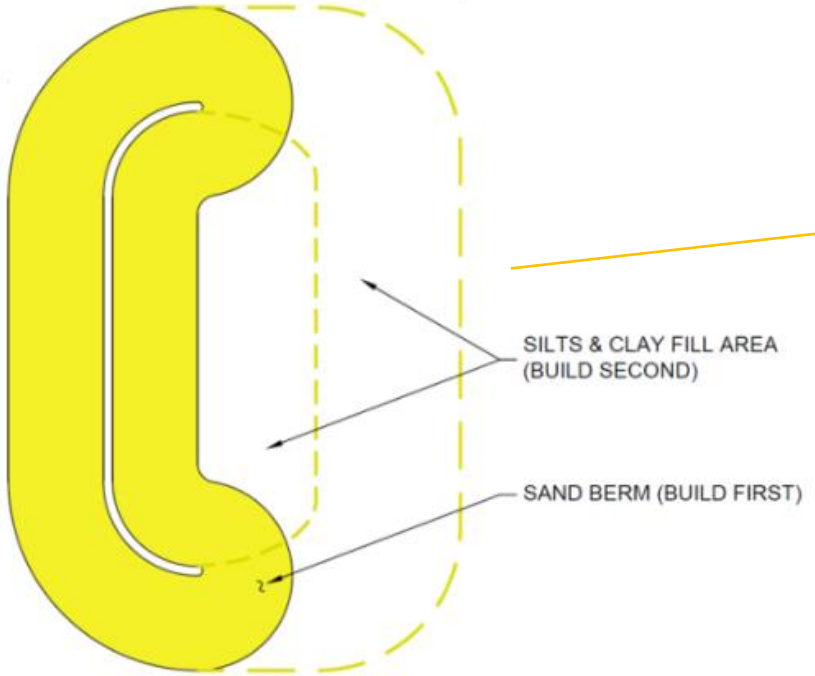
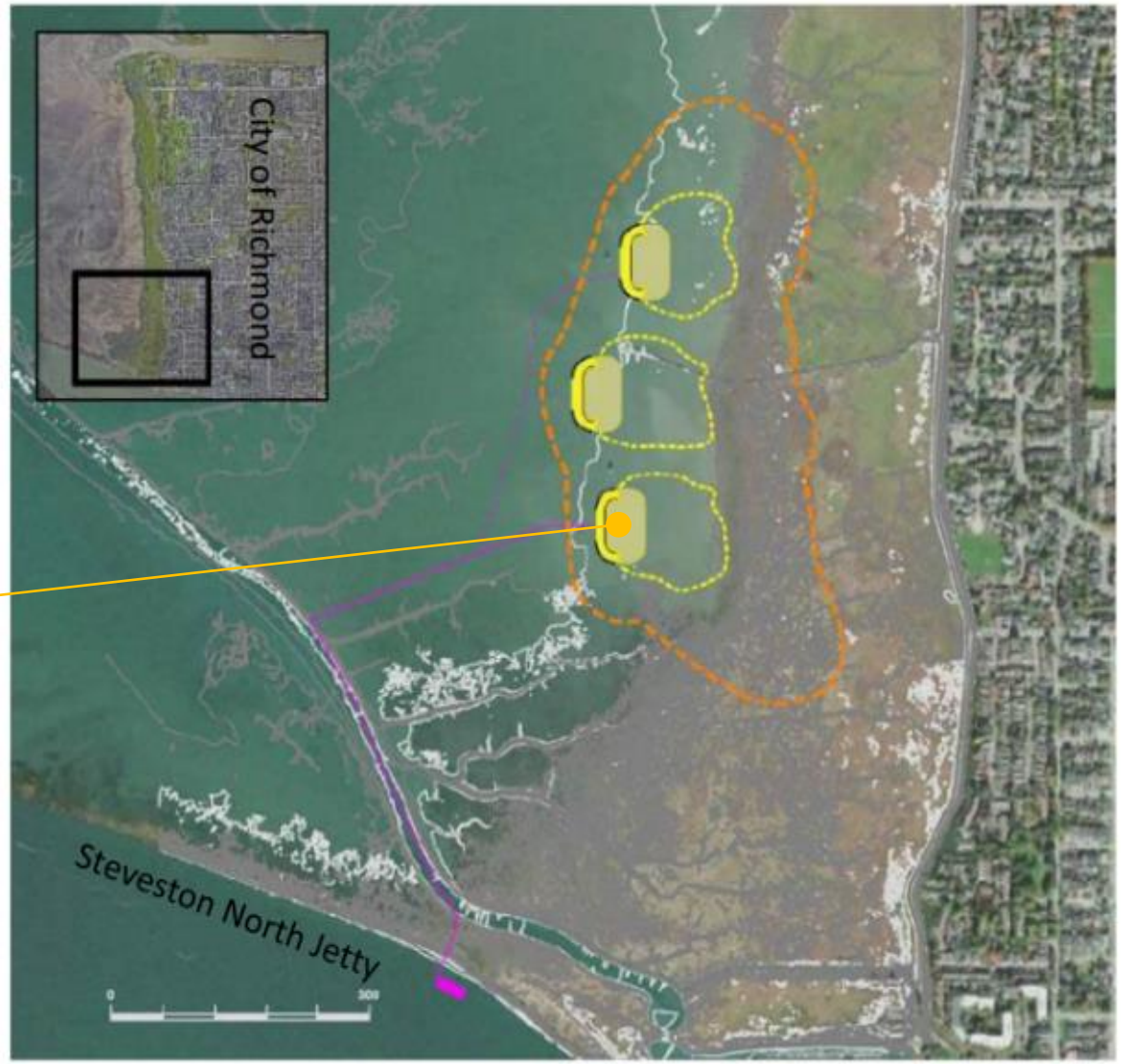
5444000
5442000
5440000
NORTHING (m)
476000
478000
480000
482000
484000
486000
488000
490000
EASTING (m)

Pilot Study Conceptual Design

CONCEPT: APPLY SEDIMENT TO THE TIDAL FLATS IN DISCRETE MOUNDS

1. Construct a sand berm that is slightly coarser than surrounding sediments
2. Place silts and clays inland of the berm





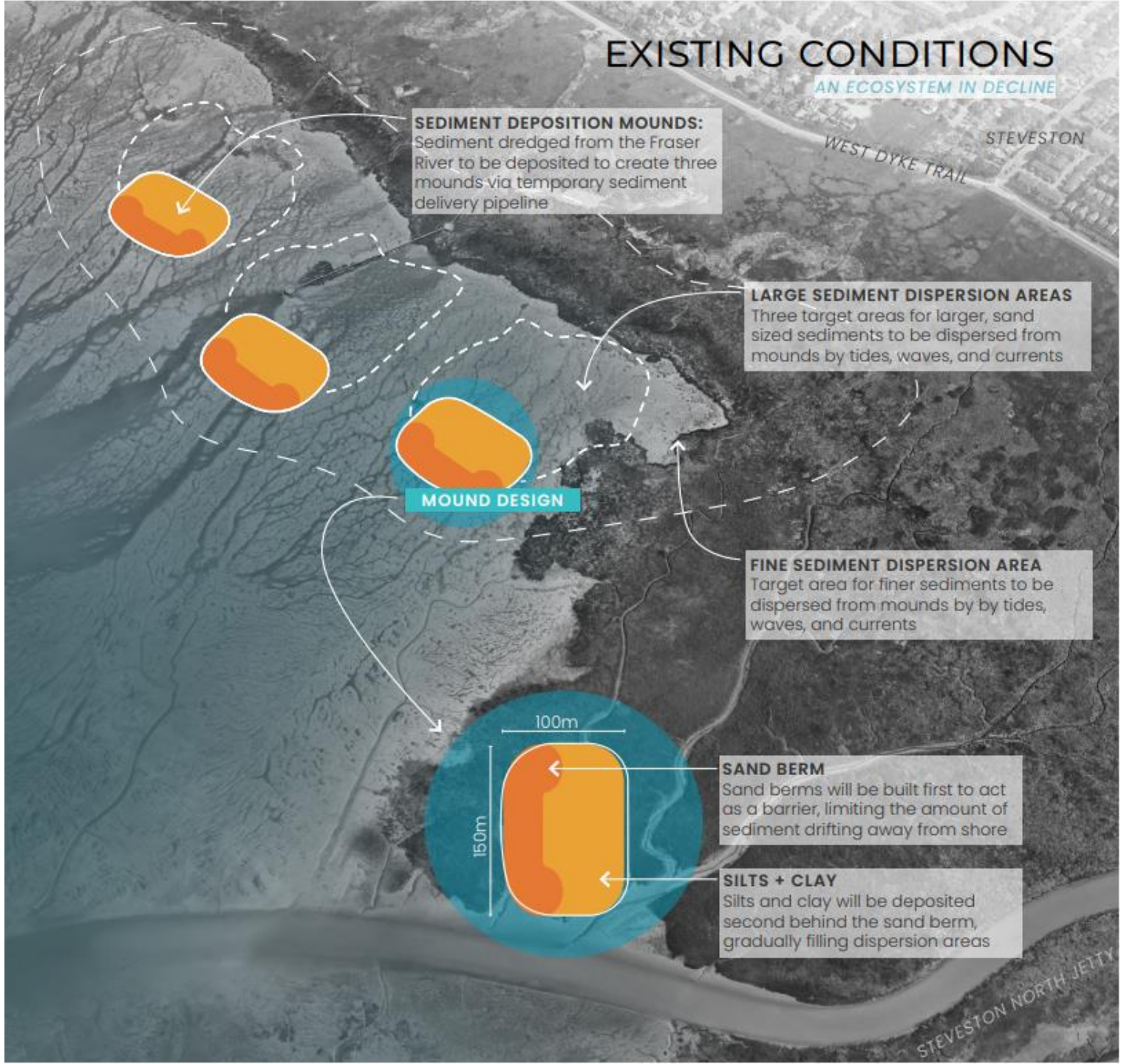


Figure: Lexi Maxwell

Figure: Lexi Maxwell

Sturgeon Bank Sediment Enhancement Pilot Project

Project Timeline

- **2011:** initial realization of marsh recession
- **2013-2014:** Sturgeon Bank Feasibility Assessment Committee
- **2015-present:** Sturgeon Bank Marsh Recession Project
- **2019:** Unsuccessful grant application
- **2019-2020:** Development of pilot project technical conceptual report & plain-language primer
    - **February 2020:** Marsh recession update forum
- **2021:** Graphical renderings of pilot project
- **2021:** Successful BCSRIF application
- **February 2023:** inaugural sediment addition
- **February 2024:** Year Two Sediment Addition
- **Fall 2024 & 2025:** Years Three & Four Sediment Addition (TBC)

Photo: Nathan Vadeboncoeur / Smart Shores

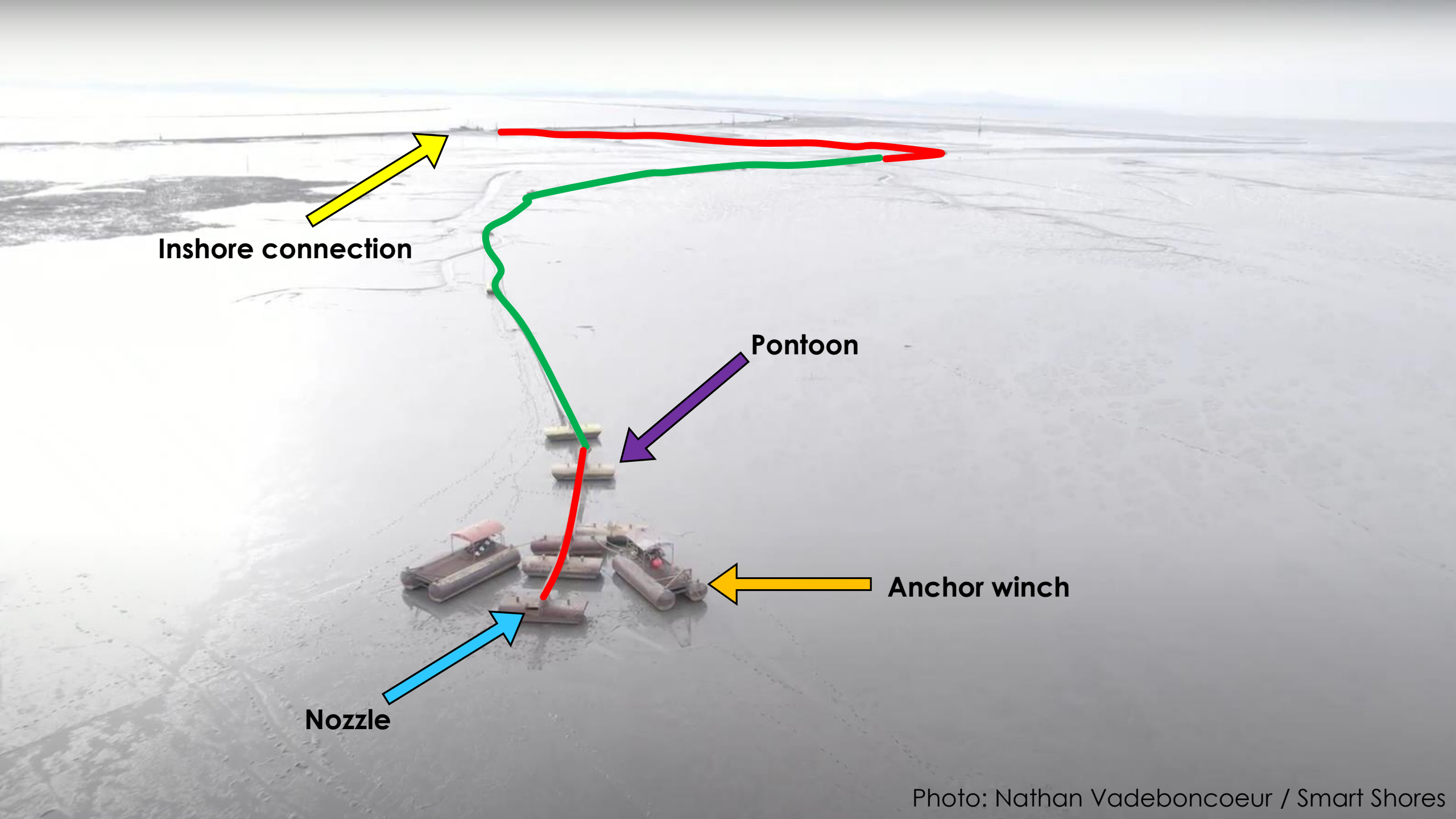


Photo: Nathan Vadeboncoeur / Smart Shores


Video: Eric Balke / Ducks Unlimited Canada
TLC200 2023/02/24 16:41:09

Photo: Nathan Vadeboncoeur / Smart Shores

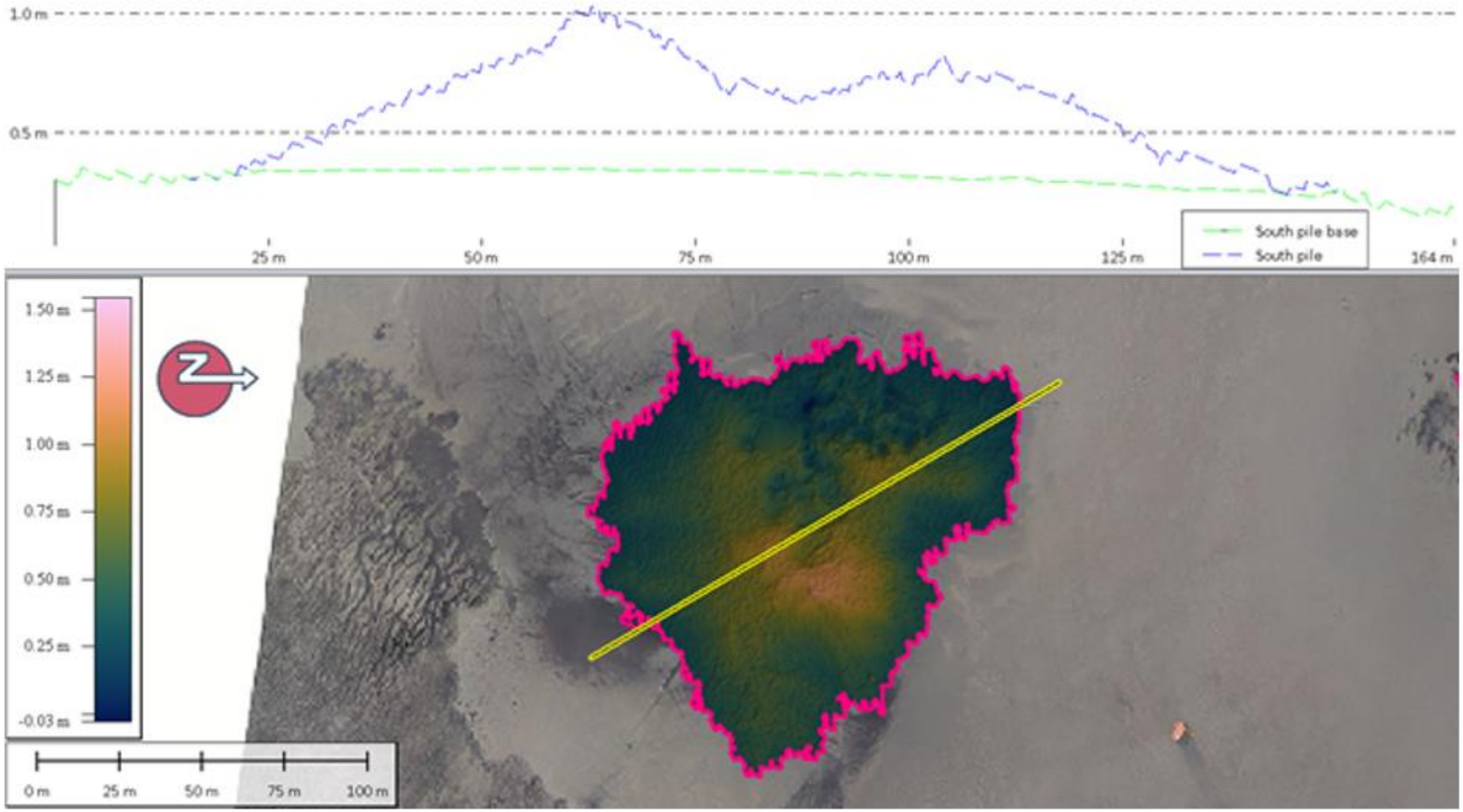
South Mound – February 2023
Beginning Sand Addition

Photo: Nathan Vadeboncoeur / Smart Shores

South & Middle Mounds – February 28, 2023
Year 1 Sediment Addition Complete

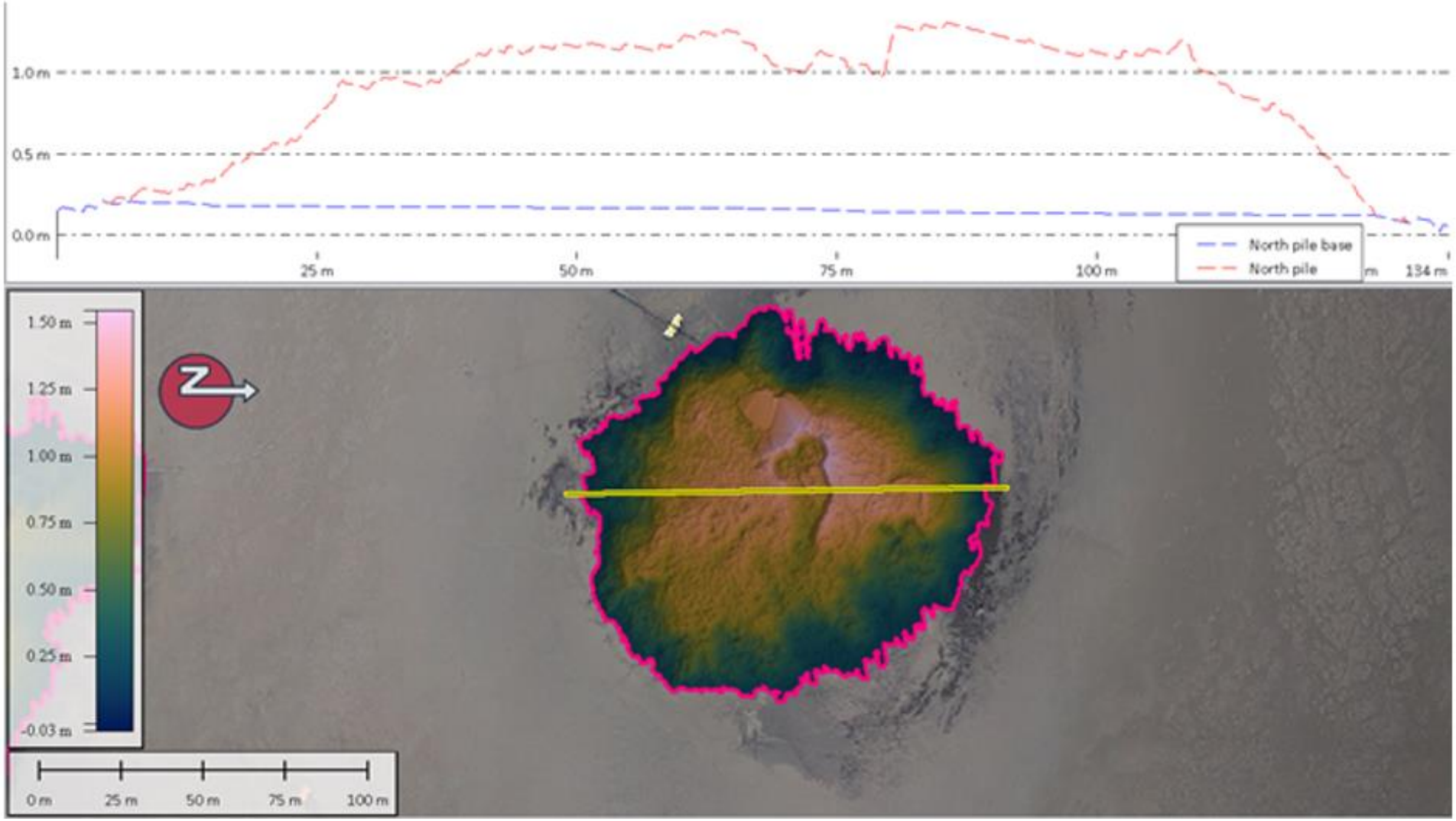
Results

South Mound



Results

Middle Mound



Plan vs Actual

Or so we thought...

PLAN

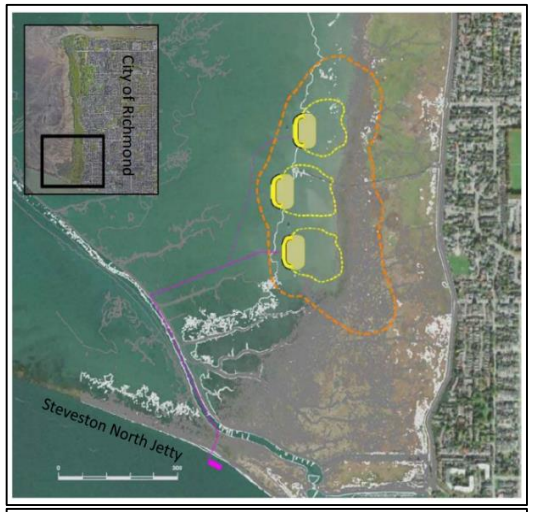
- Three mounds and three fiscal years.
- Sediment addition in September/October 2022
- Sediment source - “Piggy-back” off maintenance dredging projects
- Sand placement first followed by Silt

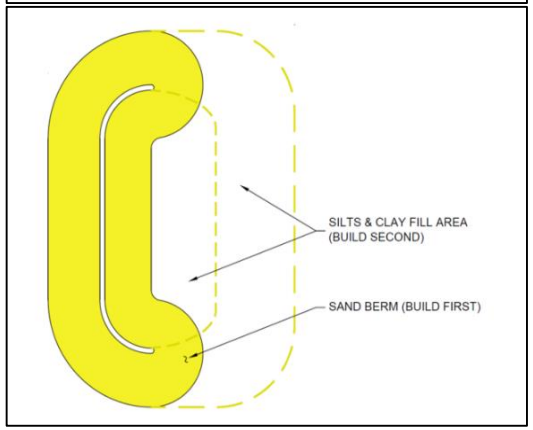
ACTUAL

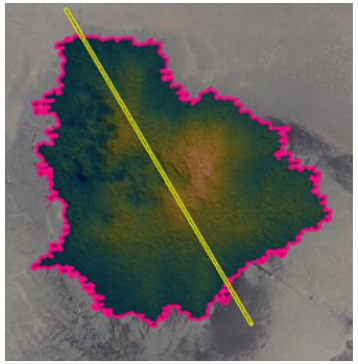
- Two mounds only
- Sediment addition in February 2023
- Sediment source under main channel maintenance dredging authorization
- Mostly sand

PLAN FOR NEXT STEPS

- Sediment addition in February 2024, additional years TBC
- Target silt from dredging secondary channels







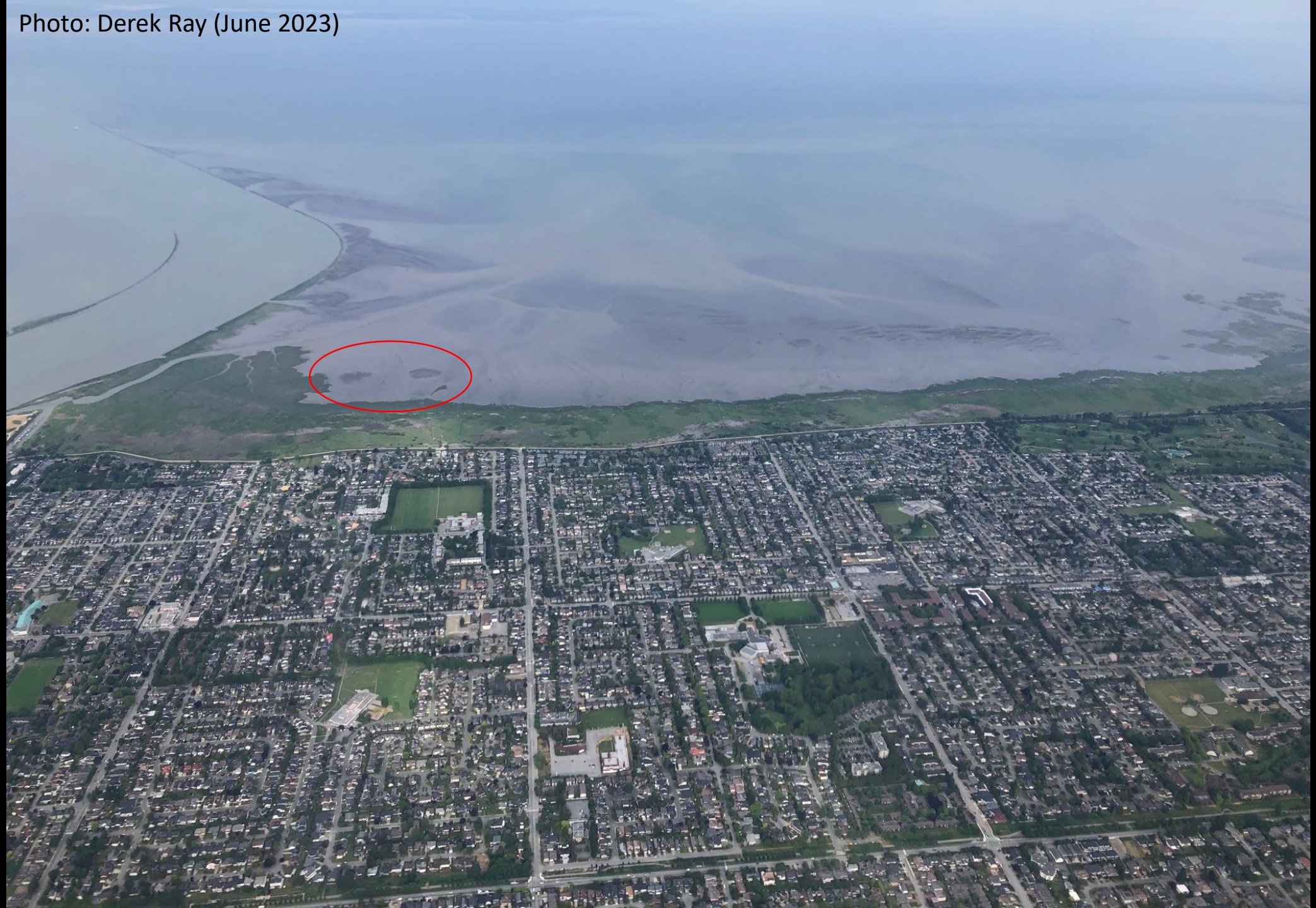


Photo: Derek Ray (June 2023)

NATURE FORCE

TAKING ACTION
TO PROTECT OUR FUTURE


AVIVA


CNA


definity.


Ducks Unlimited
Canada


Gallagher


ecclesiastical


GORE
MUTUAL
INSURANCE THAT DOES GOOD.


HUB


intact
INSURANCE


NAVACORD


Northbridge
Insurance


SGI


TRAVELERS


TRISURA


Wawanesa
Insurance

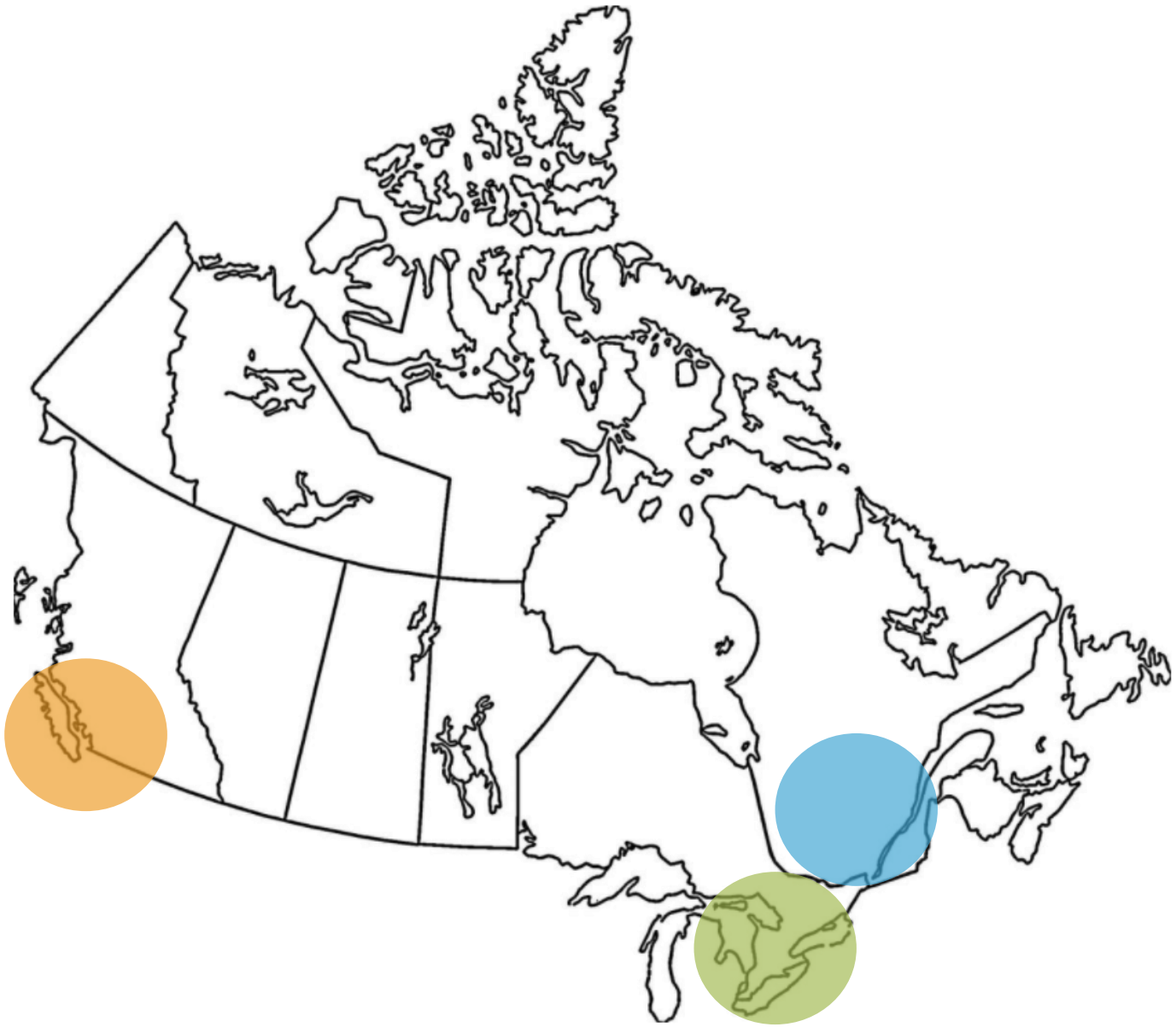

Westland
Insurance


ZURICH

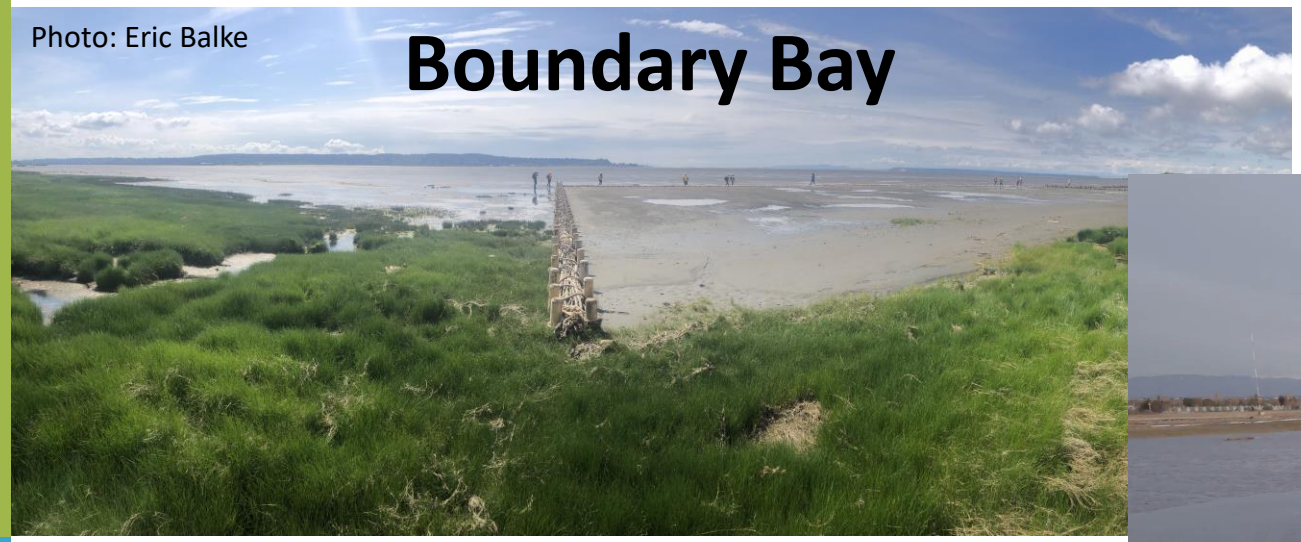
Nature Force Priorities

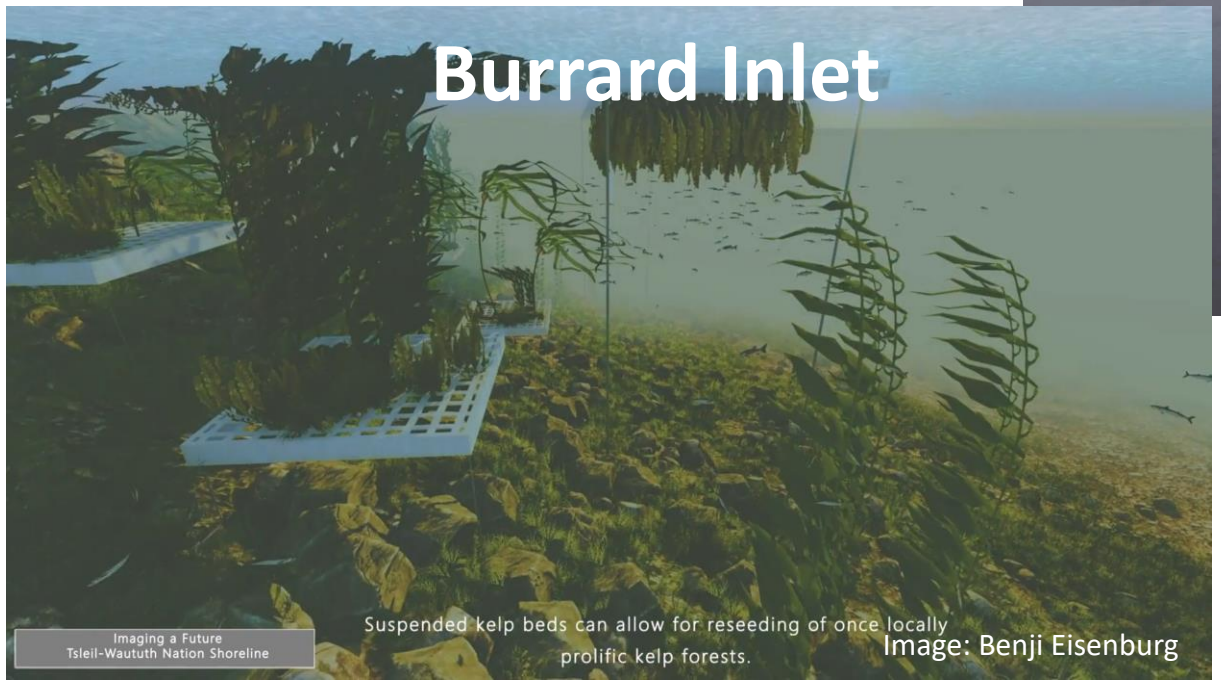
- Identify high priority urban wetland restoration projects that best align with our core objective of flood attenuation, while supporting other ancillary benefits like improved water quality, ground water replenishment, and supporting biodiversity.

- Implement wetland restoration and monitoring.



Local Examples of Natural Infrastructure





Nature Force in the Fraser River Delta, BC

- Build on existing momentum
- Workshops
- Scope data and research needs
- Develop a portfolio of projects
- Eventually implement projects

Take Away

1. Ecosystems are infrastructure
2. Pilot projects key to addressing uncertainty
3. Coordination & leadership required to mainstream nature-based coastal adaptation projects

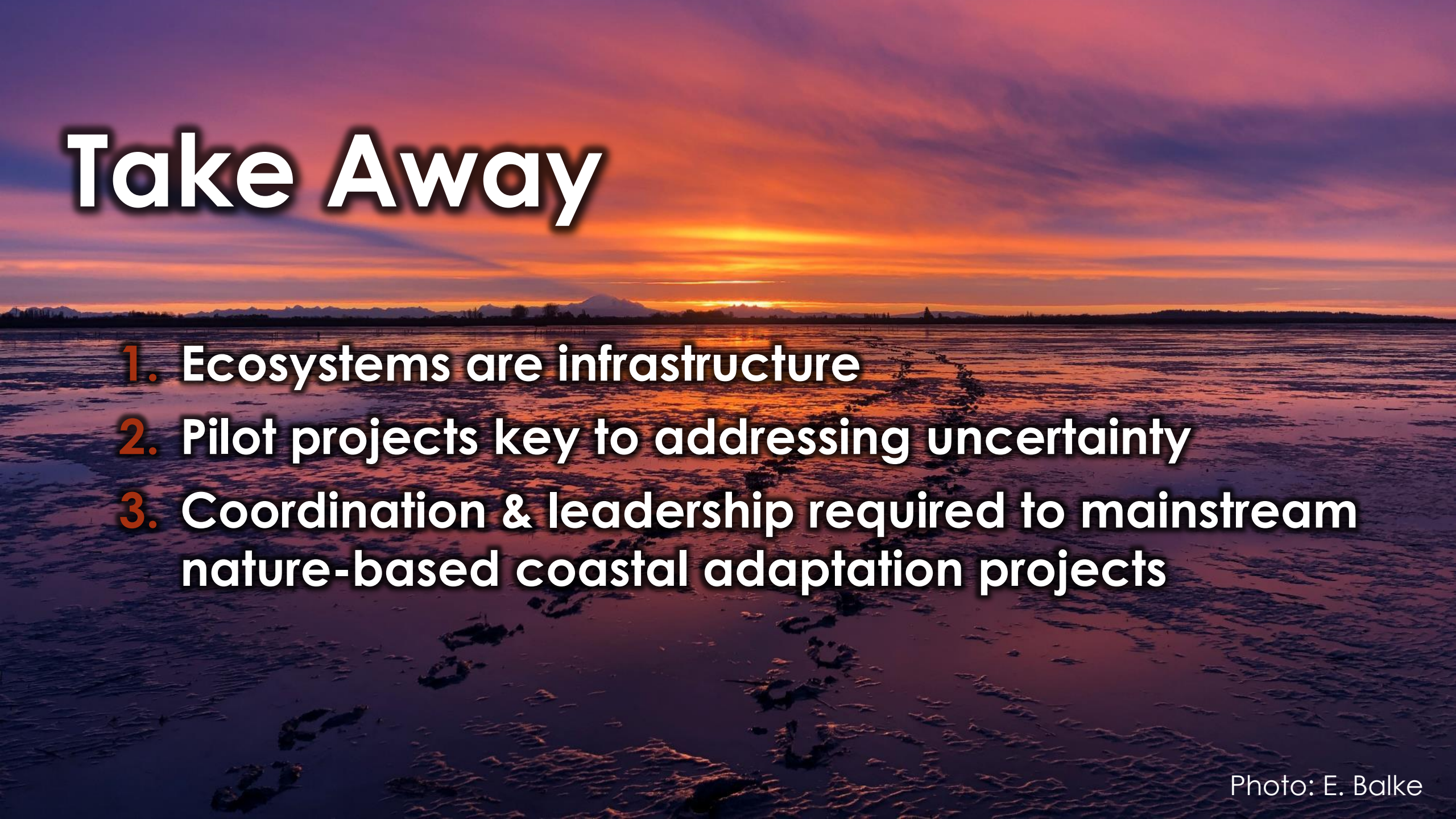


Photo: E. Balke

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RAINCOAST CONSERVATION FOUNDATION

nhc

BRITISH COLUMBIA

TSAWWASSEN FIRST NATION
sc̓əwaθən məsteyəxʷ

Ducks Unlimited Canada

Ausenco

Eric Balke
Ducks Unlimited Canada
e_balke@ducks.ca

Richmond

GL Williams & Associates Ltd.
Shoreline Management Consulting

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LFFA
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