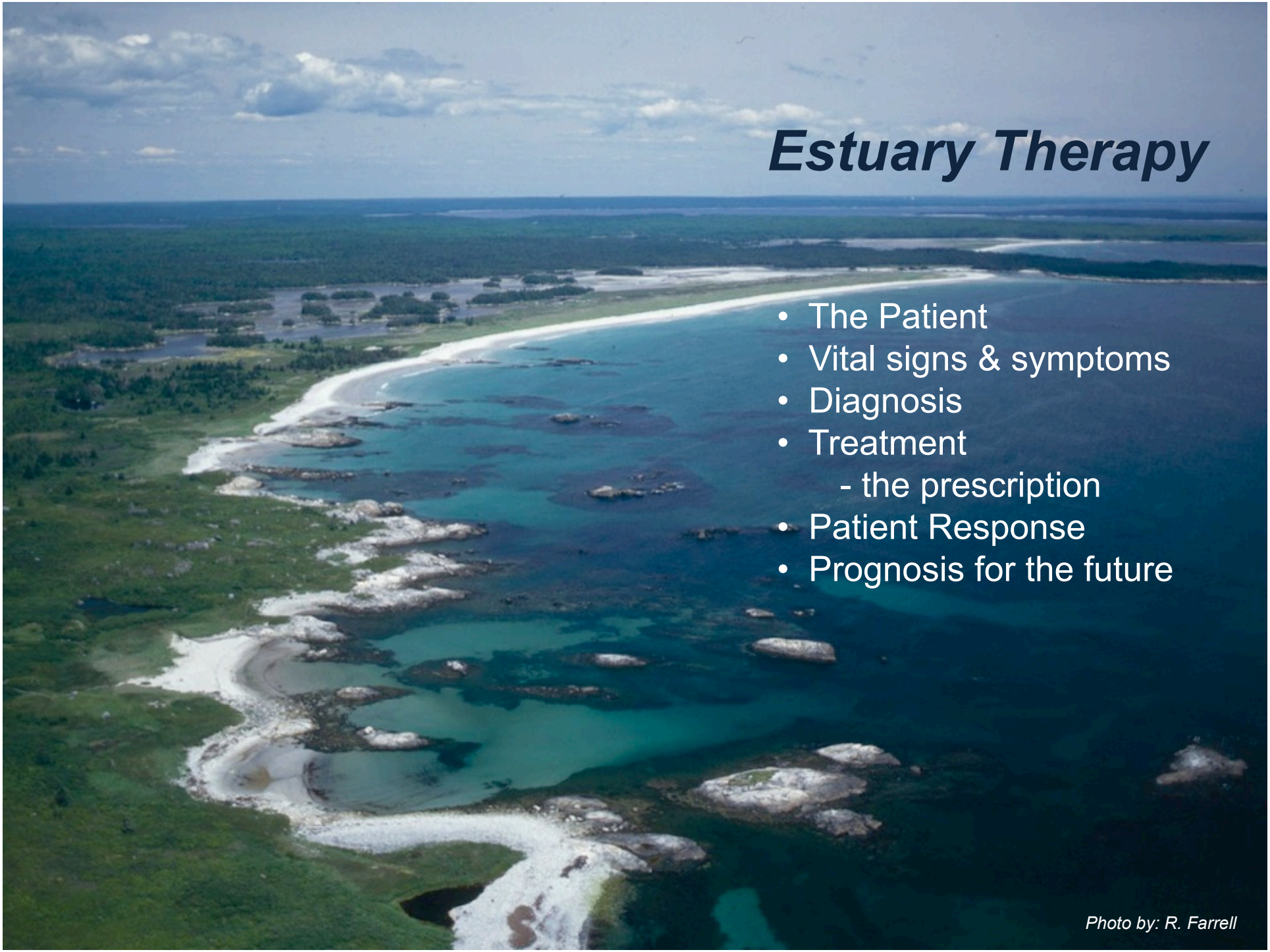
Estuary Therapy

Advances in Coastal Restoration at Kejimkujik National Park Seaside

Maine Green Crab Summit
Orono, Maine
December 16, 2013

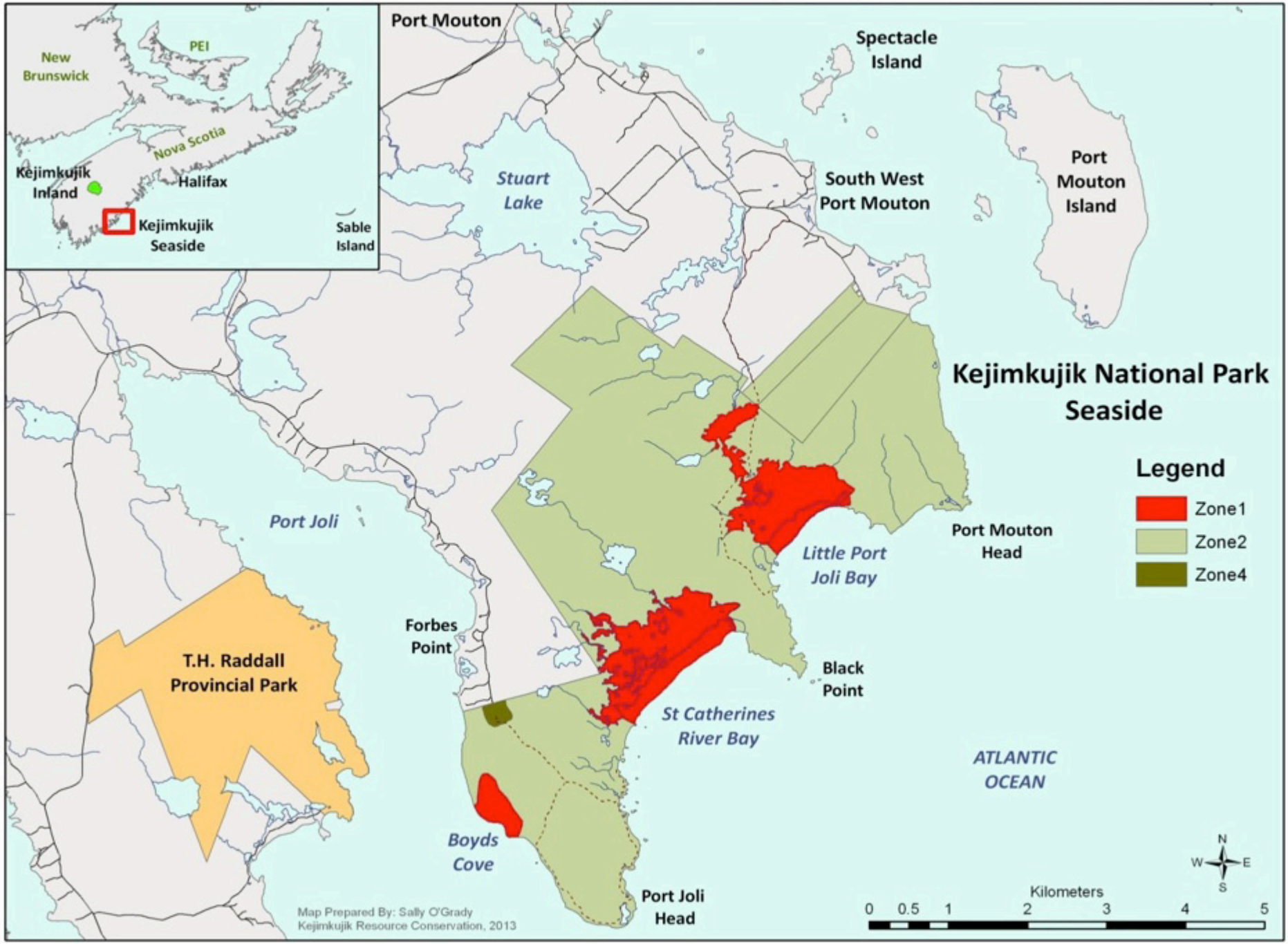
Chris McCarthy
Parks Canada Ecologist
Kejimkujik NP & NHS
Nova Scotia

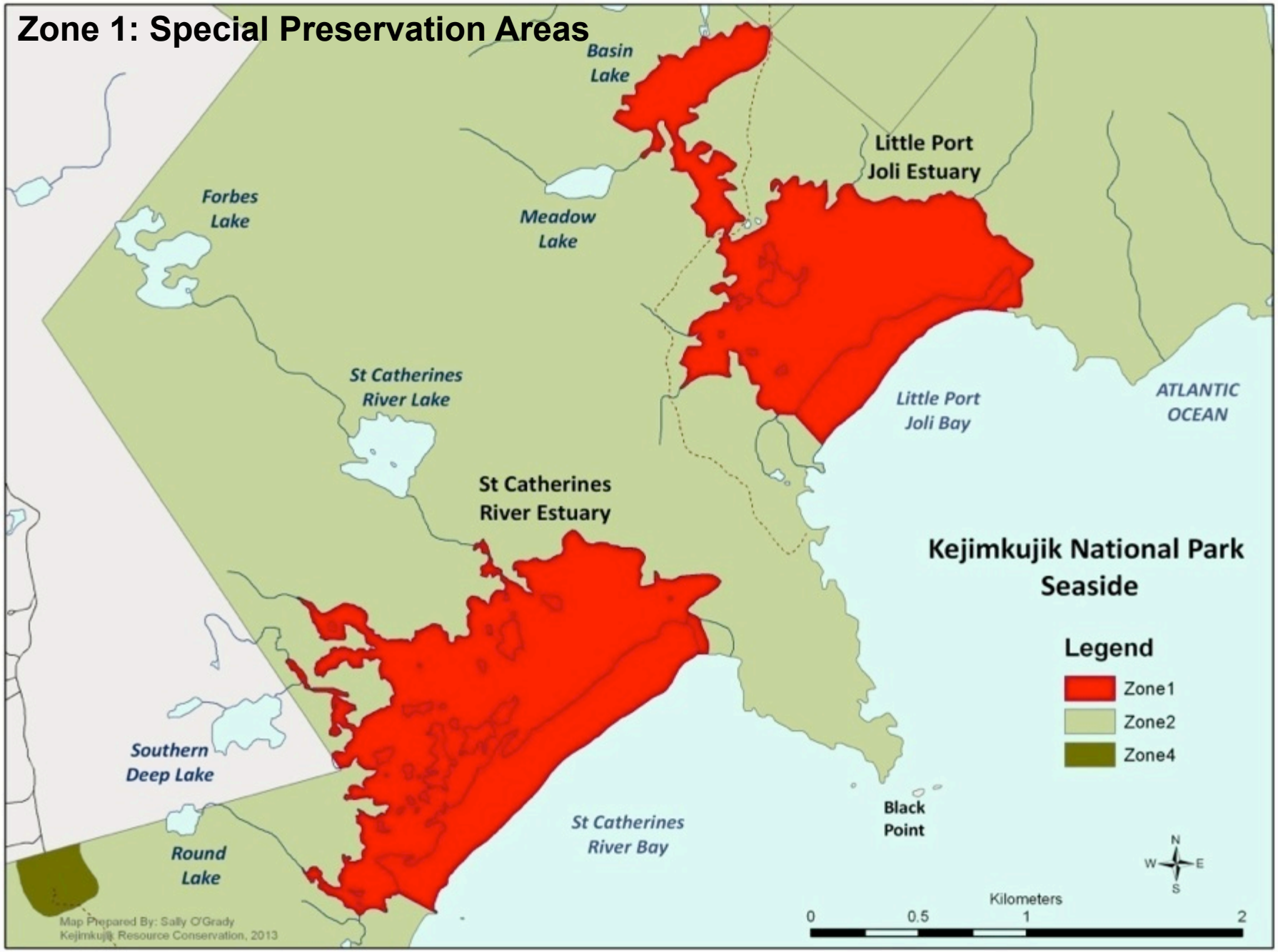


Estuary Therapy

- The Patient
- Vital signs & symptoms
- Diagnosis
- Treatment
  - the prescription
- Patient Response
- Prognosis for the future

Photo by: R. Farrell


New Brunswick
PEI
Nova Scotia
Kejimkujik Inland
Halifax
Kejimkujik Seaside
Sable Island
Port Mouton
Spectacle Island
Stuart Lake
South West Port Mouton
Port Mouton Island
Kejimkujik National Park Seaside
Legend
Zone1
Zone2
Zone4
Port Joli
Port Mouton Head
Little Port Joli Bay
Forbes Point
T.H. Raddall Provincial Park
Black Point
St Catherines River Bay
ATLANTIC OCEAN
Boyds Cove
Port Joli Head
Map Prepared By: Sally O'Grady
Kejimkujik Resource Conservation, 2013
N
W
E
S
Kilometers
0 0.5 1 2 3 4 5


Zone 1: Special Preservation Areas
Basin Lake
Little Port Joli Estuary
Forbes Lake
Meadow Lake
St Catherines River Lake
Little Port Joli Bay
ATLANTIC OCEAN
St Catherines River Estuary
Kejimkujik National Park Seaside
Legend
Zone1
Zone2
Zone4
Southern Deep Lake
Black Point
St Catherines River Bay
Round Lake
N
W
E
S
Kilometers
0
0.5
1
2
Map Prepared By: Sally O'Grady
Kejimkujik Resource Conservation, 2013

“Nowhere else in the national parks of Atlantic Canada is there such richness of marine life in such clear shallow water. The diversity and accessibility of this site rivals the tidal pools of Pacific Rim National Park.”

“Every surface under water is covered with life.” *Burzynski 1992*

Photo by: AGRG

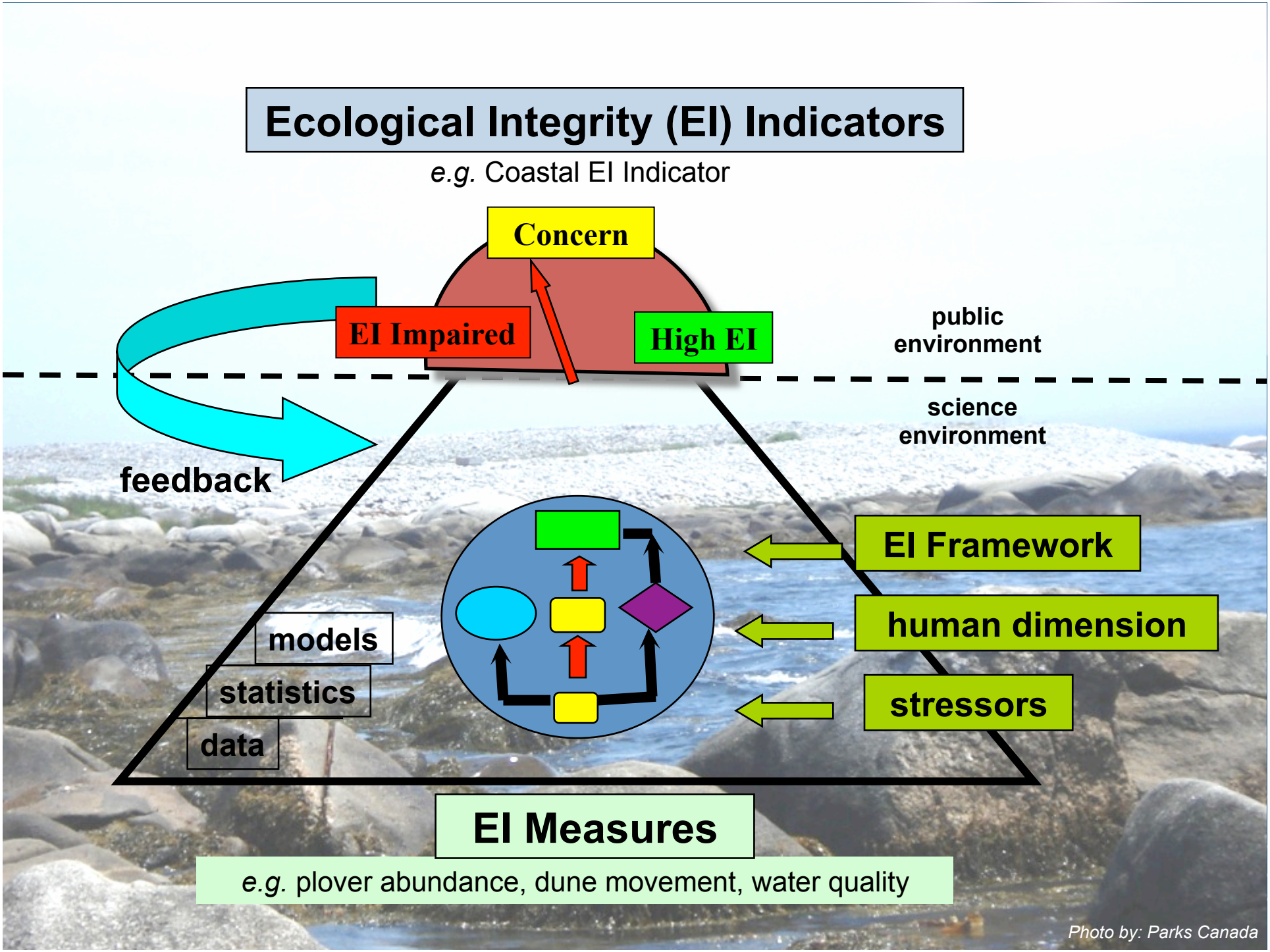

Photo by: R. Farrell

Photo by: R. Farrell

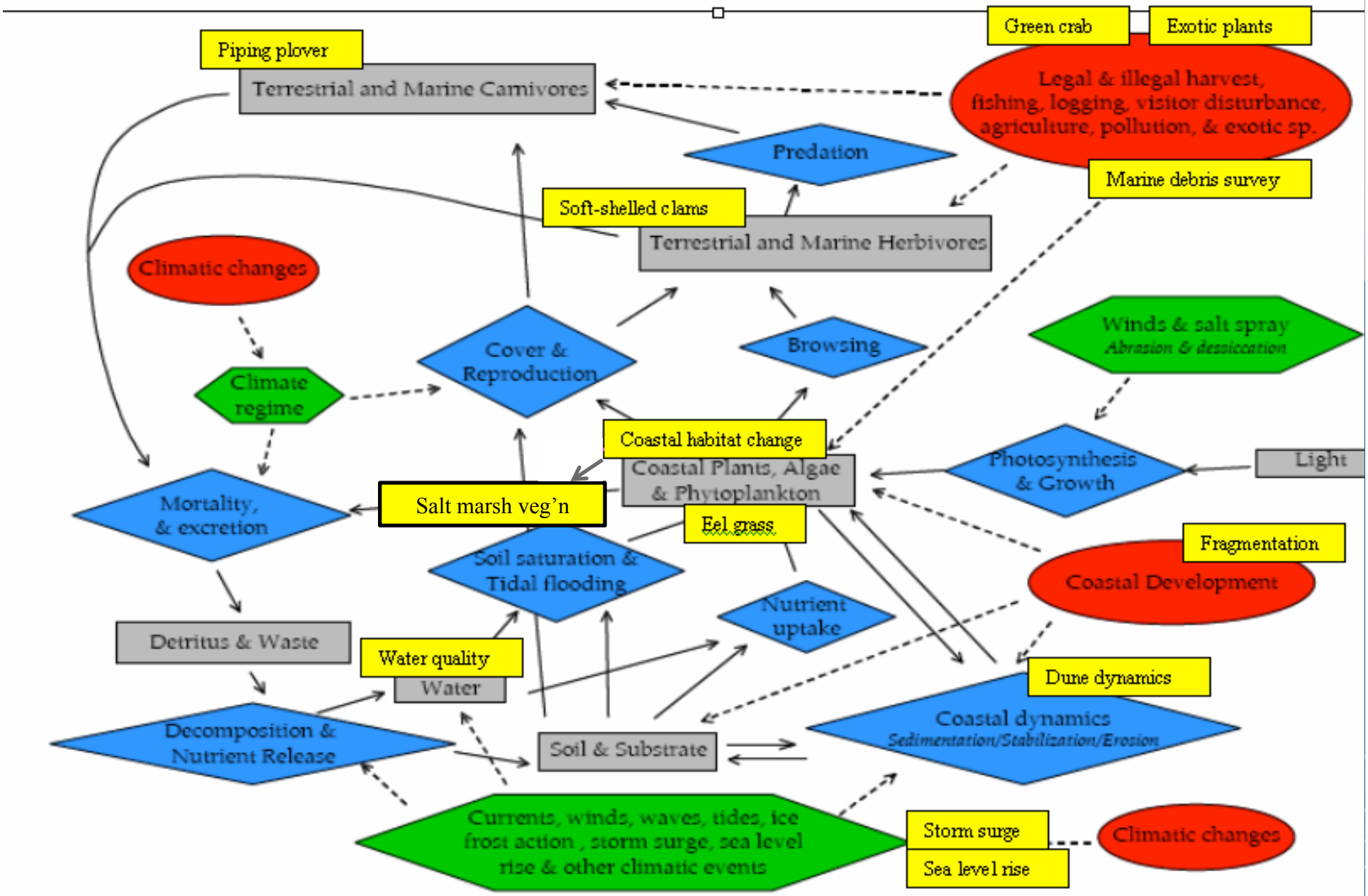
2007 Initial Observations:

- declining eelgrass beds
- decrease in smaller soft-shell clam size classes
- water quality concerns
  - heavy sedimentation
  - off-gassing
- bottom *desertification*
  '*scorched earth...*' ?

Photo by: C. McCarthy


Ecological Integrity (EI) Indicators
e.g. Coastal EI Indicator
Concern
EI Impaired
High EI
public environment
science environment
feedback
EI Framework
human dimension
stressors
models
statistics
data
EI Measures
e.g. plover abundance, dune movement, water quality
Photo by: Parks Canada

Kejimkujik Seaside Coastal Ecosystem Conceptual Model



Kejimkujik Seaside EI Monitoring Results 2010

(*Kejimkujik State of the Park and Site Report 2011*)

Coastal Measures	State
Piping Plover	
...each Stability	
Eur...b	
Soft-shell Cla...	
Eelgrass	
Salt Marsh Vegetation	
Estuarine Water Quality	

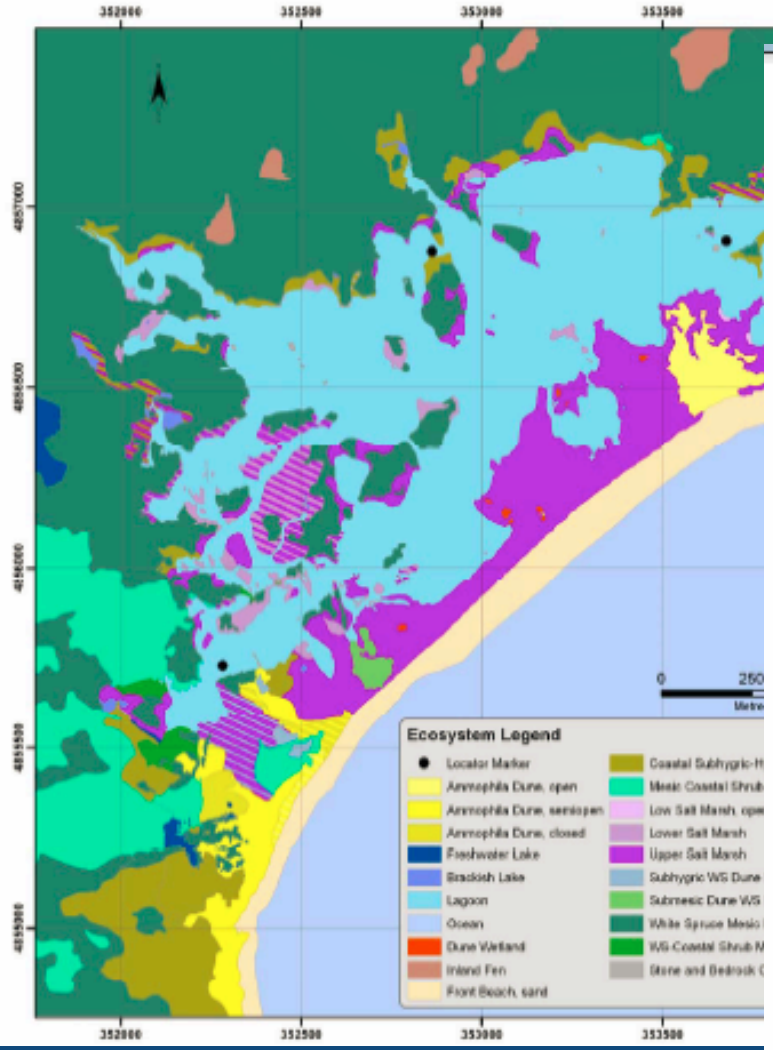
Condition				Trend			
				↑	↔	↓	N/R
Good	Fair	Poor	Not Rated	Improving	Stable	Declining	Not Rated

Coastal ecosystem: Impaired and declining

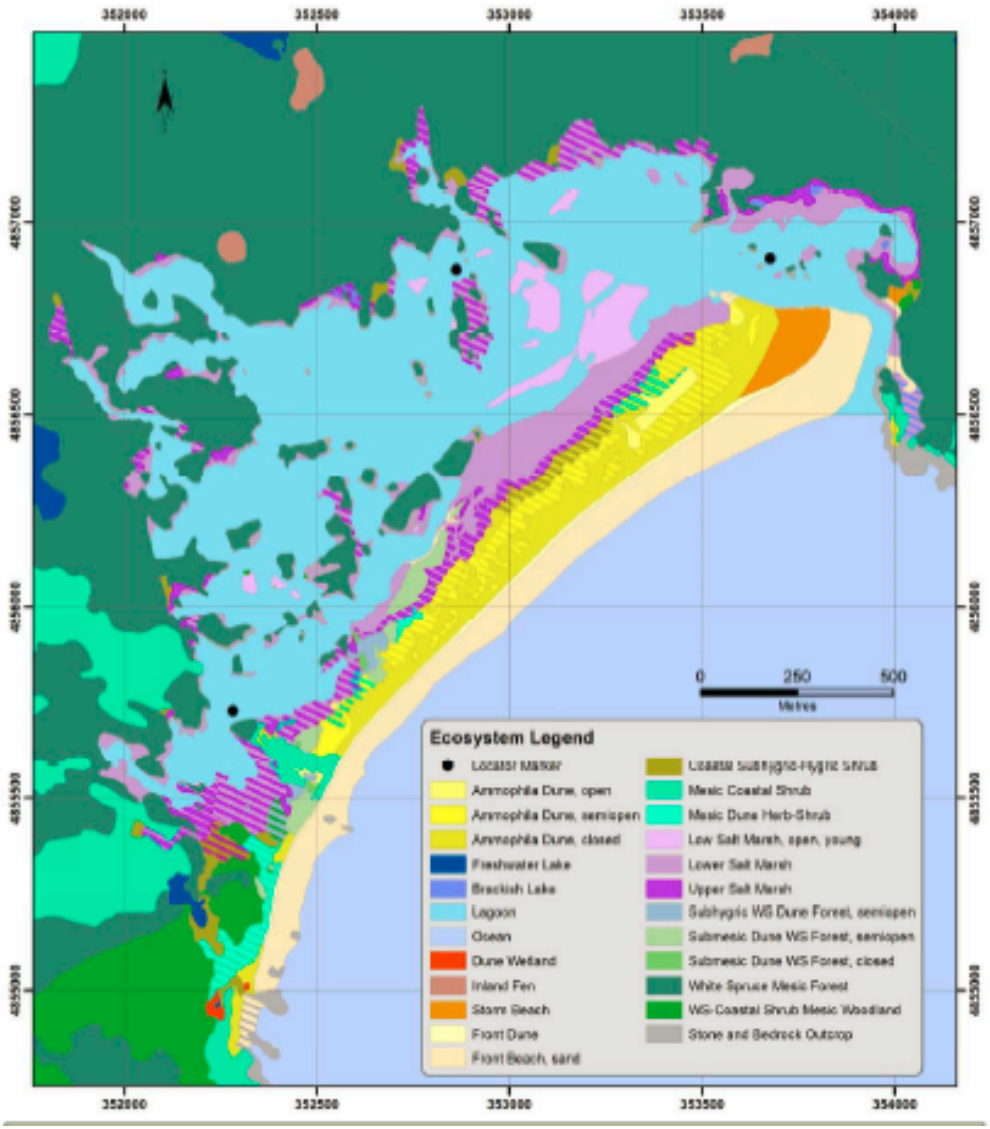
Vegetation change at St. Catherine's River Beach

Aerial photo typing 1927-2007 (11 sets / 80 years)

1927 St. Catherine's River Beach Ecosystem Map



2007 St. Catherine's River Beach Ecosystem Map



Typing and digitizing by
Danik Bourdeau 2011

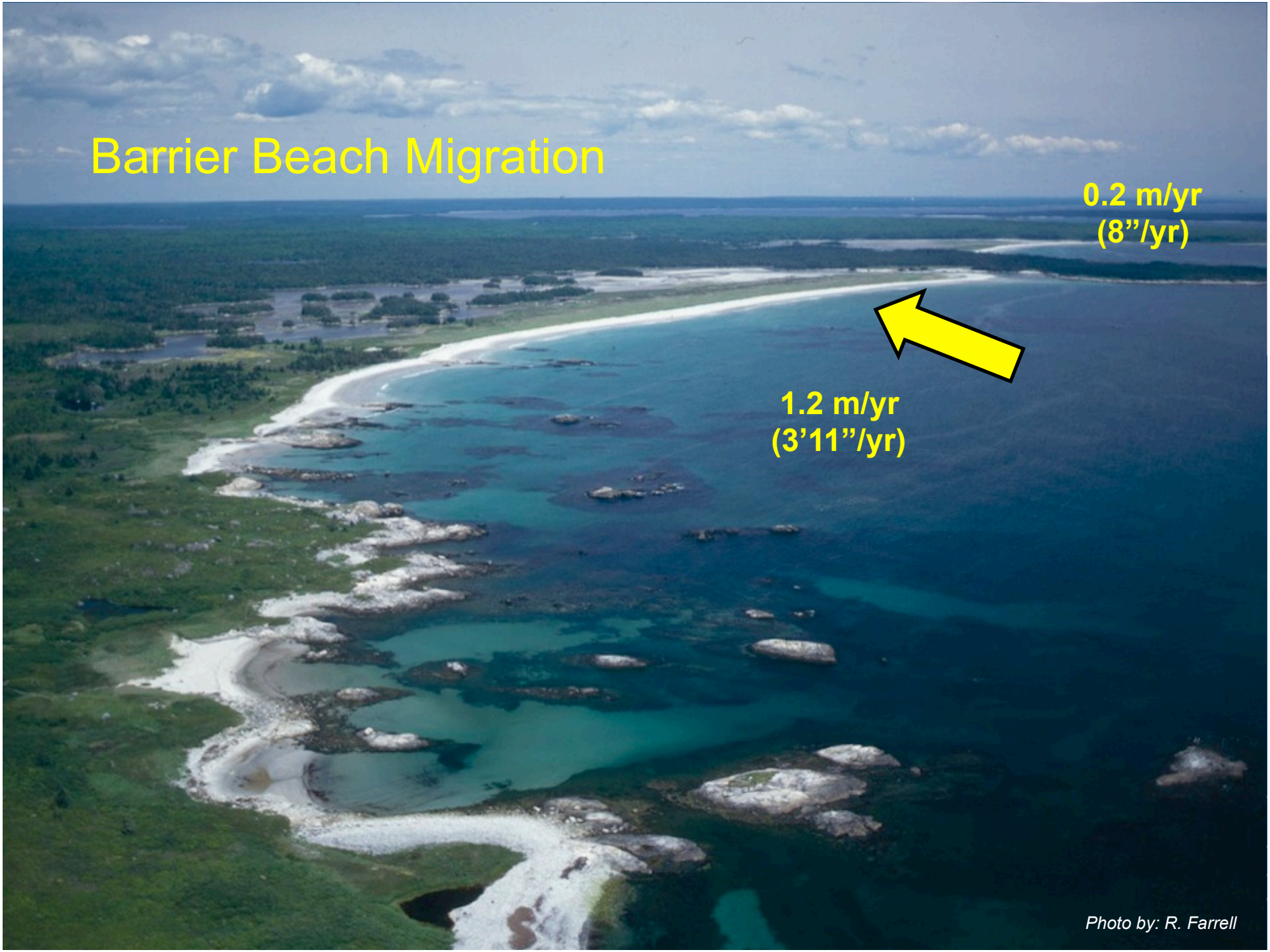
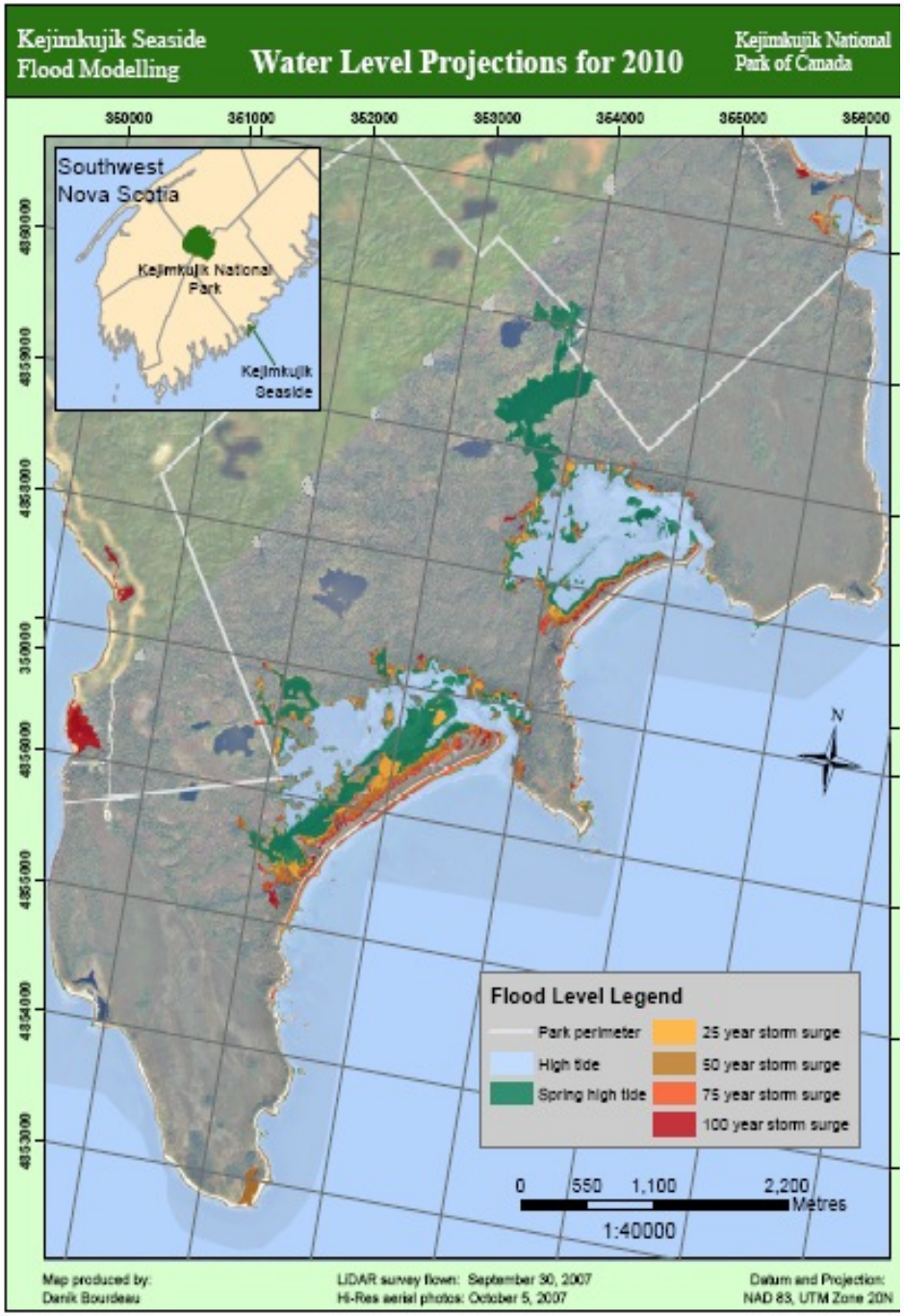
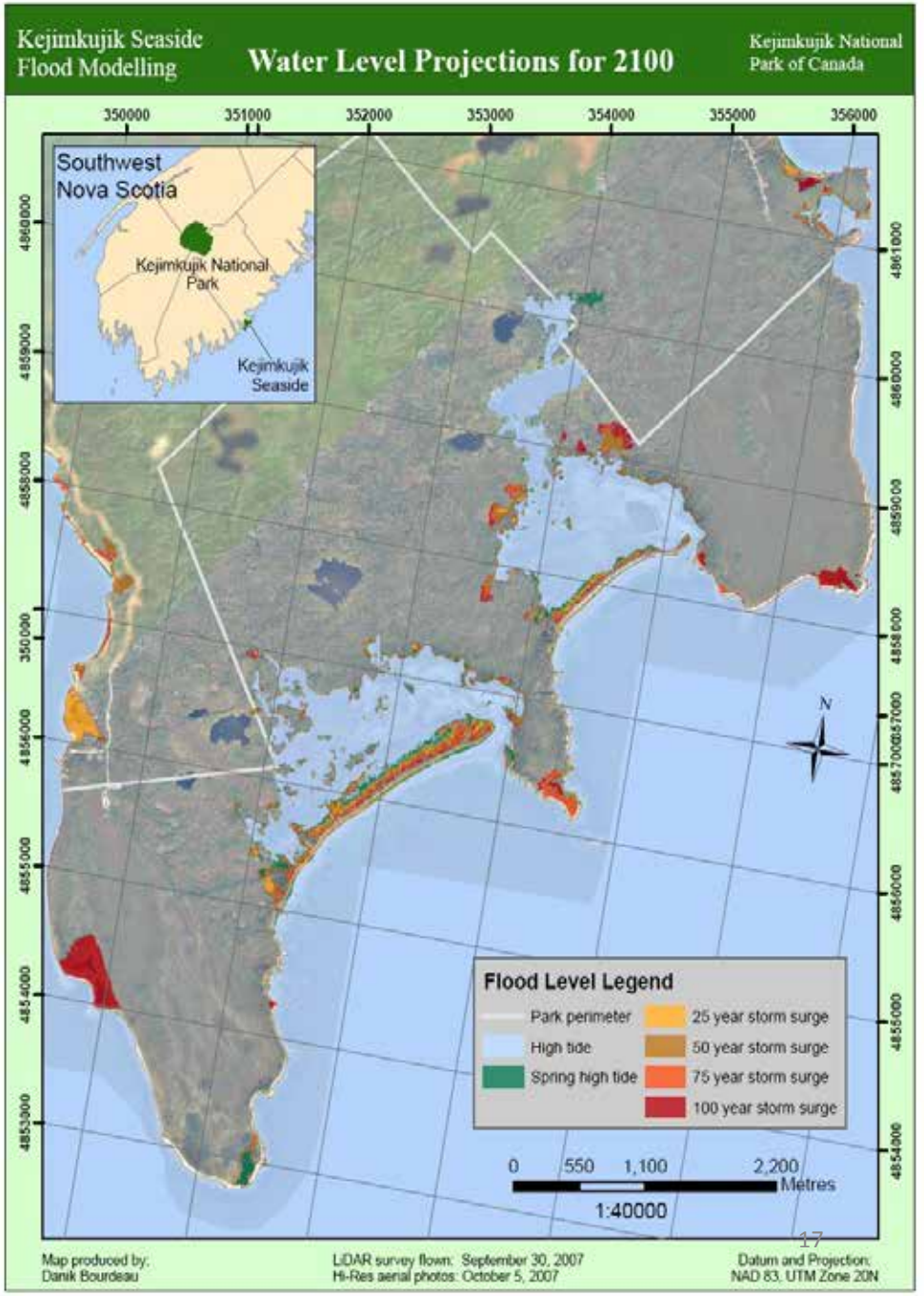

Barrier Beach Migration
0.2 m/yr
(8”/yr)
1.2 m/yr
(3’11”/yr)
Photo by: R. Farrell


Photo by: C. McCarthy

240 year old stump (Ponomarenko, 2009) on foreshore,
St. Catherine's River Beach

Photo by: R. Farrell


Kejimkujik Seaside
Flood Modelling
Water Level Projections for 2010
Kejimkujik National
Park of Canada
Southwest
Nova Scotia
Kejimkujik National
Park
Kejimkujik
Seaside
Flood Level Legend
Park perimeter
High tide
Spring high tide
25 year storm surge
50 year storm surge
75 year storm surge
100 year storm surge
0 550 1,100 2,200
Metres
1:40000
Map produced by:
Danik Bourdeau
LiDAR survey flown: September 30, 2007
Hi-Res aerial photos: October 5, 2007
Datum and Projection:
NAD 83, UTM Zone 20N


Kejimkujik Seaside
Flood Modelling
Water Level Projections for 2100
Kejimkujik National
Park of Canada
Southwest
Nova Scotia
Kejimkujik National
Park
Kejimkujik
Seaside
Flood Level Legend
Park perimeter
High tide
Spring high tide
25 year storm surge
50 year storm surge
75 year storm surge
100 year storm surge
0 550 1,100 2,200
Metres
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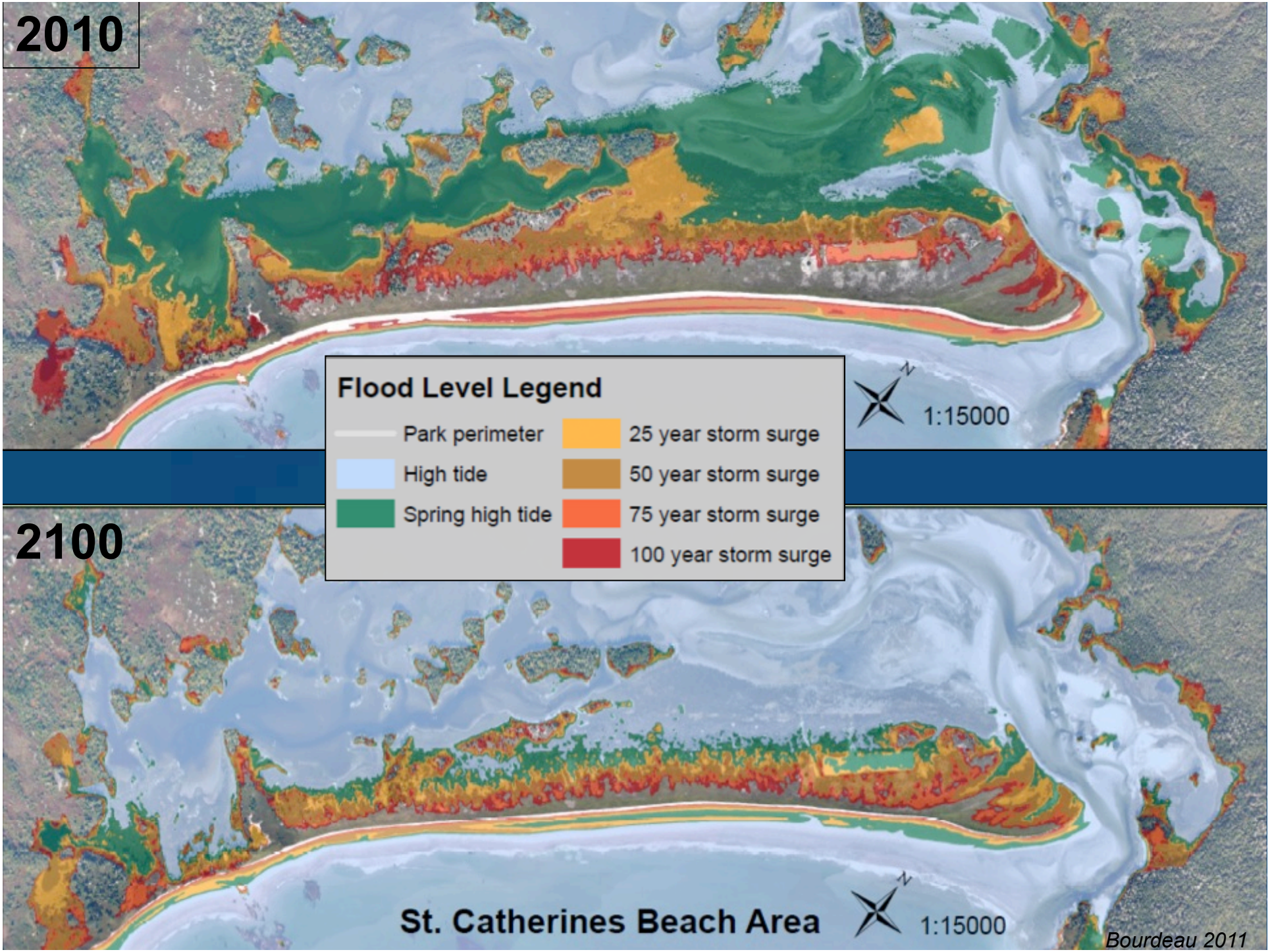
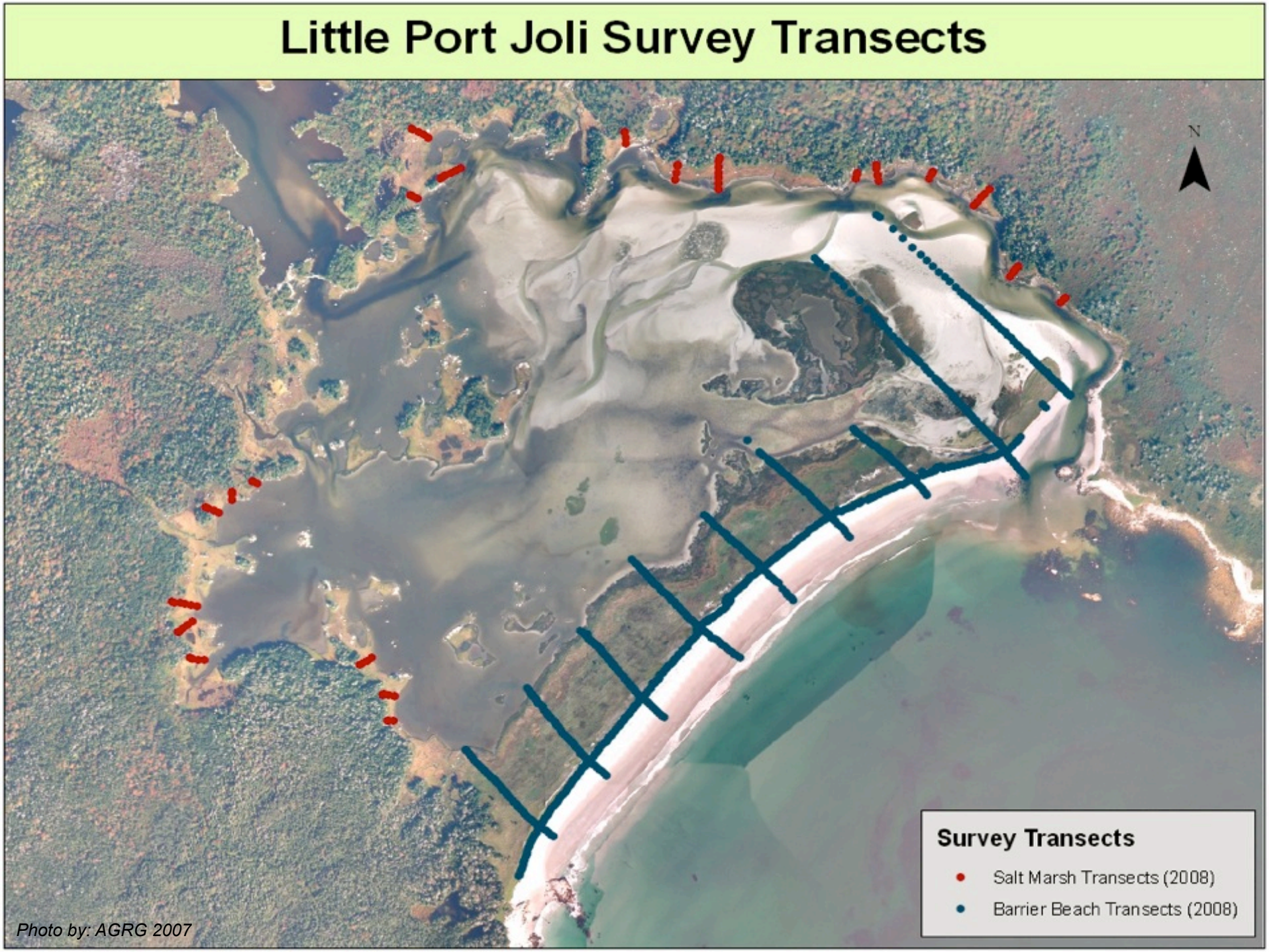

2010
Flood Level Legend
Park perimeter
High tide
Spring high tide
25 year storm surge
50 year storm surge
75 year storm surge
100 year storm surge
1:15000
2100
St. Catherines Beach Area
1:15000
Bourdeau 2011

Little Port Joli Survey Transects



Soft-shell clam (*Mya arenaria*)

- most prolific endobenthic bivalve
- important food source for shorebirds, mammals, flatfish, crustaceans
- pelagic larvae phase (~2 to 5 weeks) followed by spat settlement
- can live up to 29 years of age
- monitored since 1985
- seeing lots of spat at Little Port Joli Lagoon

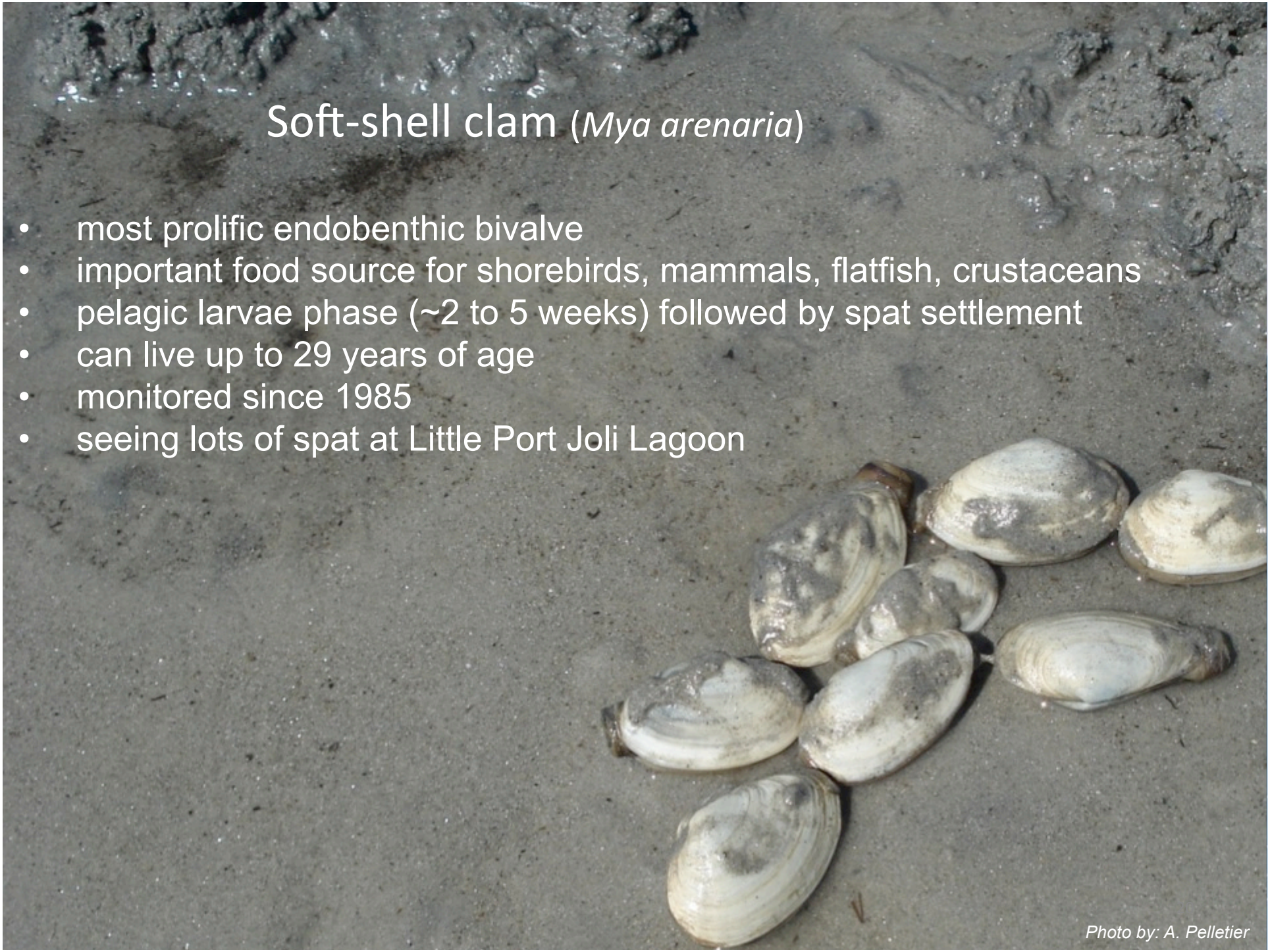
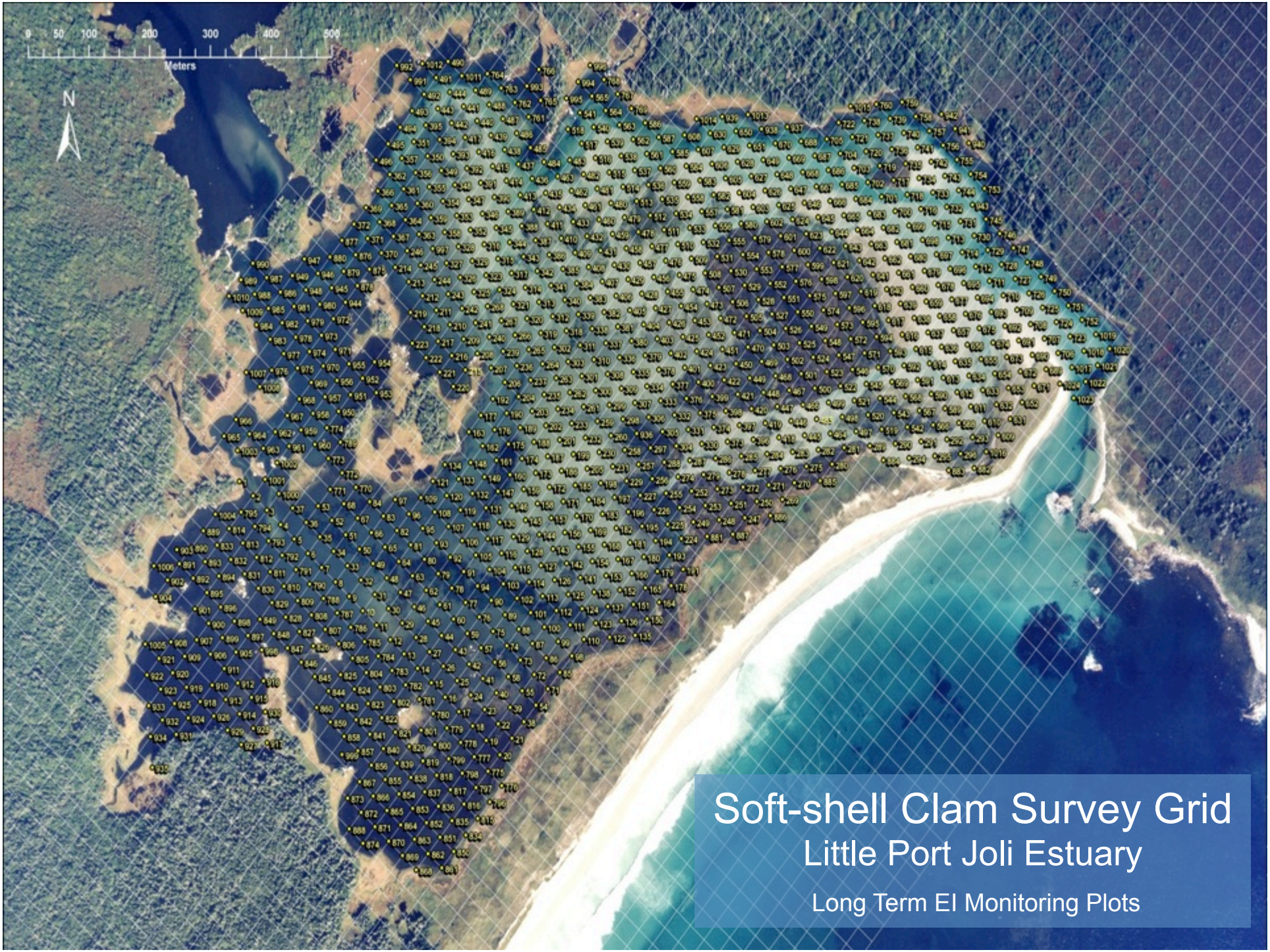
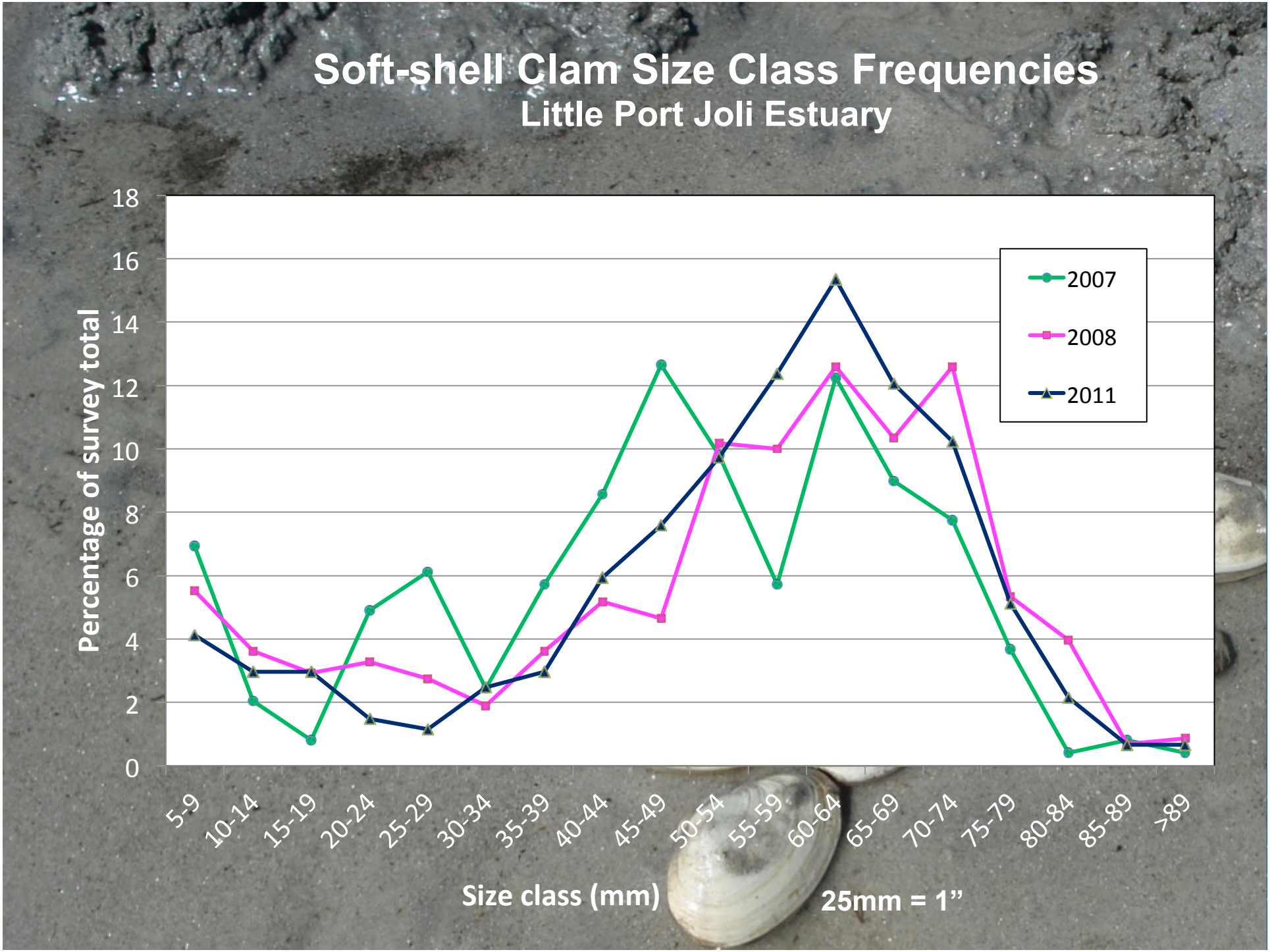


Photo by: A. Pelletier


0 50 100 200 300 400 500
Meters
N
Soft-shell Clam Survey Grid
Little Port Joli Estuary
Long Term EI Monitoring Plots

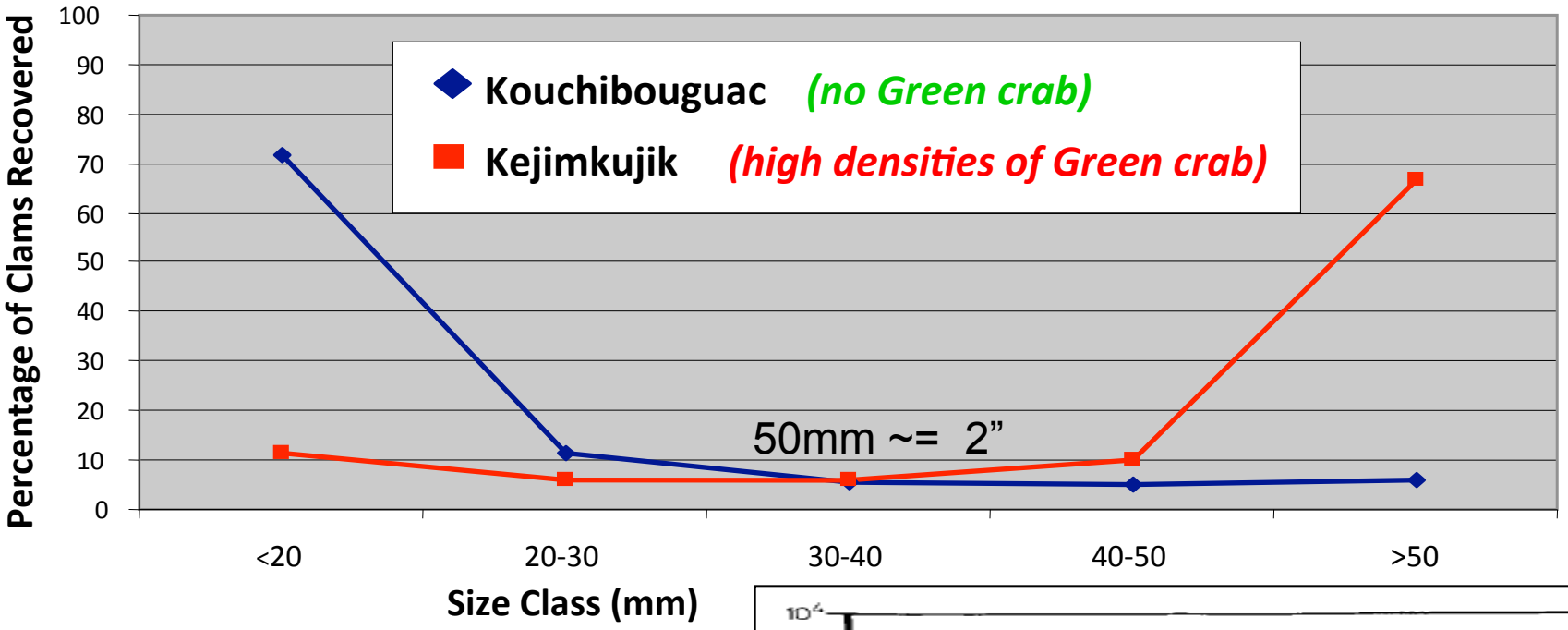
Soft-shell Clam Size Class Frequencies
Little Port Joli Estuary



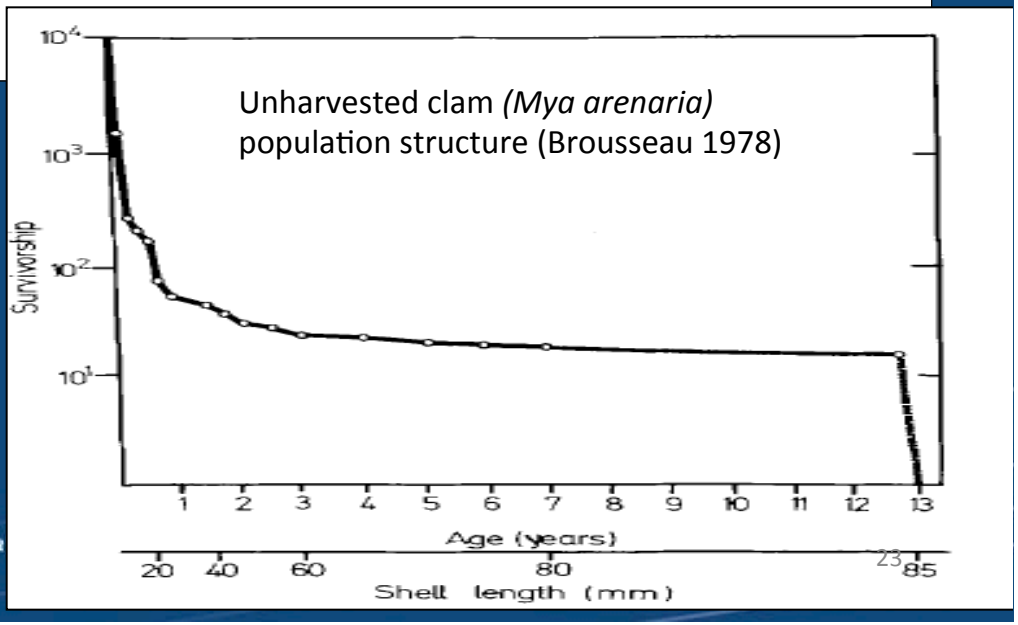
Soft-shell Clam *(Mya arenaria)* Survey by Size Class

2008 National Park Comparison

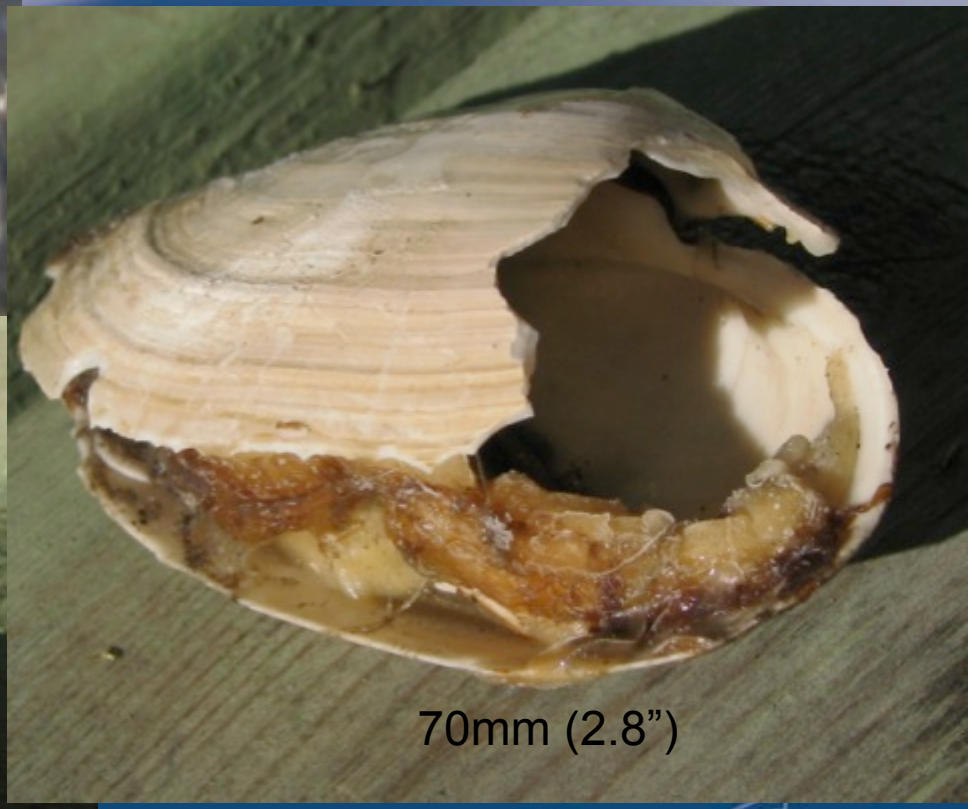
Percentage Recovered



Inverse Soft-shell clam size class relationship in two Canadian national parks, and an unharvested clam population in Gloucester, Mass.



Soft-shell clam damage caused by Green crab



70mm (2.8”)

crack with crusher, feed with pincer

historic treasures

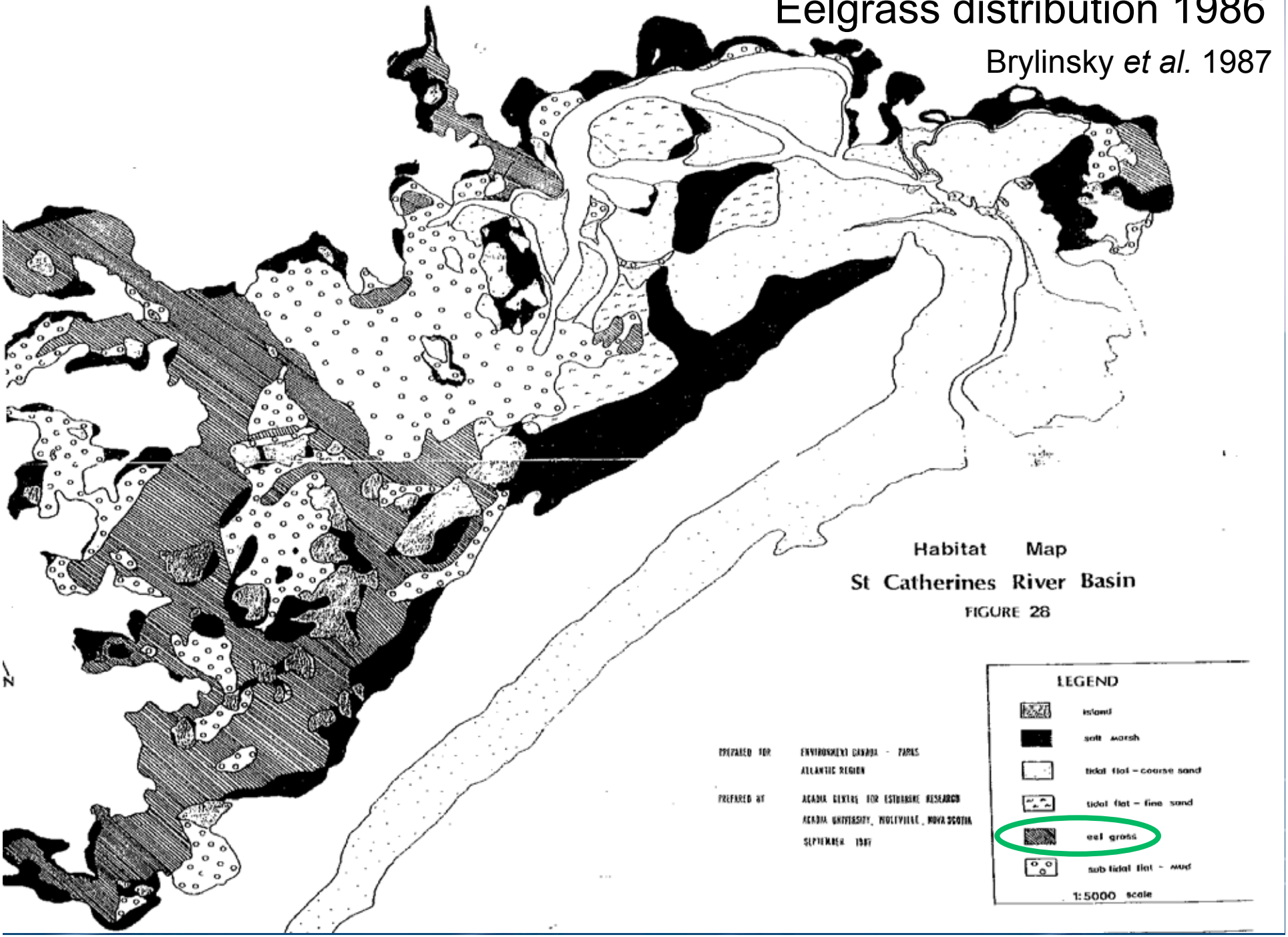
The Importance of Eelgrass (*Zostera marina)*

- Coastal ‘canary’ measure of near-shore ecosystem health
- Target of global conservation efforts
- Keystone species:
  - provides critical habitat > 50% commercial marine species
  - enhances biological productivity
  - stabilizes sediments

Photo by: Woods & Symington

Eelgrass distribution 1986

Brylinsky *et al.* 1987



Eelgrass Decline

Kejimkujik Seaside

Little Port Joli Estuary
Eelgrass:
1986: 34.5 ha (85 acres)
2010: <3%
2013: ...➡

St. Catherine's River
Eelgrass:
1986: 38.9 ha (96 acres)
2001: 0%
2013: 0%

European Green Crab (*Carcinus maenas*) "an ecosystem engineer"

Photo by: Woods & Symington 2010

- Soft-shell clam is favourite food of Green crab in our area (Elner 1981);
- Capable of ripping up vast quantities of Eelgrass with cascading ecosystem effects (Seymour *et al.* 2002)

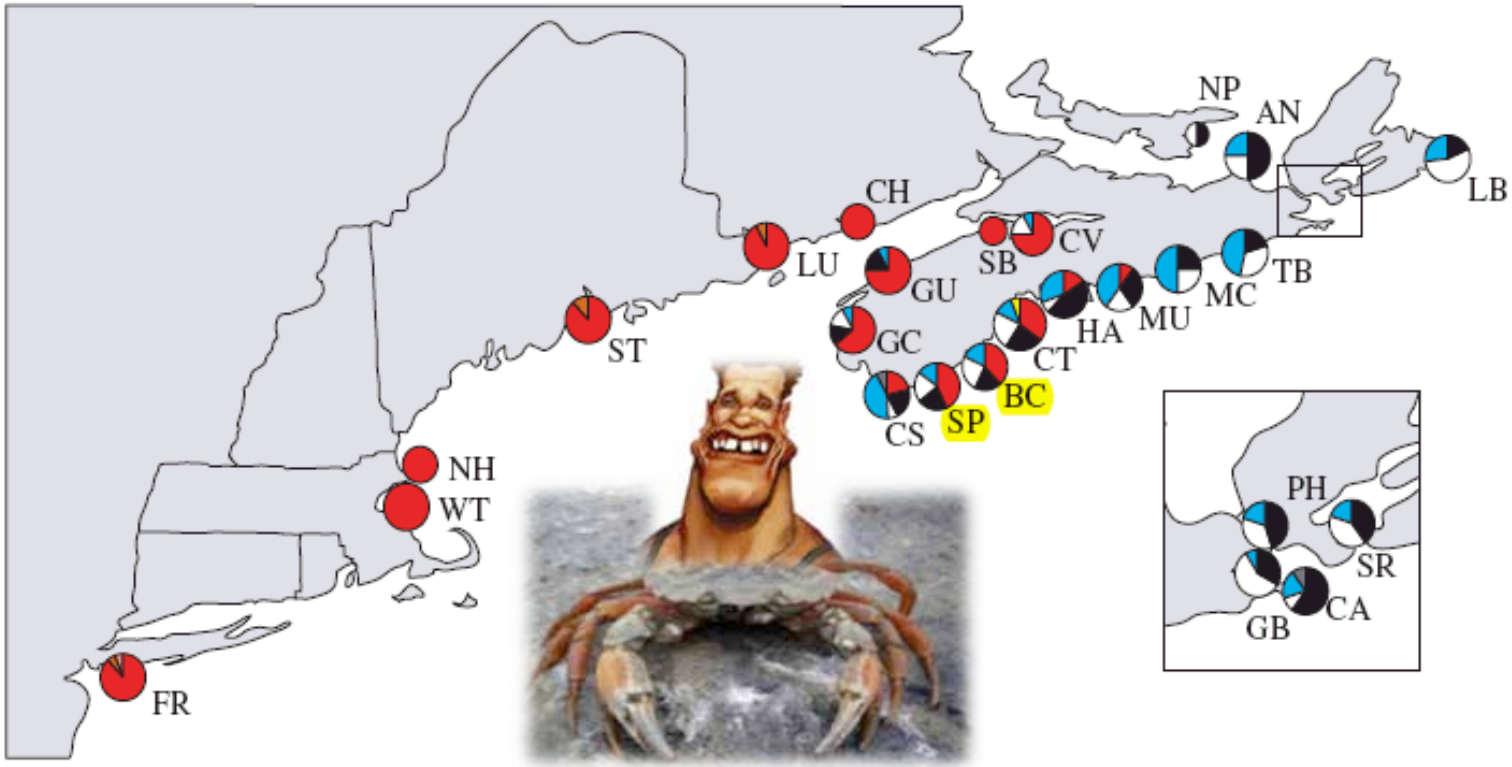


Figure 2. Relative frequencies of green crab haplotypes from 25 locations in North America sampled in 1996–2001. The size of each circle is approximately proportional to the sample size. Inset presents collection locales along the Strait of Canso.

Roman 2006

Approximate arrival at Kejimkujik Seaside:

1st Invasion: 1950's..... 2nd Invasion: *Schwartzencrab* clade in the 1990's

Could we control Green crab effects?

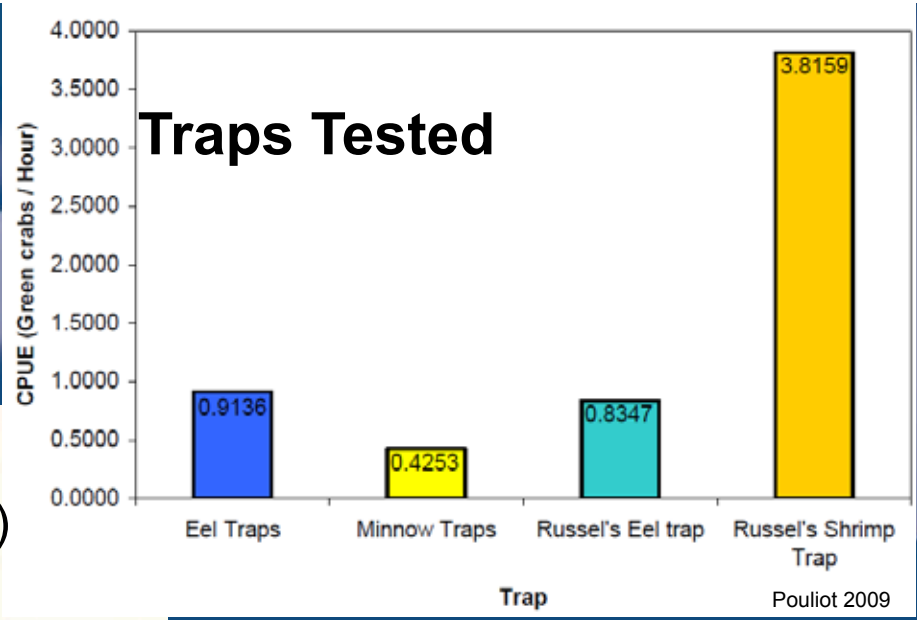
Needed 3 components: (while minimizing negative fishing impacts on the estuaries)

1) a way to remove large numbers of Green crab
2) a use for Green crab (preferably income generating)
3) minimal operational costs

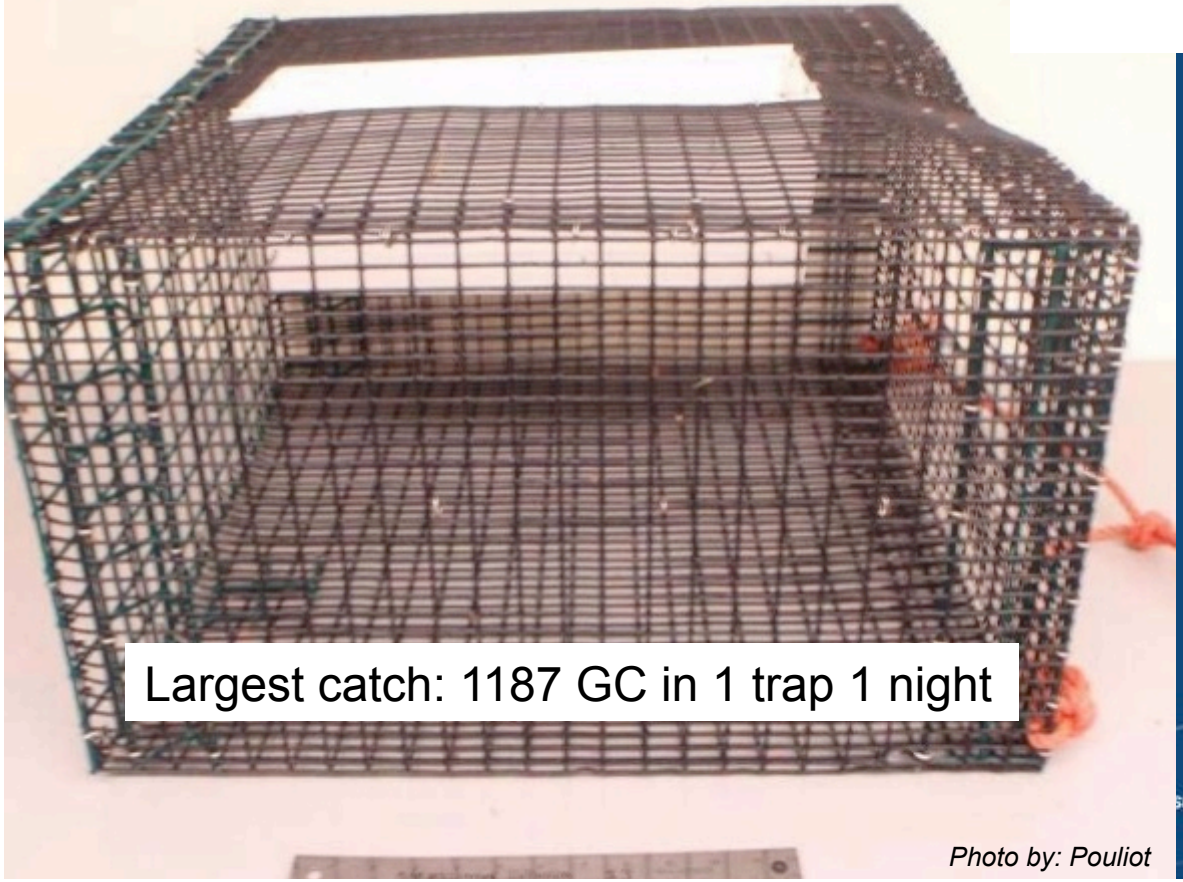
- develop and demonstrate the capacity for local control of adult Green crabs (show success in coastal/marine habitats)
- once Green crabs are under control, restore effected habitats and species
- test theories about best fishing methods, population dynamics, recovery potential

Photo by: K. Rowter

1) a way to remove large numbers



Modified shrimp (Russell) trap (Removals)



Largest catch: 1187 GC in 1 trap 1 night

Photo by: Pouliot

The Russell Trap

"The Terminator"
- developed through local fishing expertise

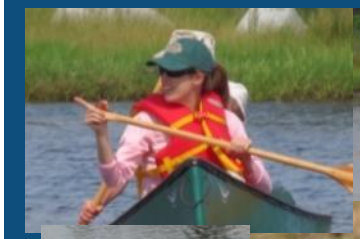
2) a use (preferably income generating)

Industry Engagement

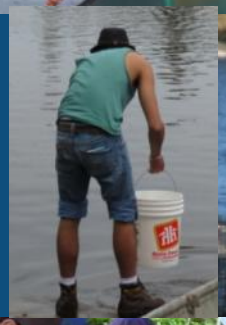
Useful products

- lobster fishery bait
  - new commercial fishery
  - jobs (53 DFO lic. fishers)
- compost, fertilizer
- bone meal replacement
- Glucosamine from chitin
- food products, solar panels
- etc.

3) minimal operational costs















Ecosystem Recovery Target

- Catch per unit of effort [CPUE] threshold: <15 crabs/trap/day

  OR

- No crabs >35mm

http://aquaviews.net/wp-content/uploads/2010/10/Green-Crab.jpg

Assess success with long term EI monitoring

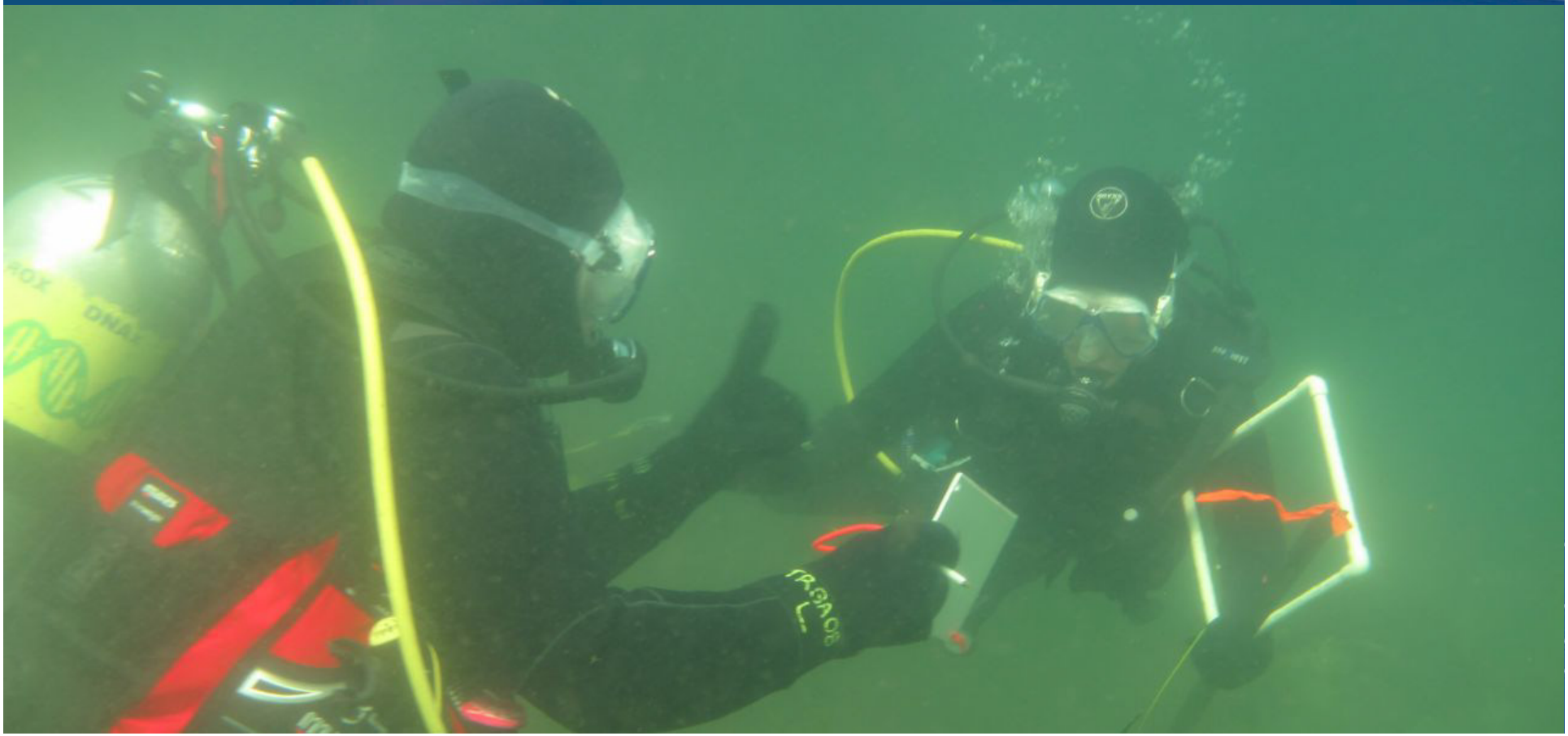
Two Green Crab Approaches

- Standardized Monitoring

  Objective: Long term EI monitoring

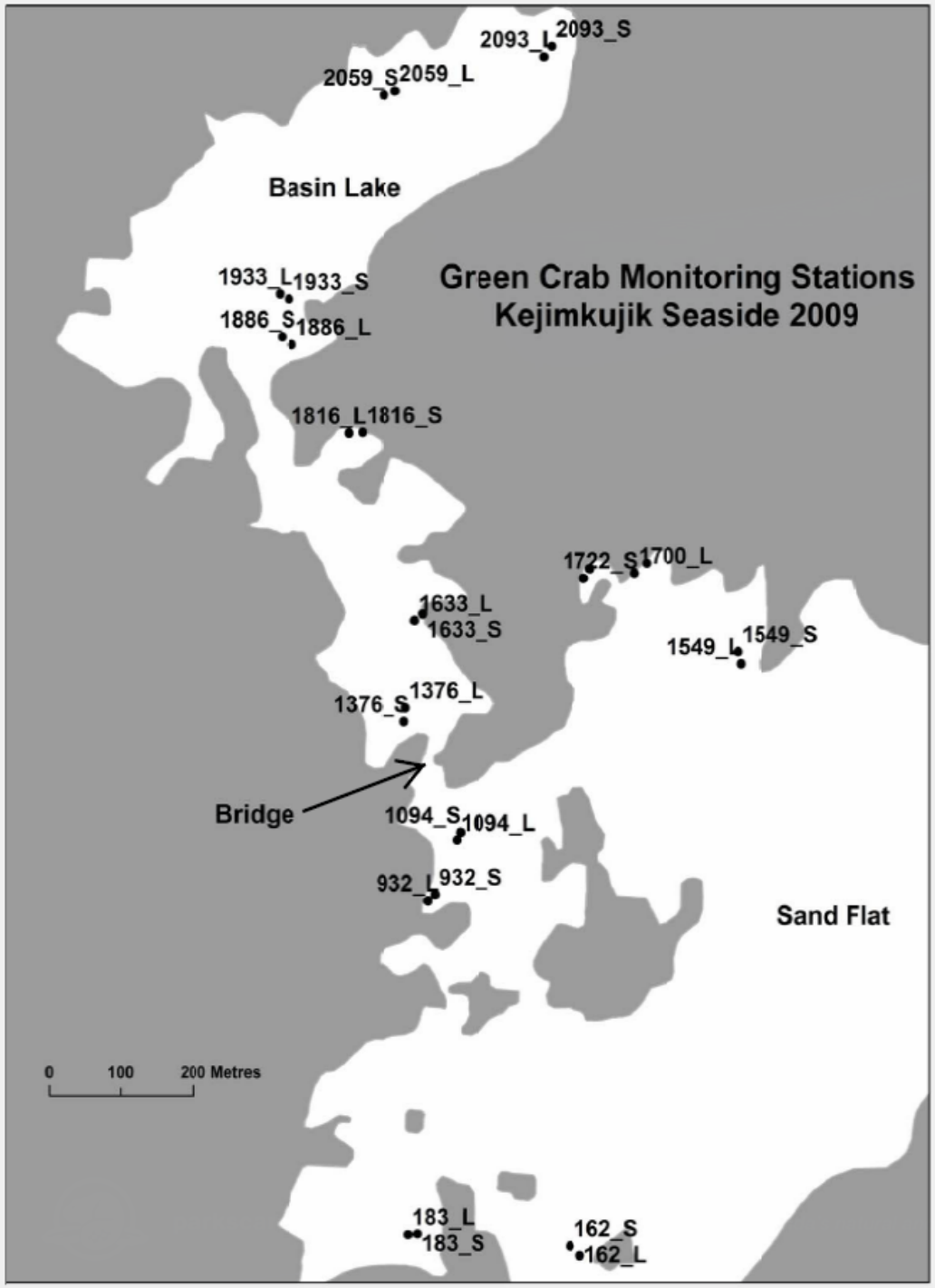
- Removals with daily 50 counts

  Objective: Remove as many crabs as fast as possible



Standardized Monitoring Results

Objective: Long term EI monitoring



STANDARDIZED MONITORING
Catch Results

Aug, Sept, Oct 2009-2012:
25,933 Green crabs processed (sexed, measured, reproductive condition, etc.)

By-catch recorded and released

Modified eel trap (monitoring)

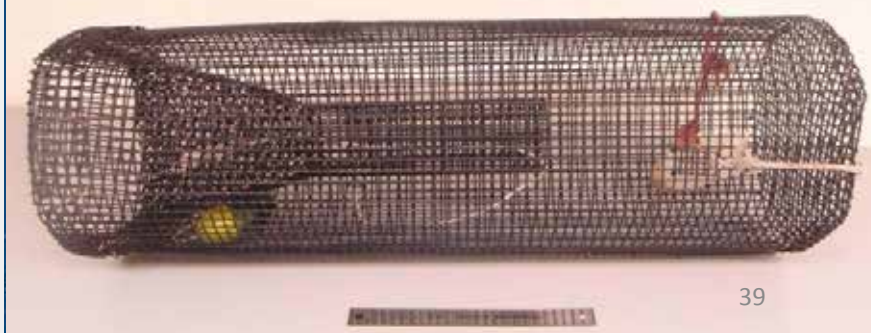
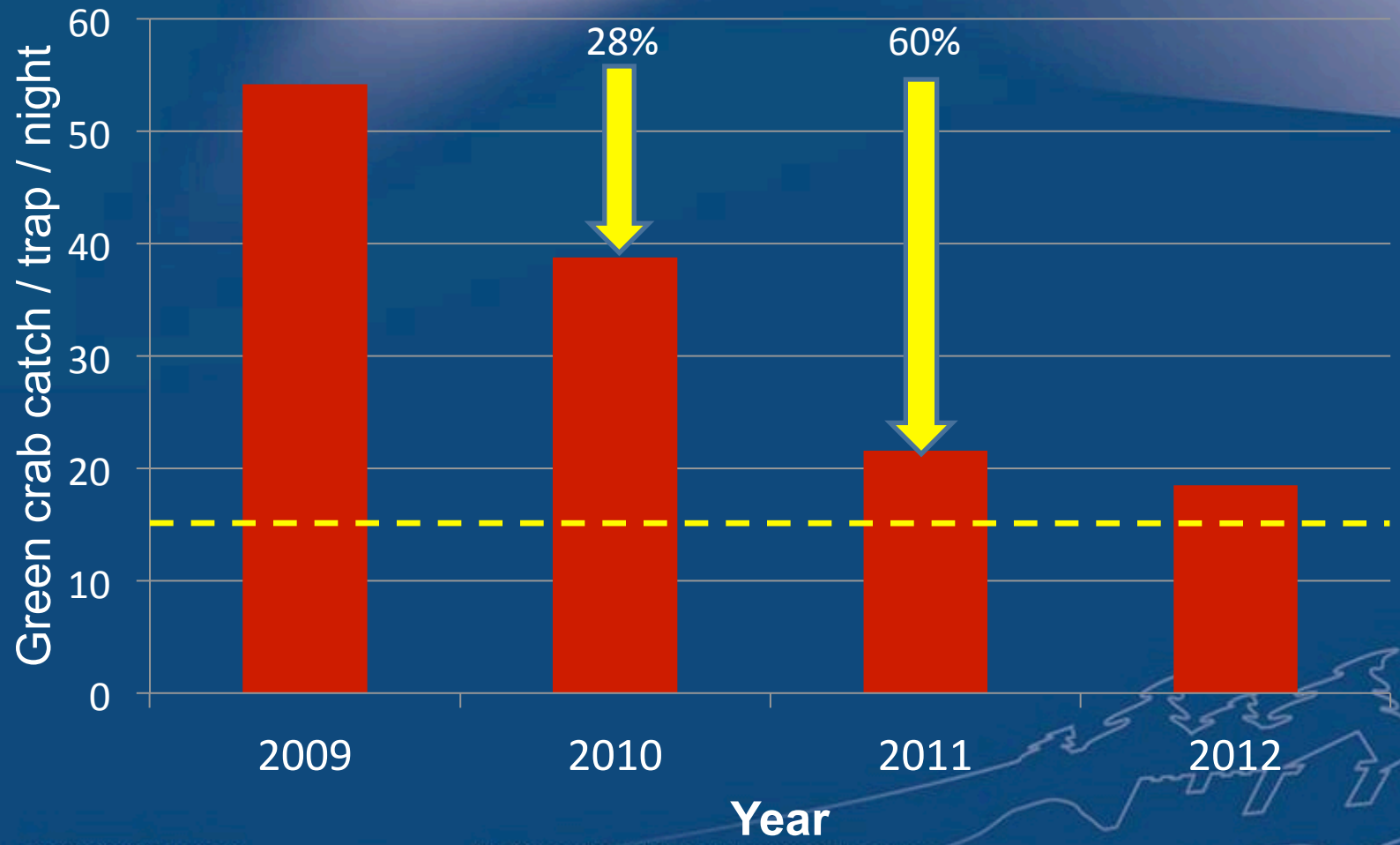


Photo by: D.Pouliot

Green Crab Catch Per Unit Effort

Little Port Joli Estuary

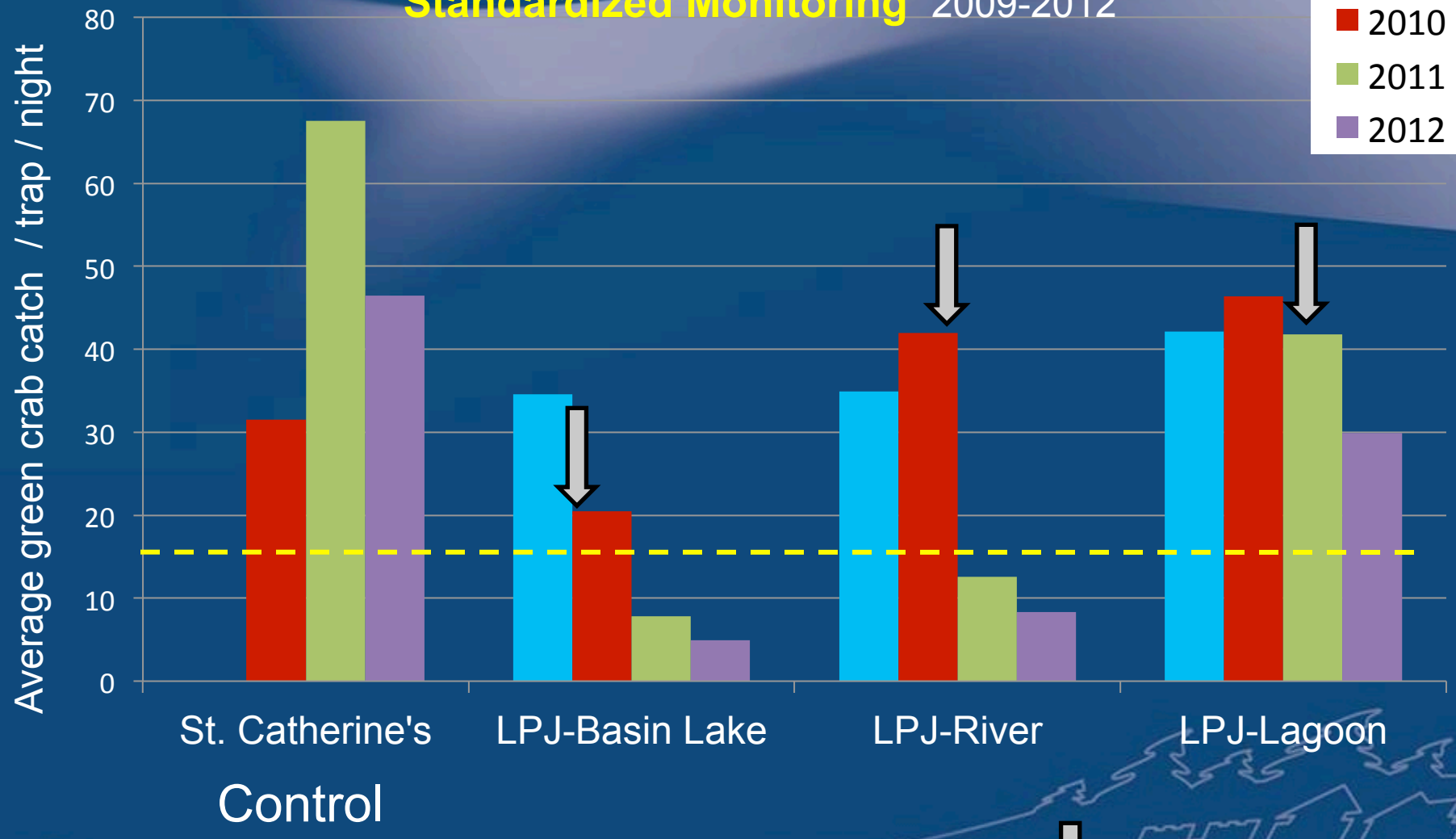
Standardized Monitoring 2009-2012



Annual Change in Catch Per Unit Effort

Kejimkujik Seaside Estuary

Standardized Monitoring 2009-2012



Annual Change in Biomass Per Unit Effort

Kejimkujik Seaside Estuary

Standardized Monitoring 2009-2012

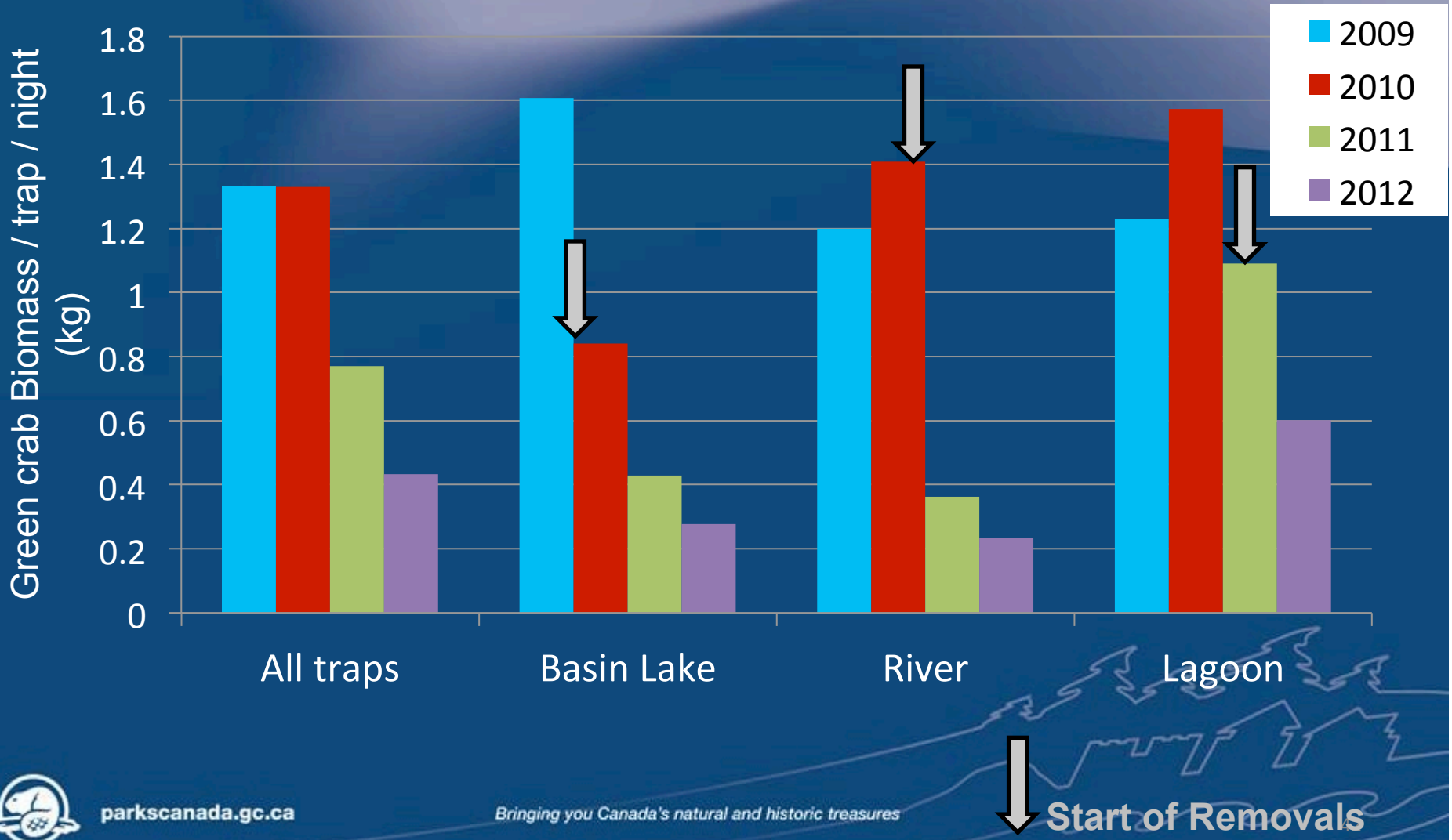
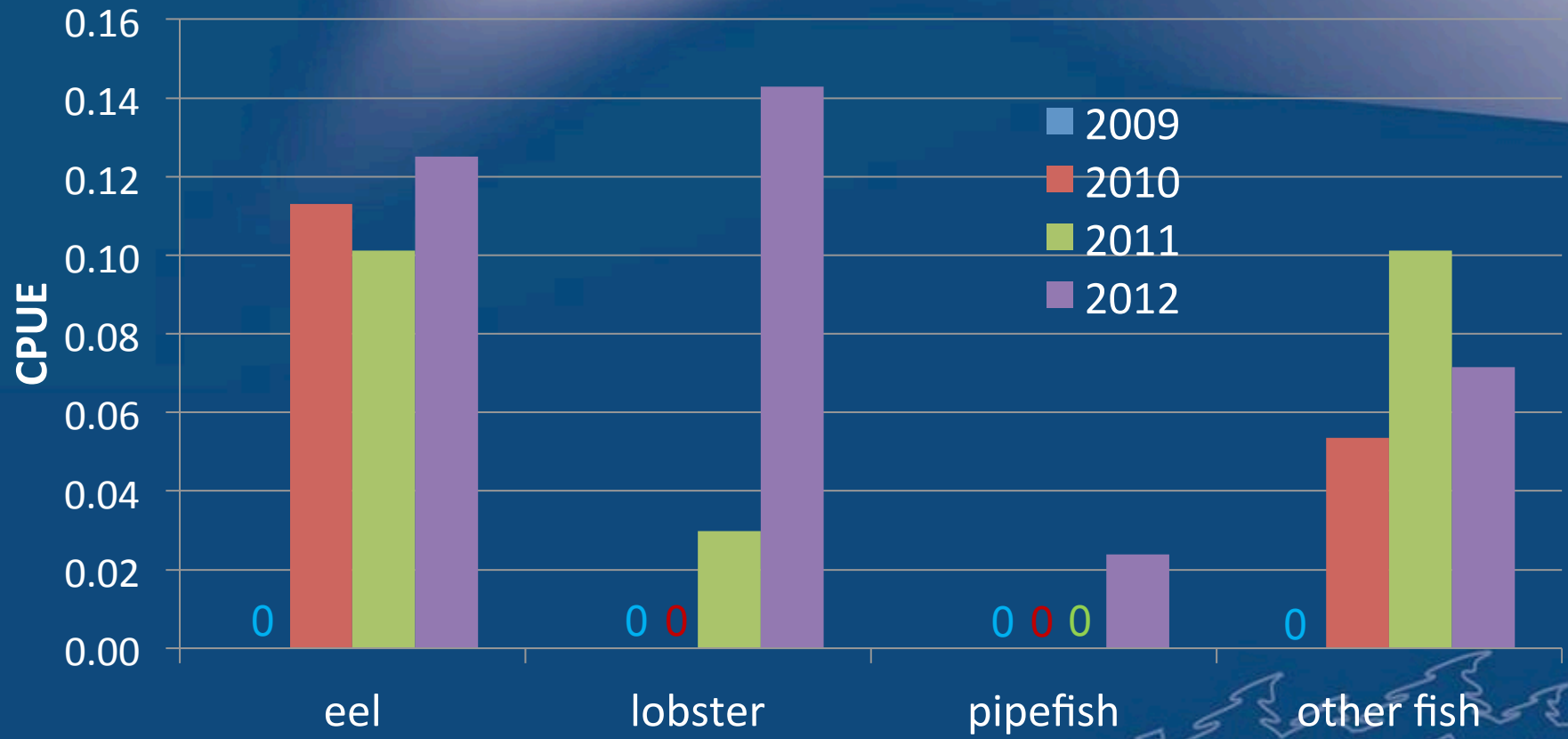



Photo by: S. O'Grady

Monitoring By-catch

Little Port Joli Estuary

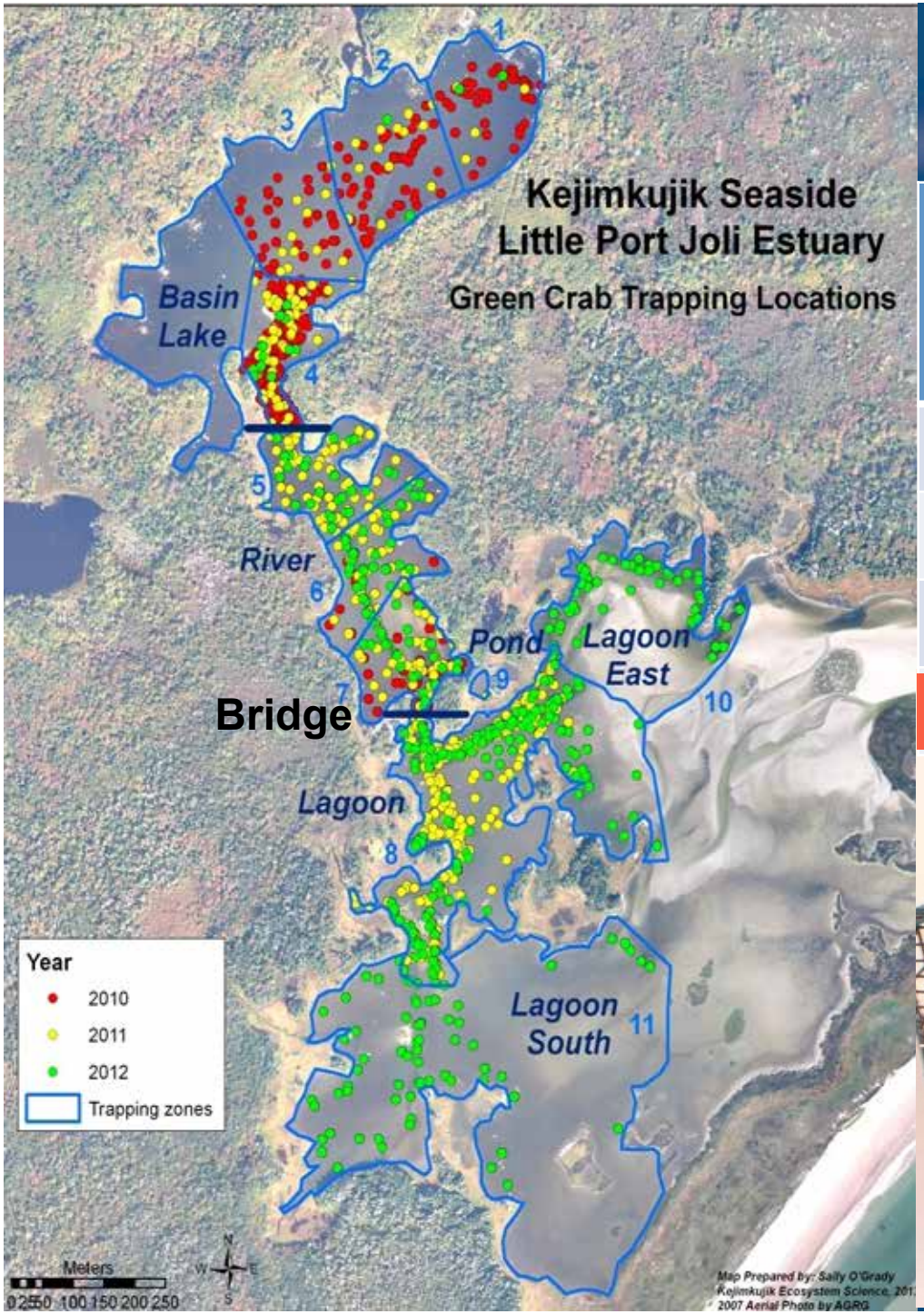
Standardized Monitoring 2009-2012



No by-catch at St. Catherine's River in 4 years fishing

Green Grab Removals Results

Objective: Remove as many Green crabs as fast as possible - using the Russell trap



REMOVALS
Catch Results

Year	Crabs removed	Trap nights	Crabs/ trap night
2010	175,110	3532	49.6
2011	488,202	6821	71.6
2012	263,262	6570	40.1

OVER **1 MILLION** CRABS REMOVED

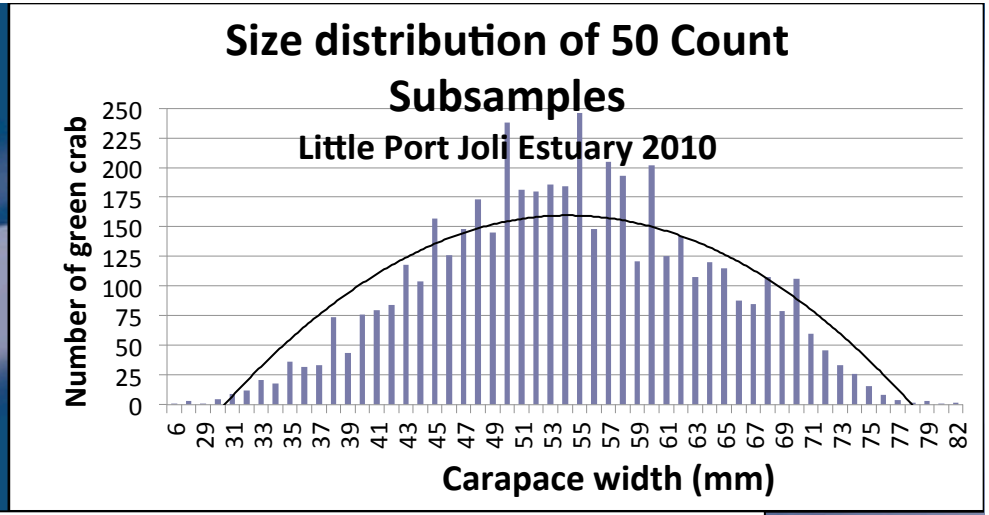
Poulio

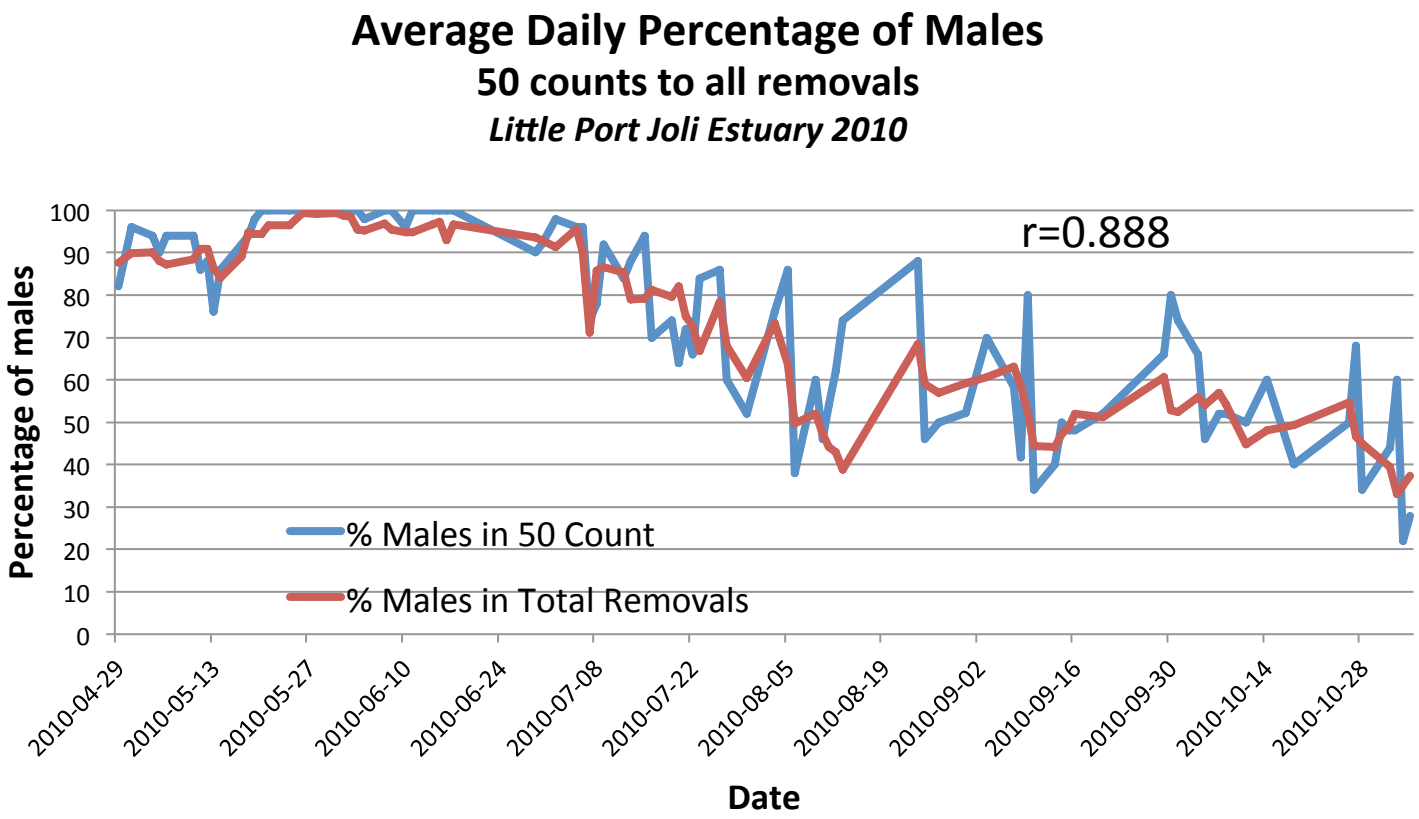
Removals

50 Count Correlation

Little Port Joli Estuary

2010

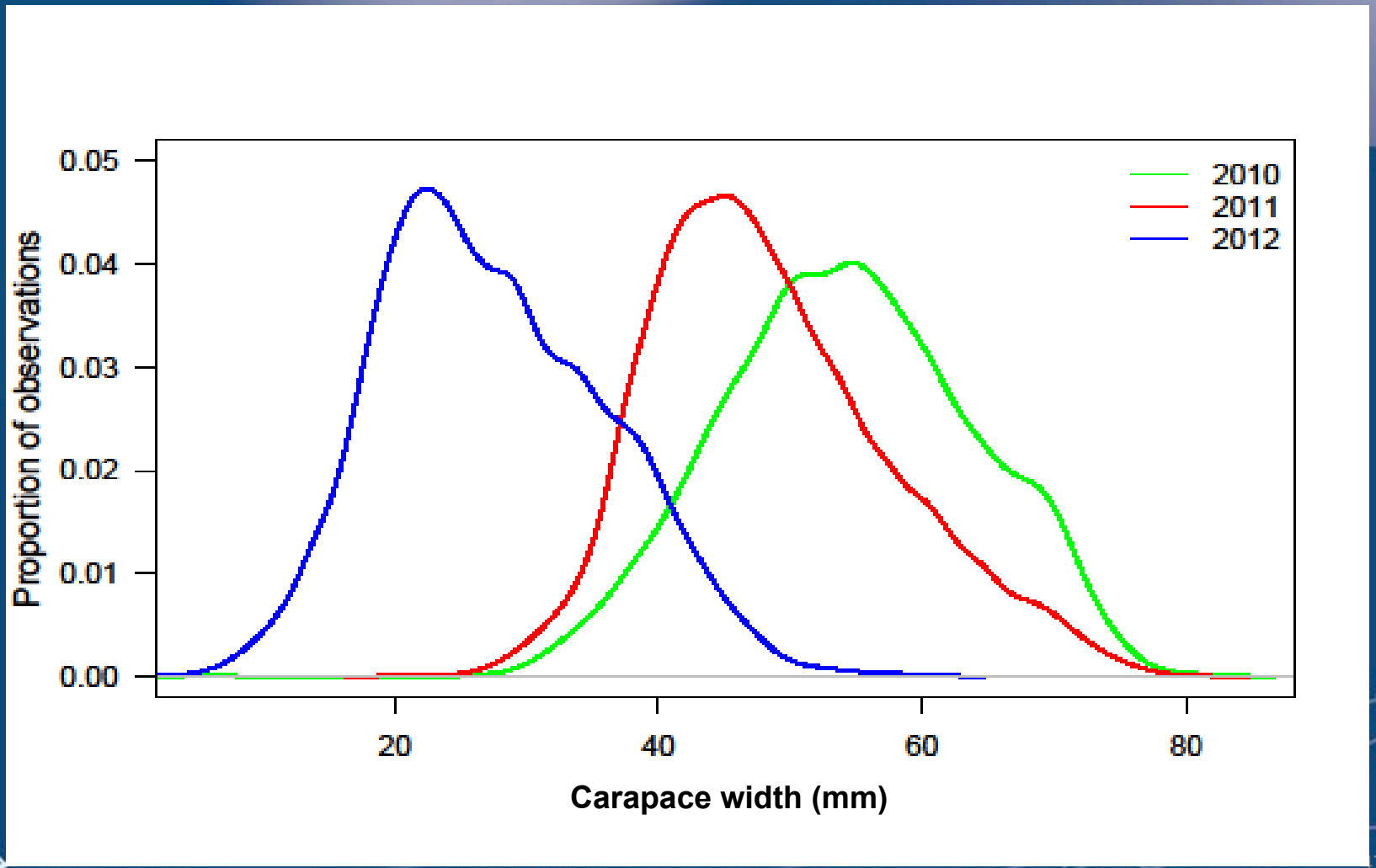




Green Crab Size Distribution

Removals 50 Counts

Little Port Joli Estuary 2010-2012



Eel Grass Change


Photo by: A. Pelletier

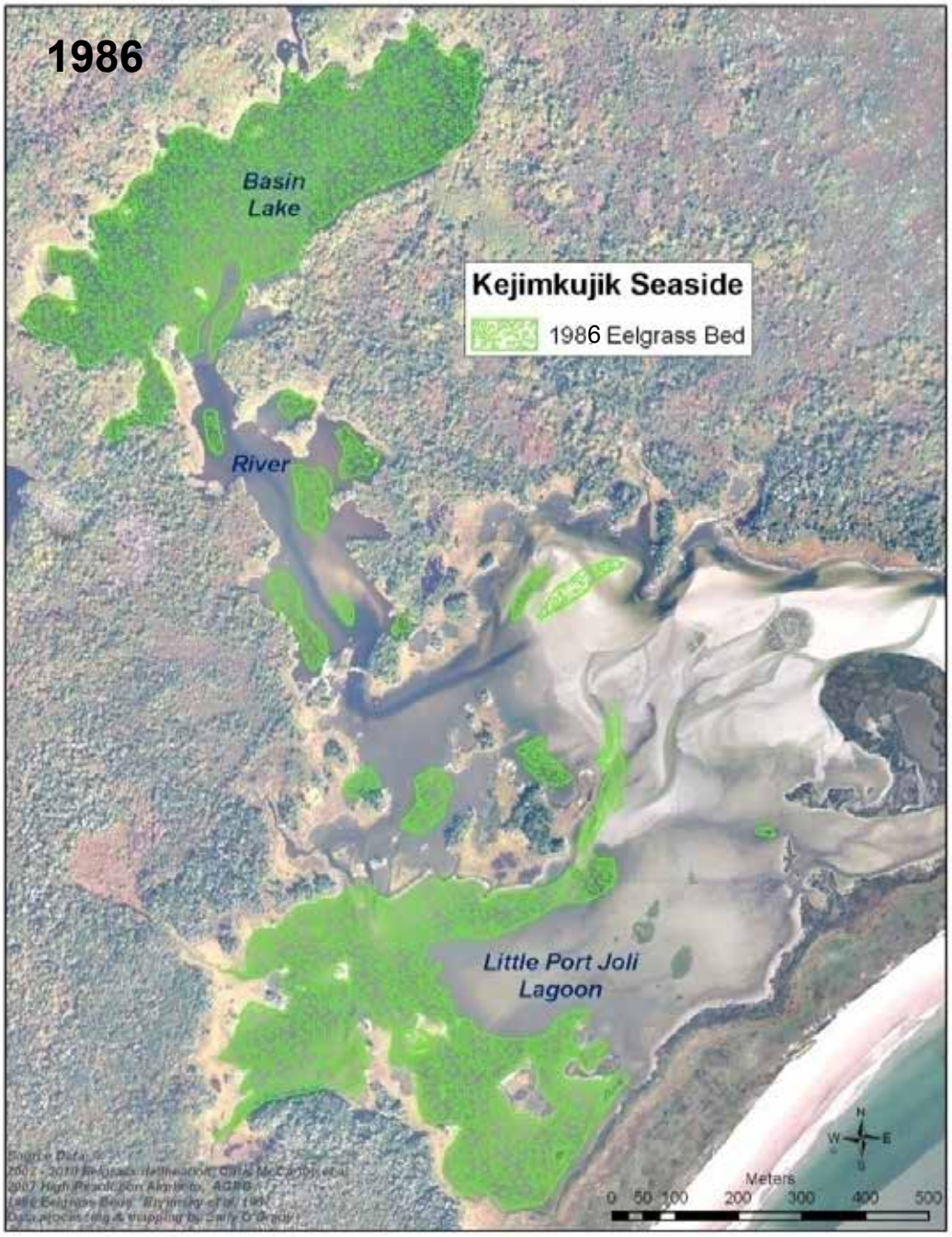
Eelgrass Decline: Effects of Green Crab

Photo by: C. McCarthy

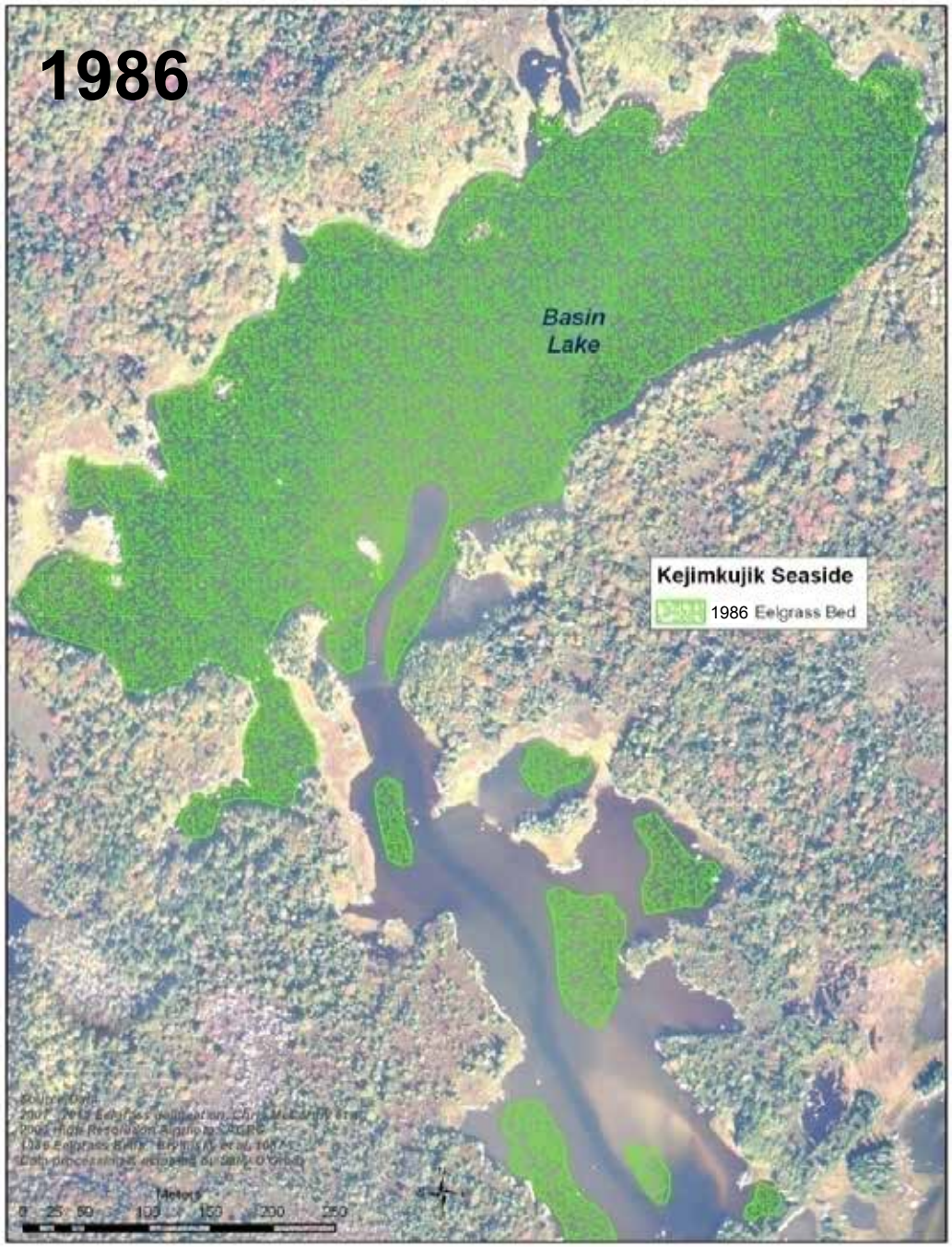
Eelgrass Recovery: Monitoring

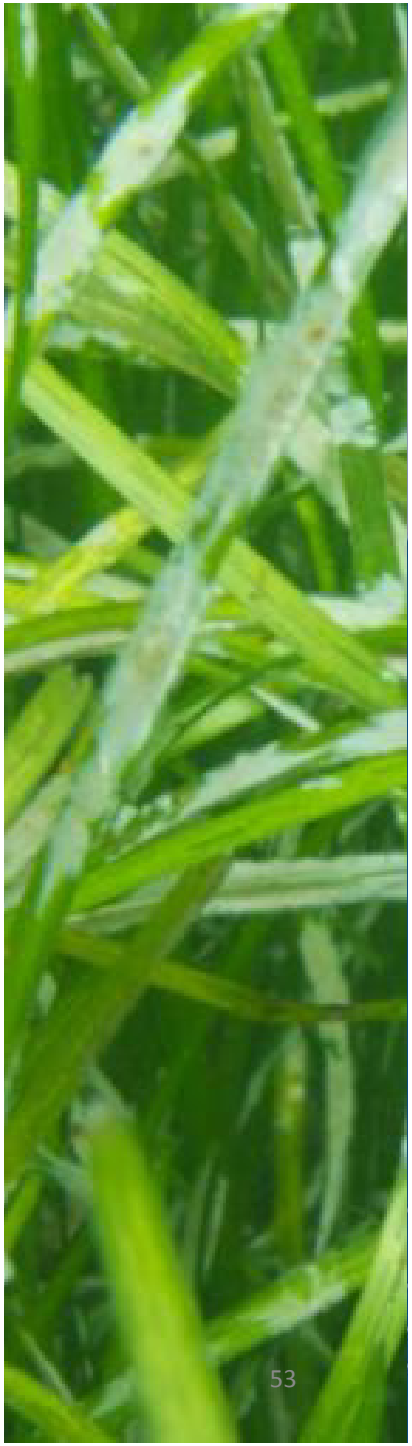
Photo by: A. Pelletier

Photo by: C. McCarthy

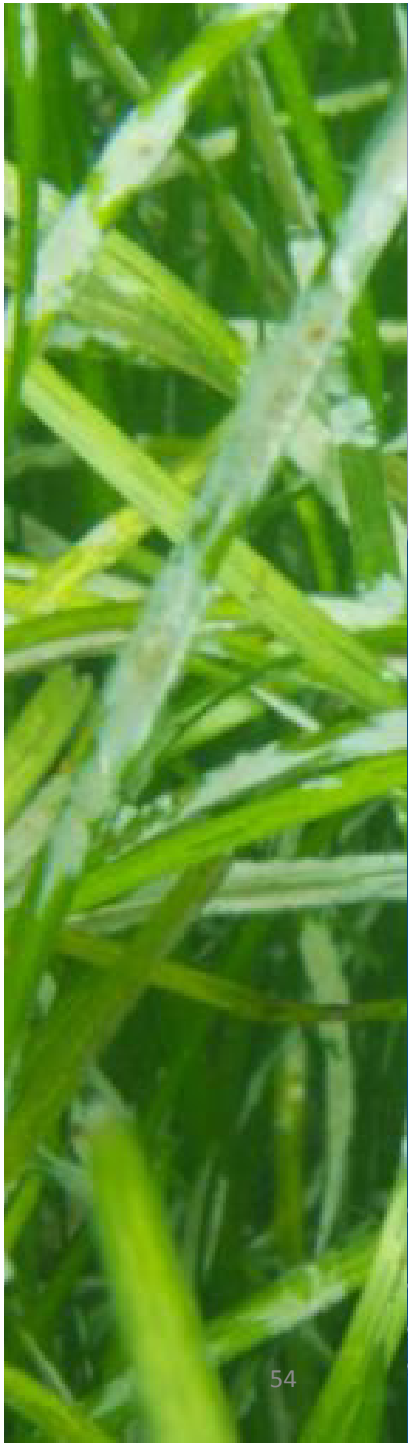


Eelgrass distribution 1986
Little Port Joli Estuary 34.5 ha
(85 acres) (Brylinsky *et al.* 1987)

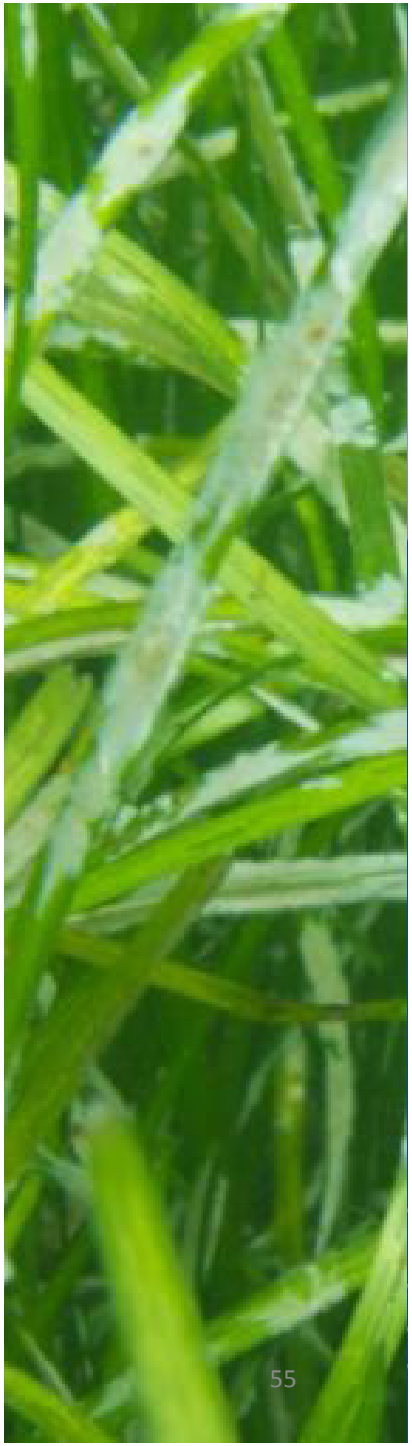

1986
Basin
Lake
Kejimkujik Seaside
1986 Eelgrass Bed



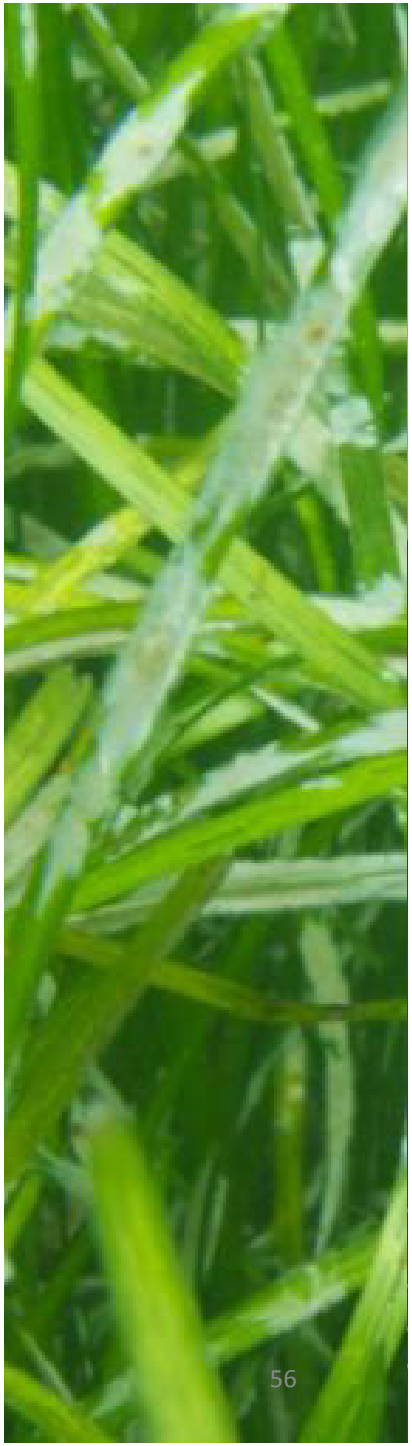

2007
Basin
Lake
Kejimkujik Seaside
2007 Eelgrass Bed
Meters
0 25 50 100 150 200 250




2008
Basin
Lake
Kejimkujik Seaside
2008 Eelgrass Bed
Meters
0 25 50 100 150 200 250




2009
Basin
Lake
Kejimkujik Seaside
2009 Eelgrass Bed
Meters
0 25 50 100 150 200 250

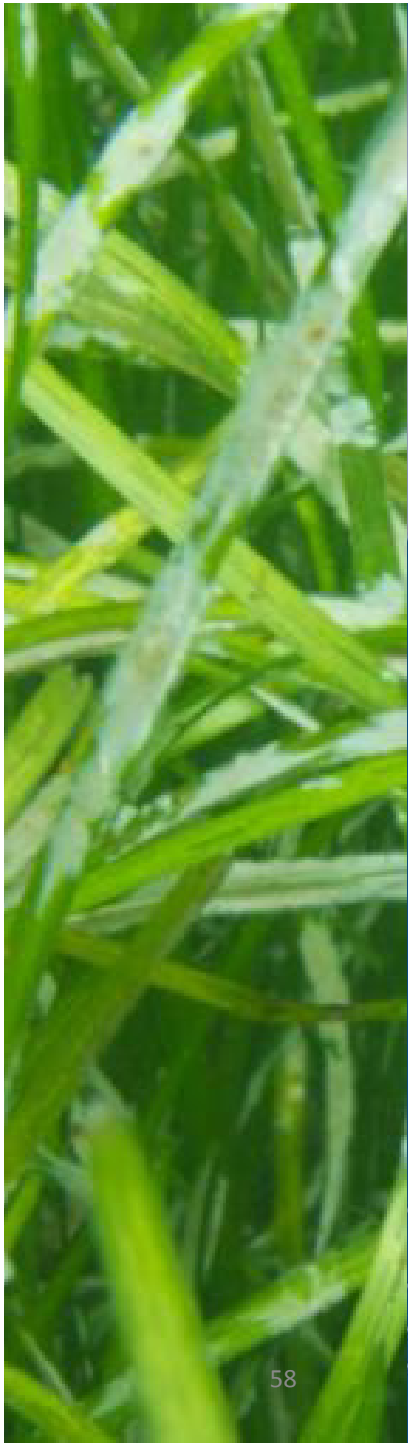


2010

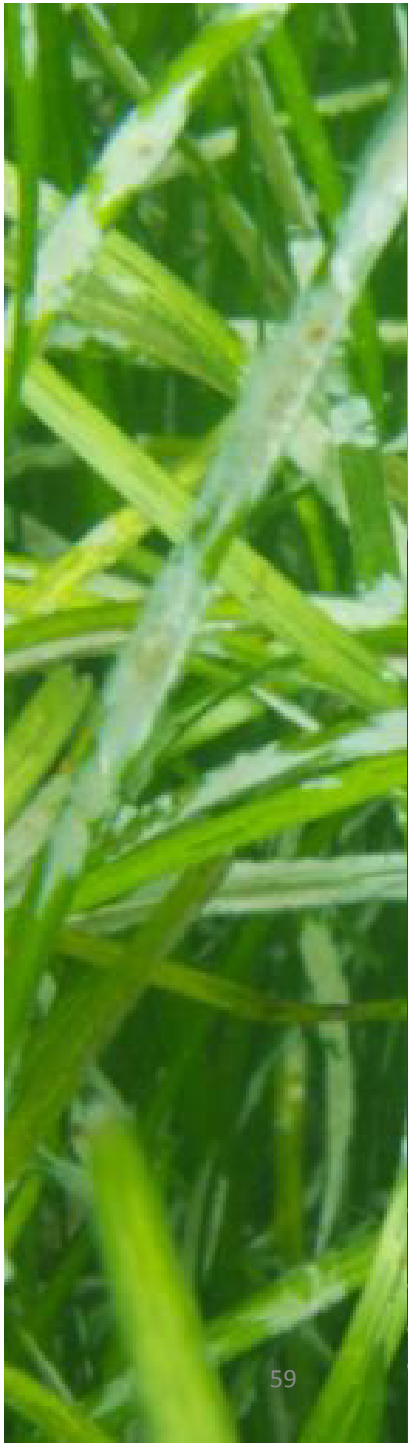
Kejimkujik Seaside

2010 Eelgrass Bed

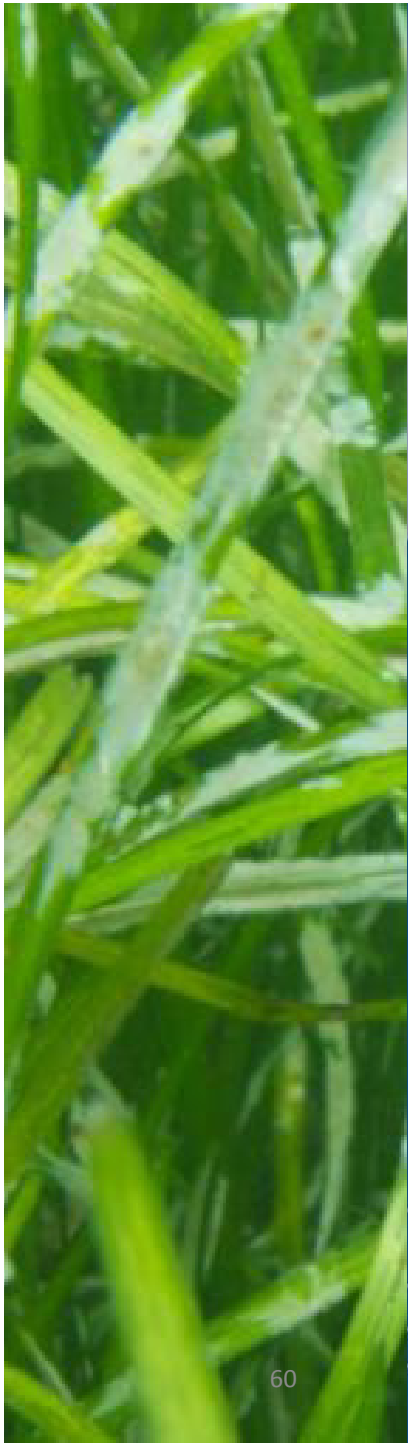

2010
Basin
Lake
Kejimkujik Seaside
2010 Eelgrass Bed



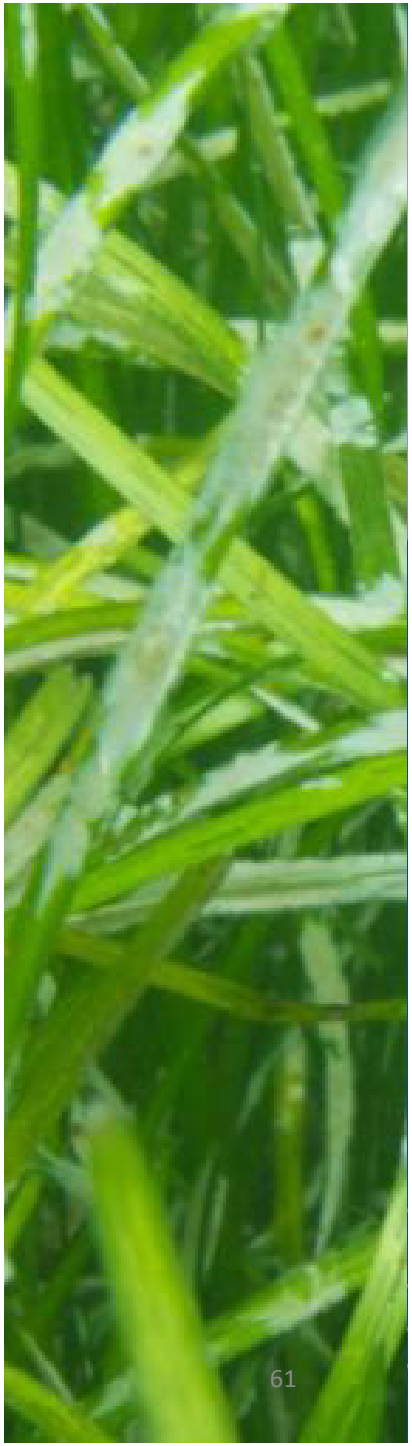

2011
Basin
Lake
Kejimkujik Seaside
2011 Eelgrass Bed



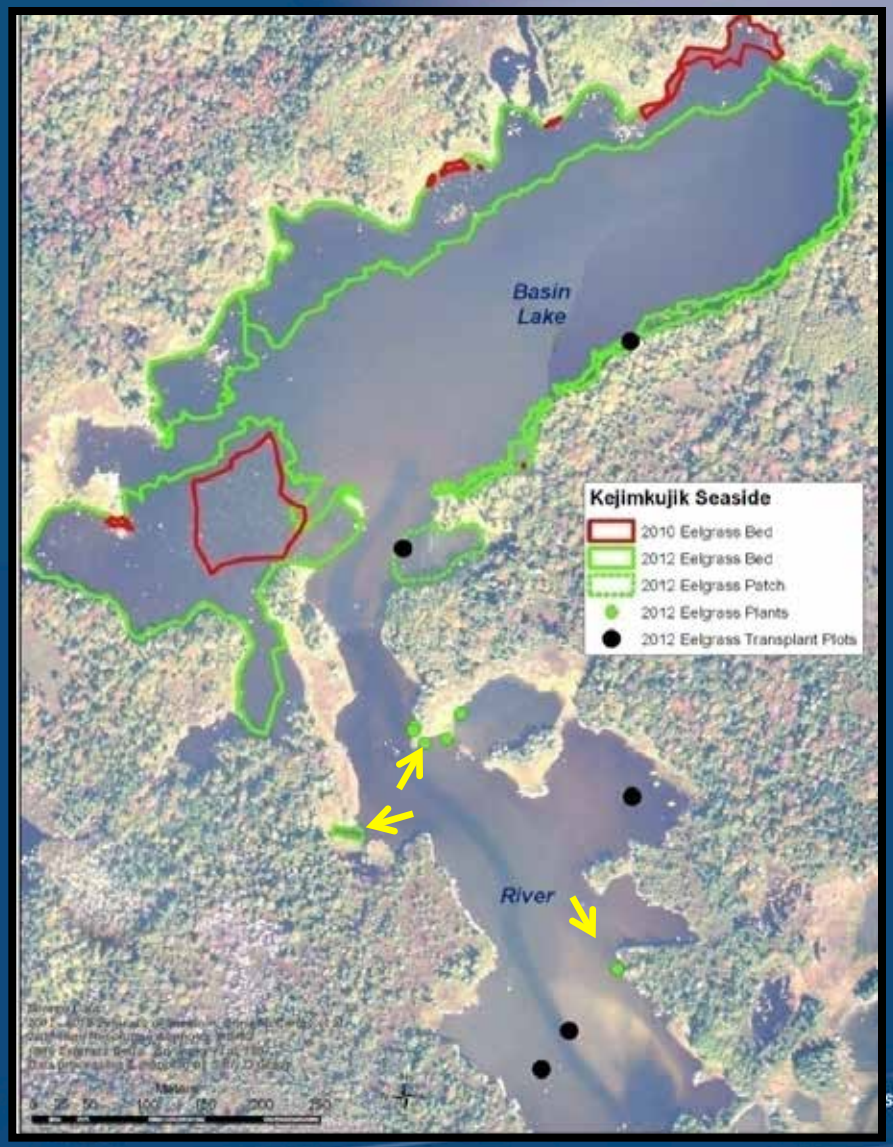

2012
Basin
Lake
Kejimkujik Seaside
2012 Eelgrass Bed
Meters
0 25 50 100 150 200 250



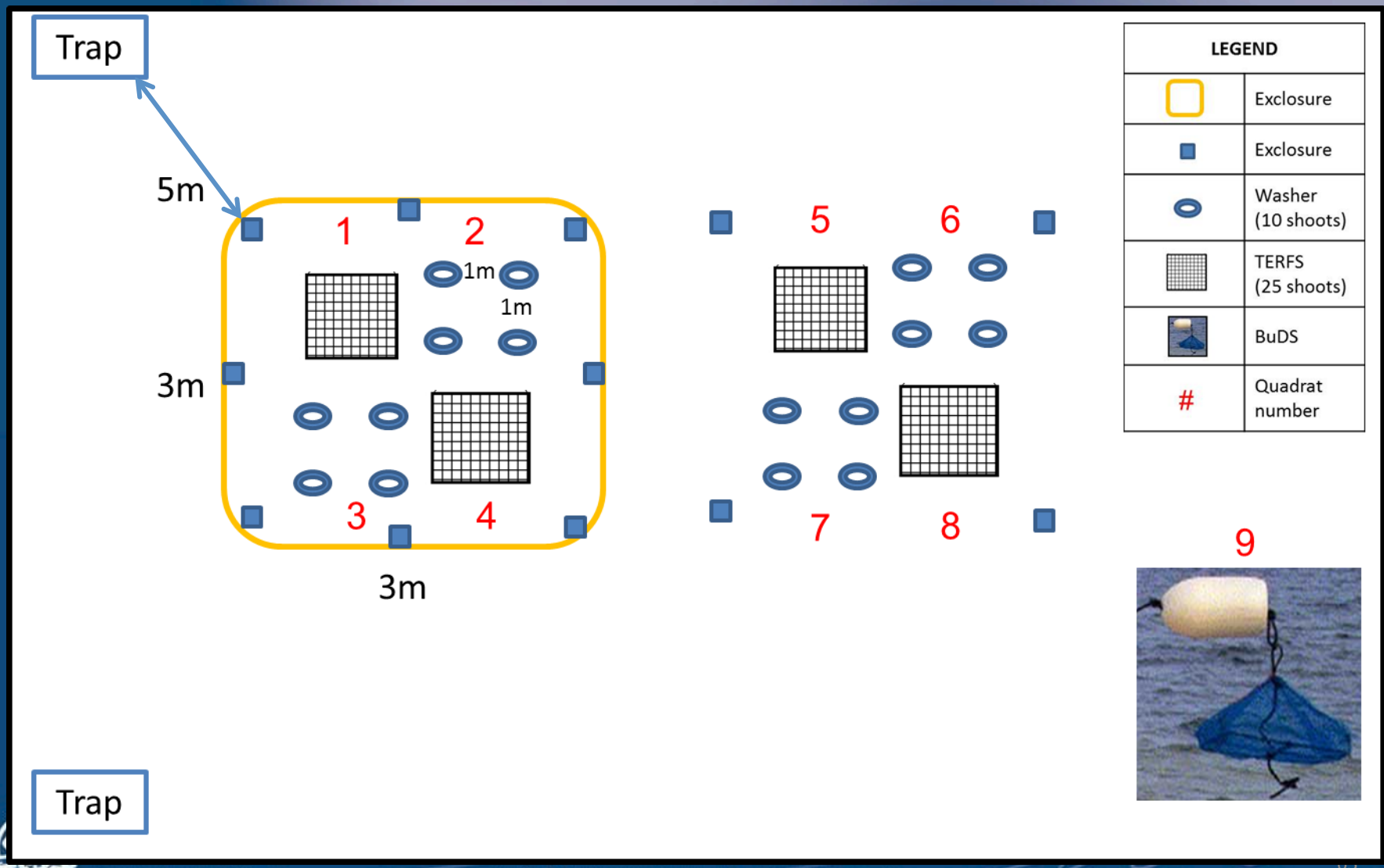

2013
Basin
Lake
Kejimkujik Seaside
2013Eelgrass
Meters
0 25 50 100 150 200 250



Eelgrass Recovery: Transplants



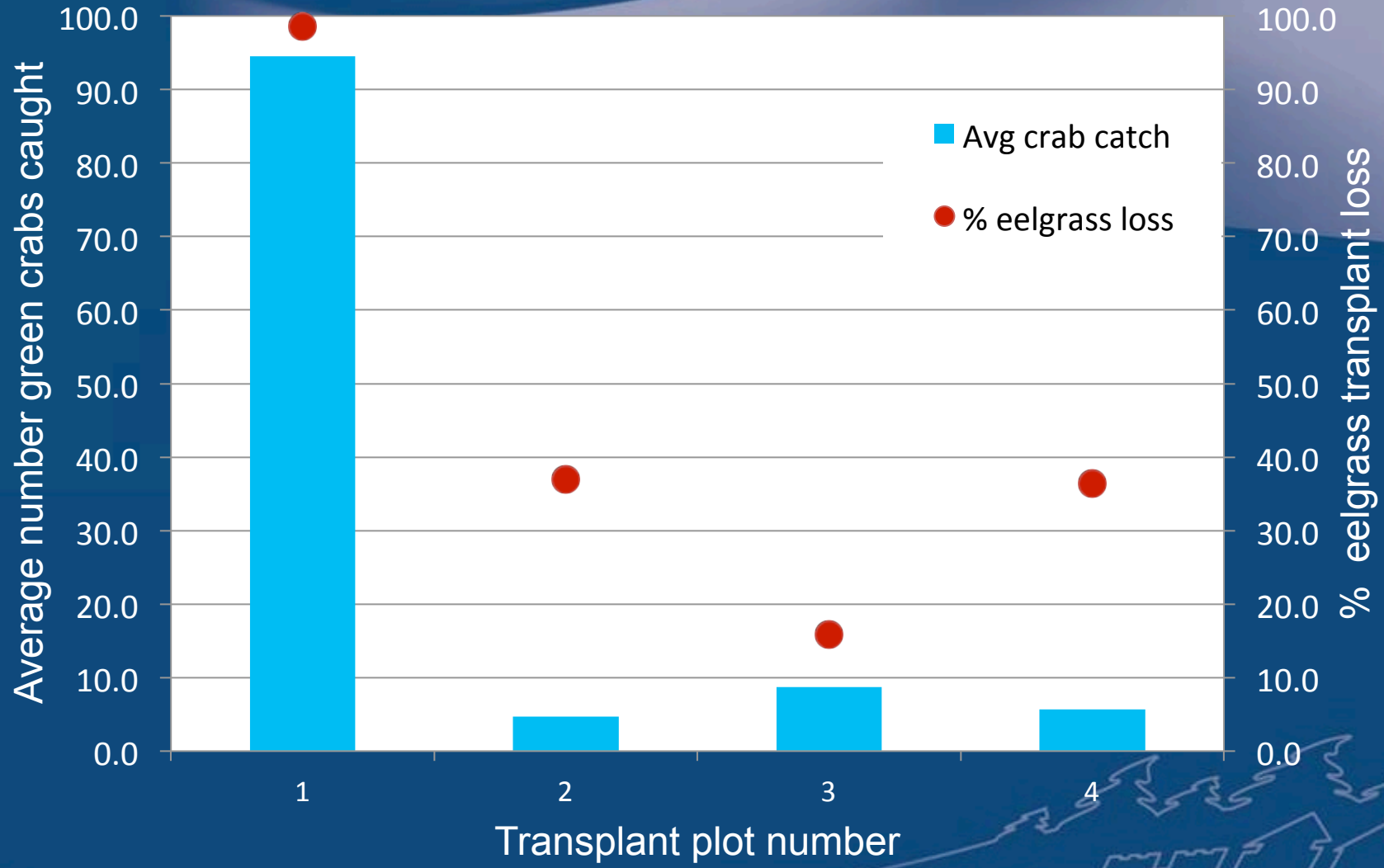
Eelgrass Transplants: Sample Design



Average Green Crab Catch vs Eelgrass Loss

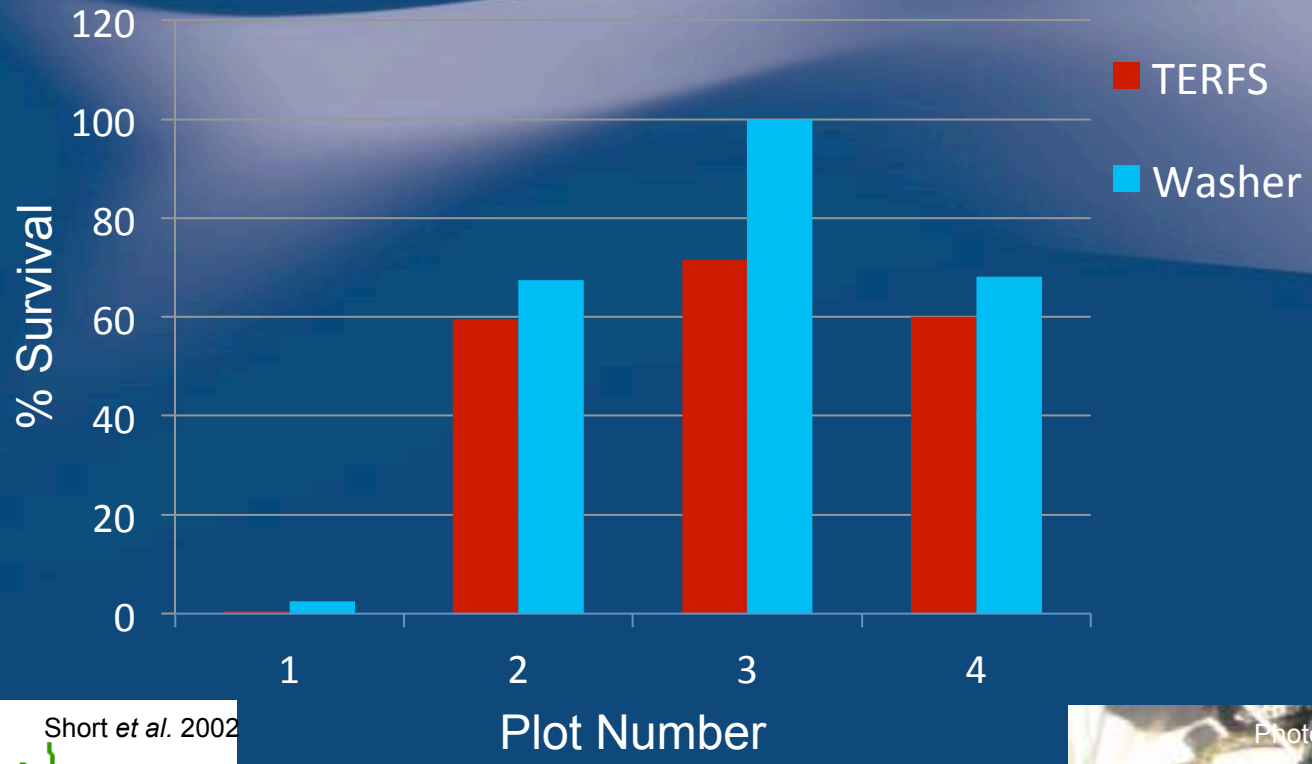
Eelgrass Transplant Plots Little Port Joli

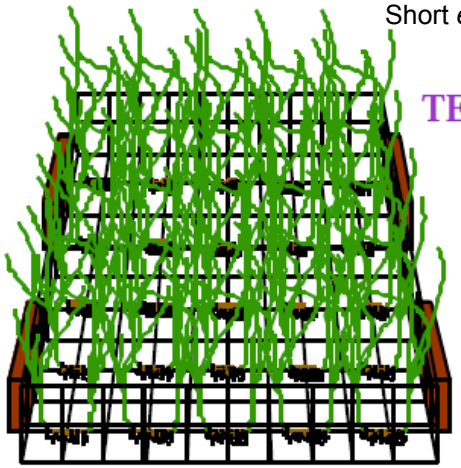
2012



Transplant Methodology Survival Rate

Little Port Joli
2012



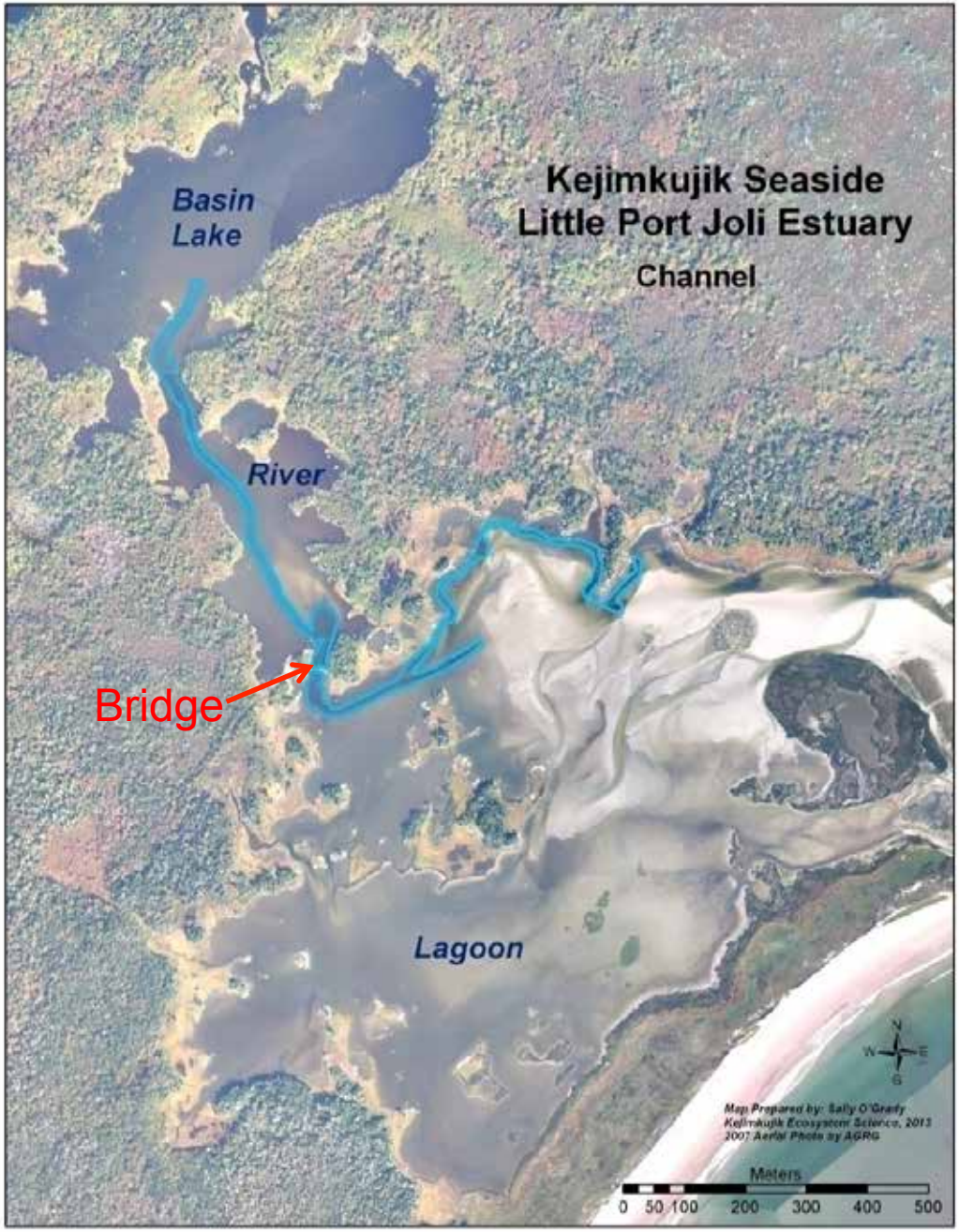


Short *et al.* 2002

TERFS™

Photo by: Durance 2011

Washer technique



-**How to fish more efficiently:**

- double baiting
- glory holes
- channel vs shallows
- involve local fishers!

Hydrology / Water Quality:
Little Port Joli Bridge

Now you see it...

Photo by: D. Pouliot

Now you don’t

Photo by: C. McCarthy

New Invader: Chesapeake Blue Crab

Terminator 2?

www.naturalnorthflorida. com

www.weddingbee.com

Terminator 3?

Photo by: D. Reid

Summary of Major Findings

- More crabs than we thought
- Disposal challenges / Income potential a major factor
- Trapping has reduced green crab catch per unit effort
- Average green crab size has decreased as fishing proceeds
- Green crab favourable habitat identification (hotspots)
- With green crab control:
    - By-catch increased in relative abundance
    - Eelgrass distribution and condition has improved
    - Eelgrass transplants successful (Washers & TERFS)
- Ecosystem approach yields bigger returns
- Can decrease initially… long term... still lots to learn

Future Coastal Recovery Components

- Continue EI monitoring measures: dune and salt marsh dynamics, water quality, green crab abundance, eelgrass distribution, soft-shell clam size class composition, plover mgt success
- Monitor effects and implement sustainable maintenance schedule
- Follow-up eelgrass transplanting to increase distribution
- Enhance soft-shell clam size class distribution with seeding trials
- Continue monitoring Little Port Joli Bridge removal restoration

The crabs are in the bucket!

Volunteer and Educational Experiences

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Schwartzencrab Photo (scraps20.com)