The Green Crab Invasion: Impacts in Southern Maine Marshes

Kristin Wilson[1], Jeremy Miller[1], Earl Davey[2], Jacob Aman[1], Dan Belknap[3]
[1]Wells National Estuarine Research Reserve, [2]Atlantic Ecology Division United States Environmental Protection Agency, [3]School of Earth & Climate Sciences University of Maine


WEST COAST
Padilla Bay, Washington
South Slough, Oregon
San Francisco Bay, California
Elkhorn Slough, California
Tijuana River, California
Kachemak Bay, Alaska
NOAA
NATIONAL ESTUARINE RESEARCH RESERVE SYSTEM
Lake Superior, Wisconsin
GREAT LAKES
Old Woman Creek, Ohio
NORTHEAST
Wells, Maine
Great Bay, New Hampshire
Hudson River, New York
Waquoit Bay, Massachusetts
Narragansett Bay, Rhode Island
MID ATLANTIC
Jacques Cousteau, New Jersey
Delaware
Chesapeake Bay, Maryland
Chesapeake Bay,Virginia
SOUTHEAST
North Carolina
North Inlet-Winyah Bay, South Carolina
ACE Basin, South Carolina
Sapelo Island, Georgia
Weeks Bay, Alabama
Grand Bay, Mississippi
Guana Tolomato Matanzas, Florida
Apalachicola, Florida
Mission-Aransas,Texas
Rookery Bay, Florida
GULF OF MEXICO
CARIBBEAN
Jobos Bay, Puerto Rico

wellsreserve
Wells National Estuarine Research Reserve

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Wells National Estuarine Research Reserve, Wells, Maine

wellsreserve
at laudholm
Wells National Estuarine Research Reserve
342 Laudholm Farm Road, Wells, Maine
wellsreserve.org 207-646-1555

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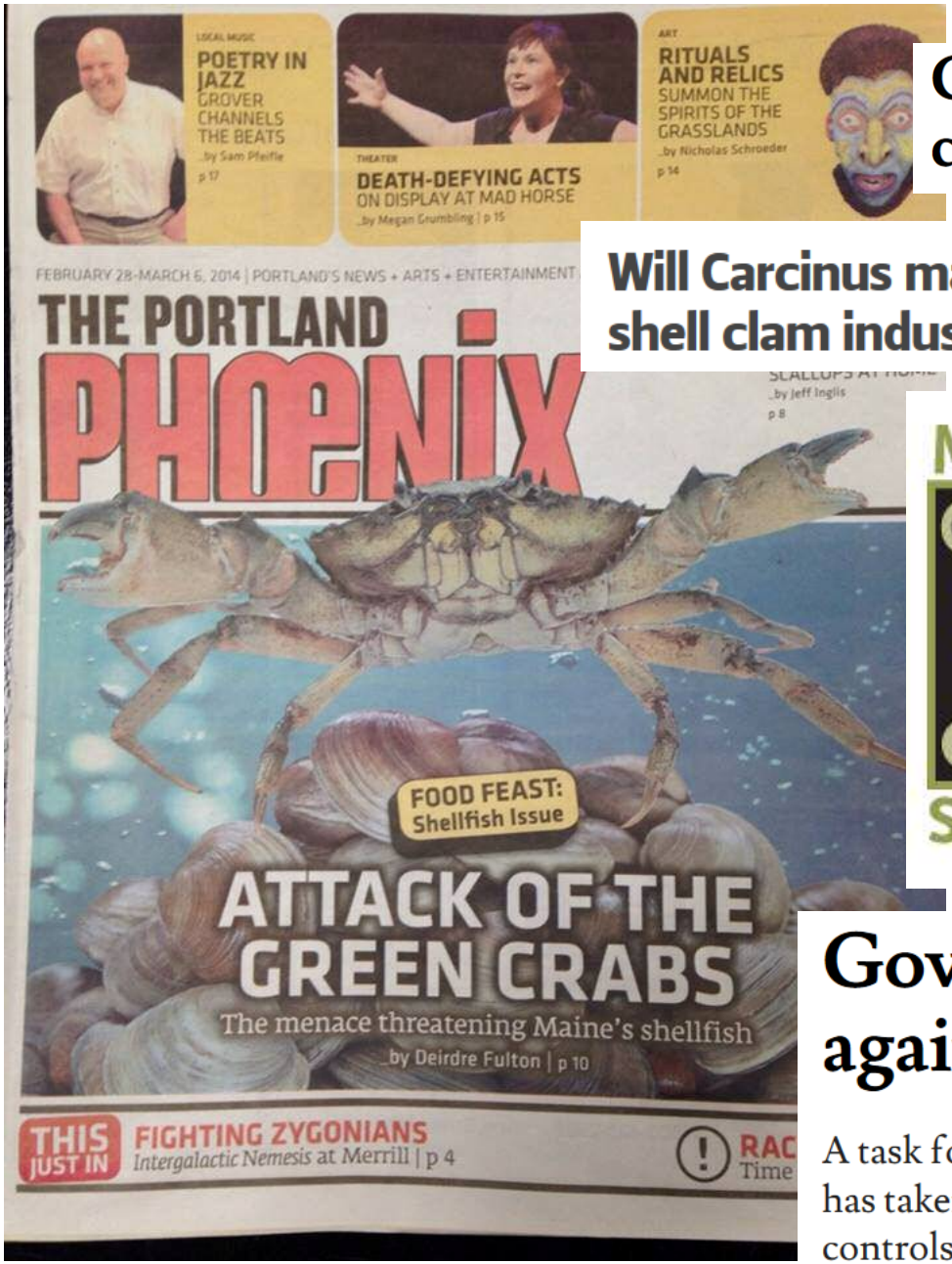


Green crabs overtaking Maine's clam flats

Will Carcinus maenas destroy Maine's $15 million soft-shell clam industry?

MAINE GREEN CRAB SUMMIT

Fishermen try to rid Maine's Frenchman Bay of green crabs

"Green crabs are a calamity."

Gov. LePage orders action against invasive green crabs

A task force will study the impact of the European species that has taken a bite out of Maine's bivalve fishery and develop controls.

Basic Ecology

- One of the world's most successful aquatic invaders (Darling *et al* 2008)
- Adult size can reach 6 cm in length and 9 cm wide! (Our range was 1.8 - 8.7cm carapace width)
- Omnivore with a wide tolerance for salinity variation, water temperature and habitat types (Klassen & Locke, 2007)
- Adults can tolerate temperatures ranging from 0 to 33°C, salinities from 4 to 54, starvation for up to 3 months, and air exposure in damp burrows for up to 10 days (Bravo, Cameron & Metaxas, 2007)
- Considered responsible for significant impacts on epibenthic and infaunal species, such as bivalves, and crustaceans, through predation, competition, and burrowing activities (Bravo, 2007)

"Maquoit Bay used to have over five hundred hectares of eelgrass. Now there is none left in the intertidal zone." –Hilary Neckles, USGS

ECOSYSTEM IMPACTS

Penobscot, ME

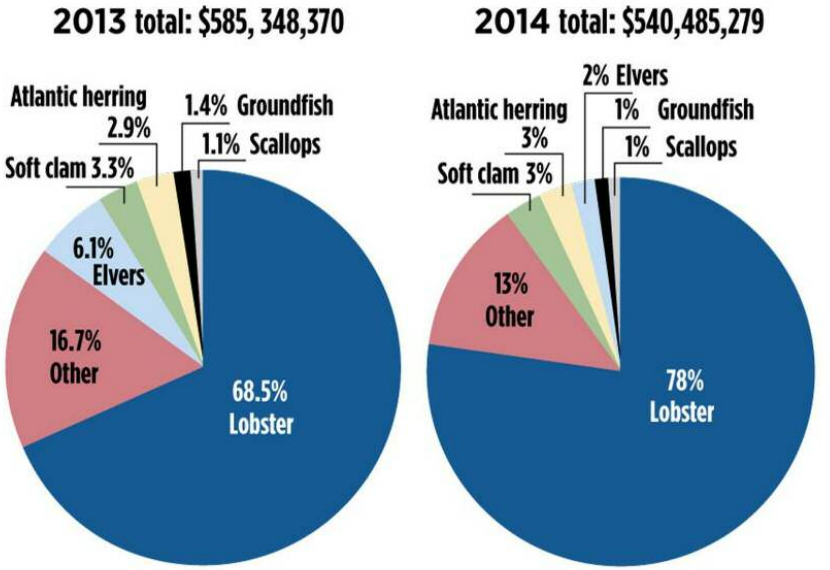
Penobscot Shellfish Conservation Committee

ECONOMIC IMPACTS

~$17.5 million

Commercial landings in Maine Portland Press Herald

The overall value of Maine's fishing industry rose by more than $40 million from 2013 to 2014. Lobsters continued to lead the way with more than $457 million landed while elvers lost their No. 2 spot, falling from $33 million in 2013 to $8.4 million last year.



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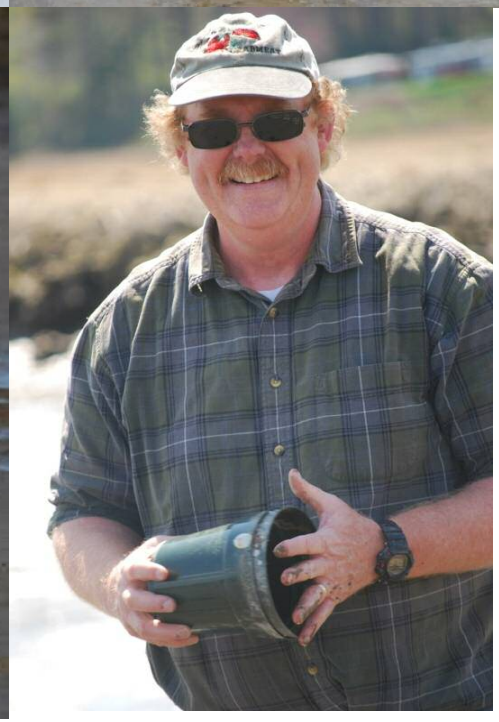
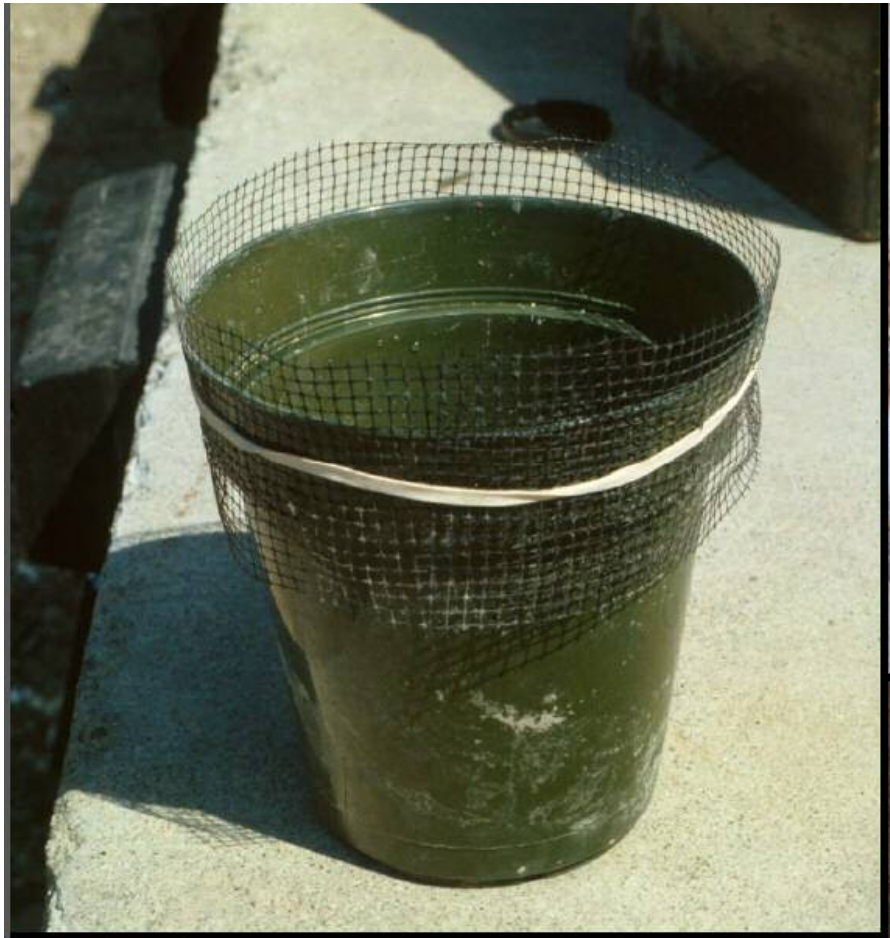
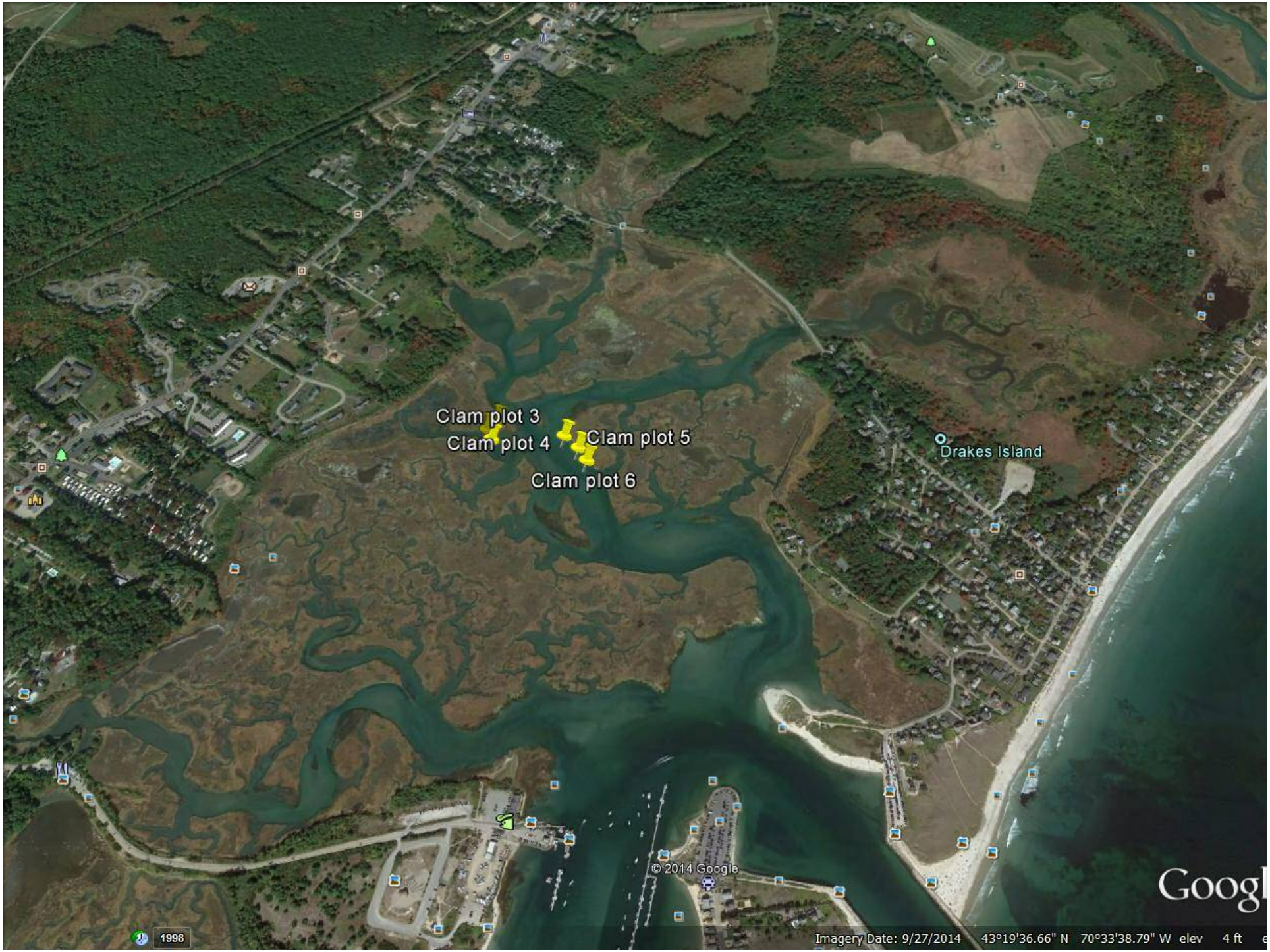
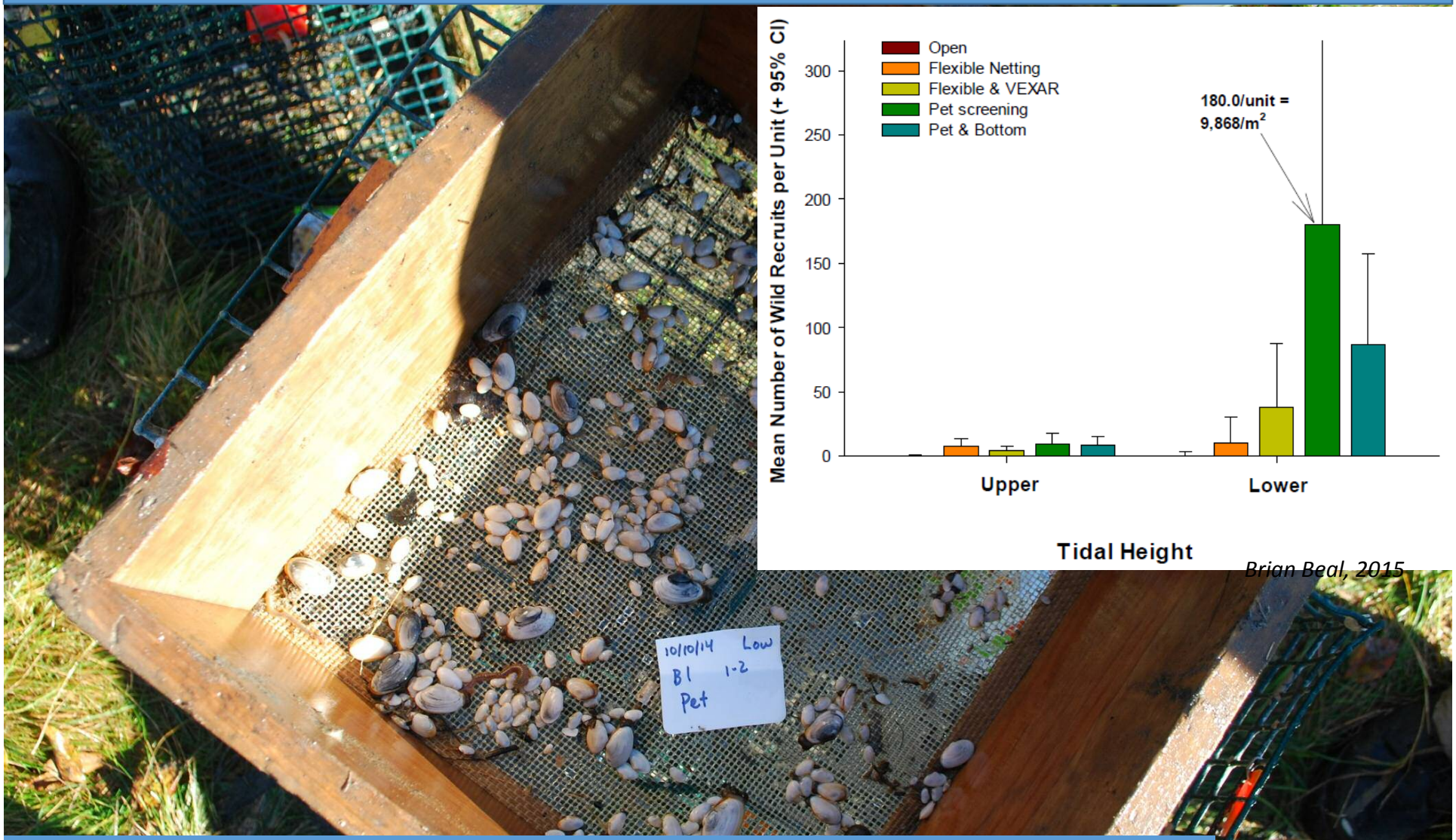


Dr. Brian Beal
Downeast Institute




Clam plot 3
Clam plot 4
Clam plot 5
Clam plot 6
Drakes Island
© 2014 Google
1998
Imagery Date: 9/27/2014 43°19'36.66" N 70°33'38.79" W elev 4 ft


9/10/14 Low
B3 2-1
Open



Brian Beal, 2015

"we retained all the living clams PLUS 467 wild 0-year class recruits that ranged in size from 2.5 mm to 13.0 mm. In the control pots (without any protective netting), the highest number of wild recruits was two." –Brian Beal

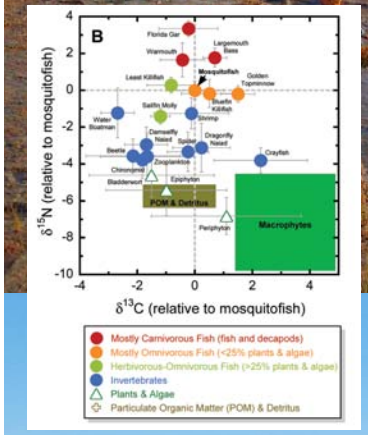

Wells, Maine

Harpswell, Maine

http://www.harpswell.maine.gov/vertical/Sites/%7B3F690C92-5208-4D62-BAFB-2559293F6CAE%7D/uploads/Green_crab_burrows_in_salt_marsh(1).JPG

fyke netting

trapping



stable isotopes

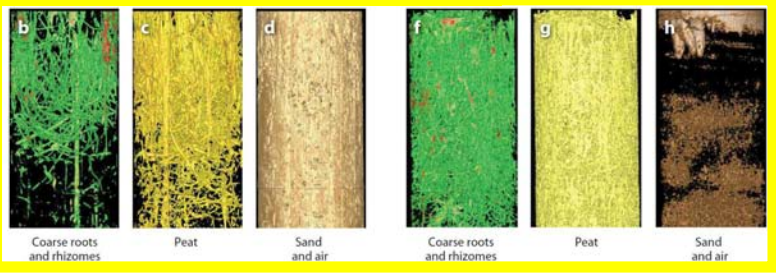
BIOLOGICAL MEASUREMENTS

modified, shallow SETs

15 min. water quality data

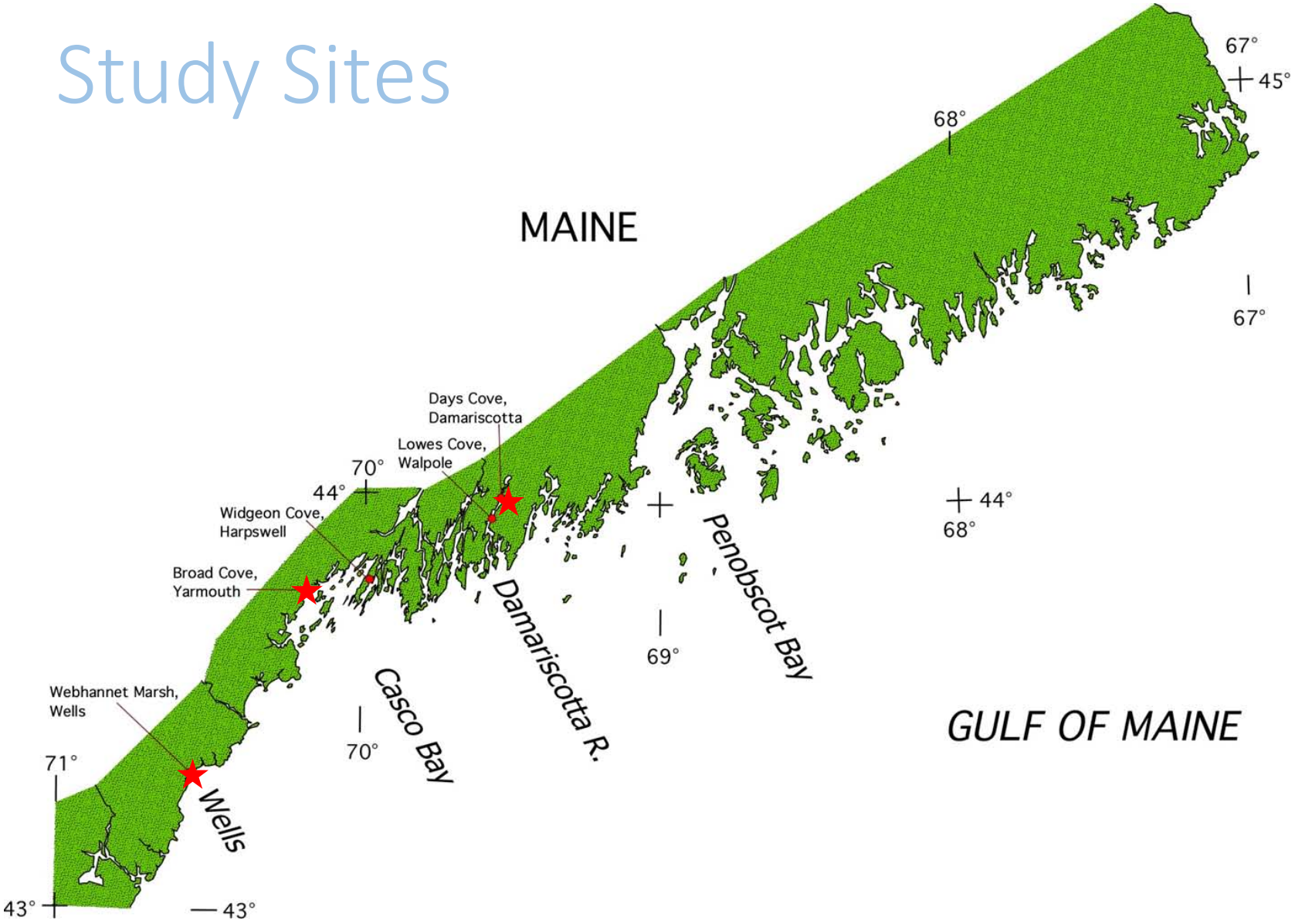
shear vane strength

stake arrays



BIOPHYSICAL MEASUREMENTS

Study Sites

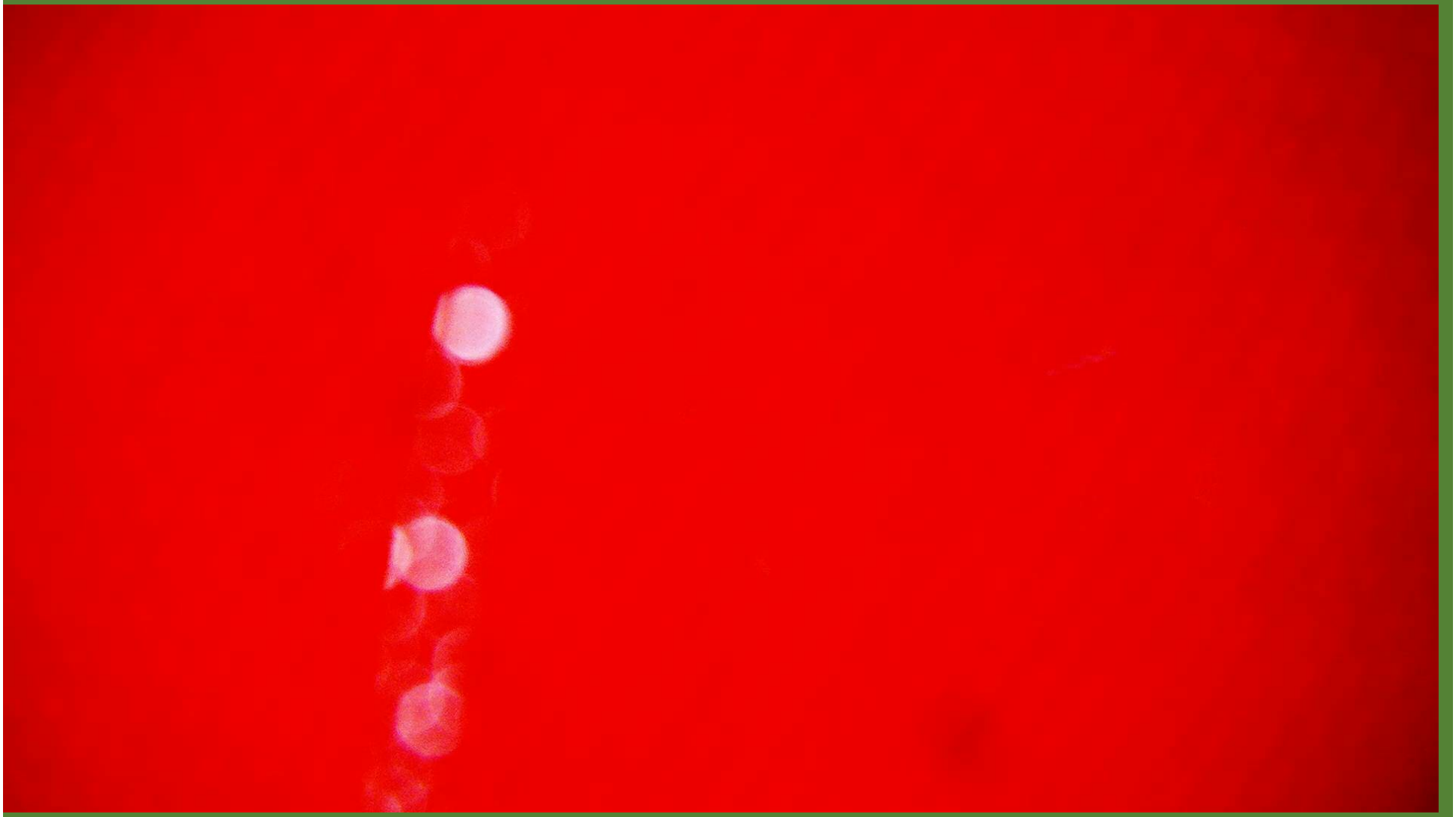


Graphic: Dan Belknap

TRAPPING AND FYKE NETTING

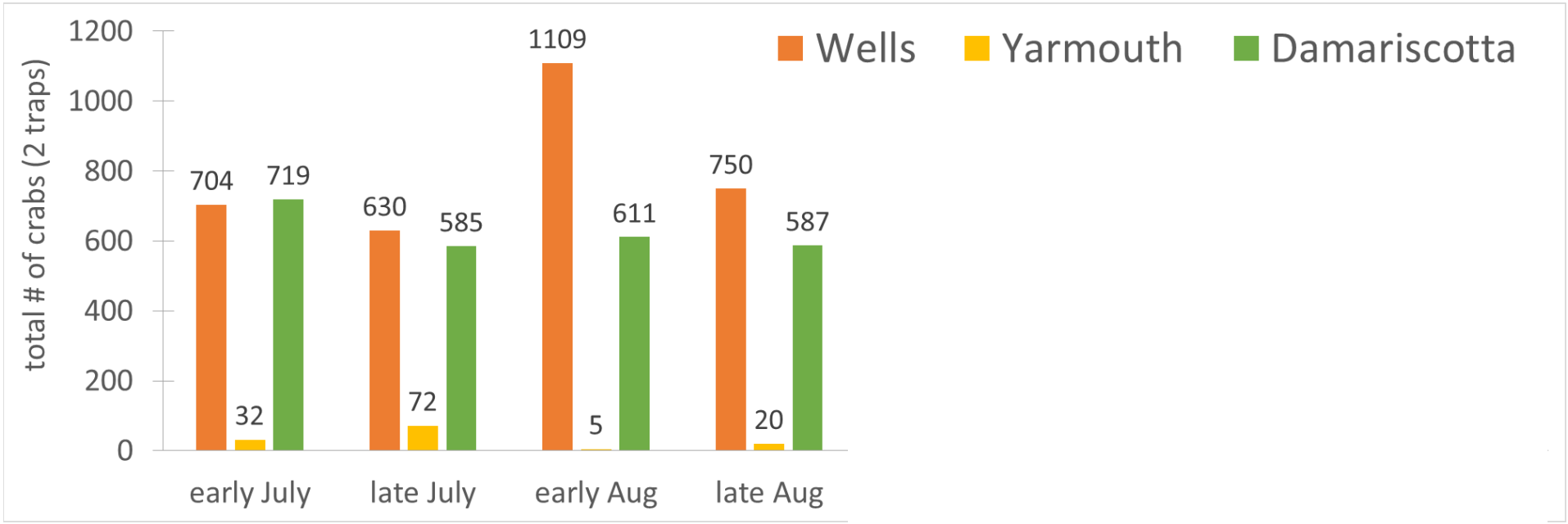
Days Cove, Damariscotta, October 2, 2014

https://www.youtube.com/watch?v=-oIH6F5Cjg0

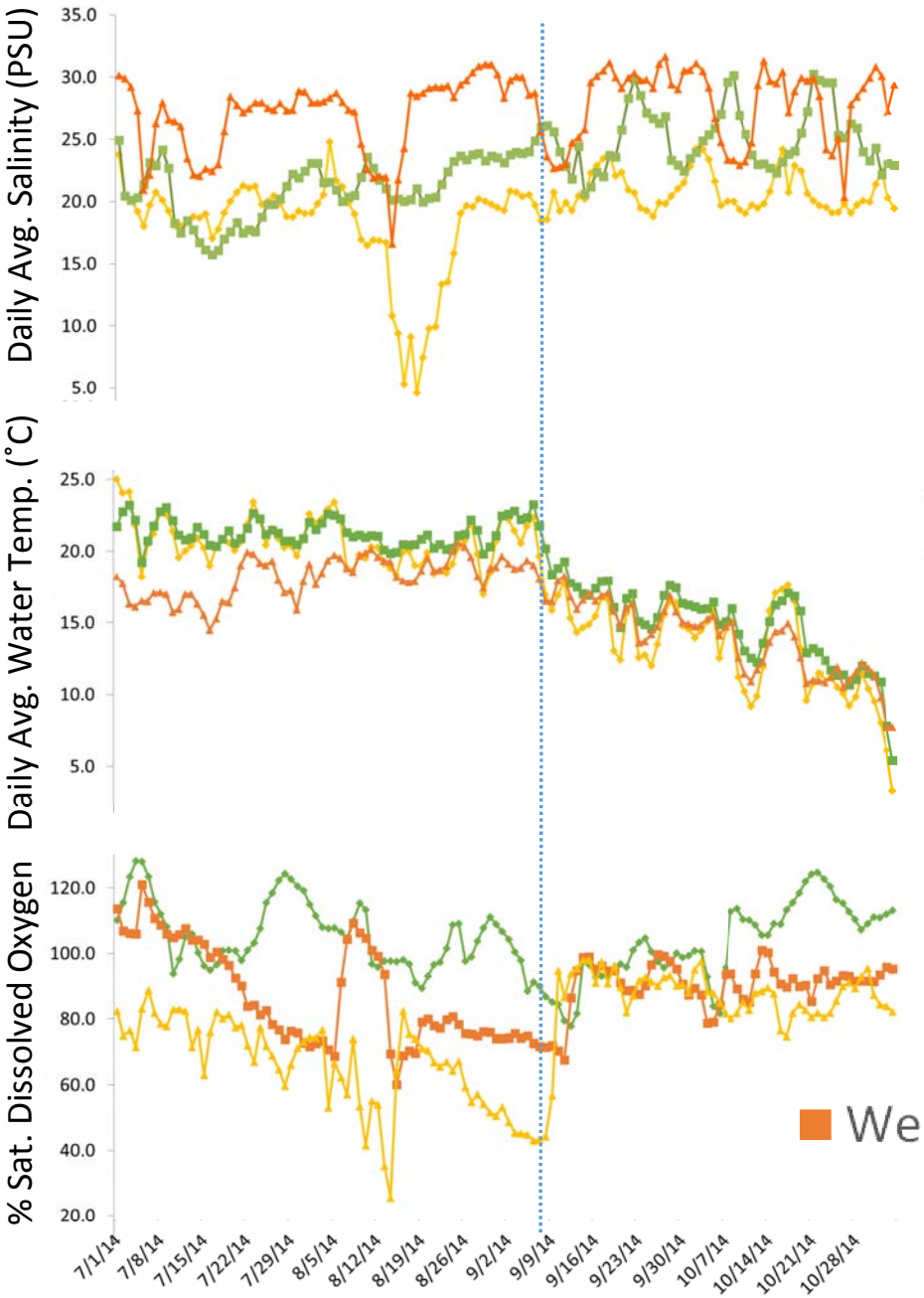


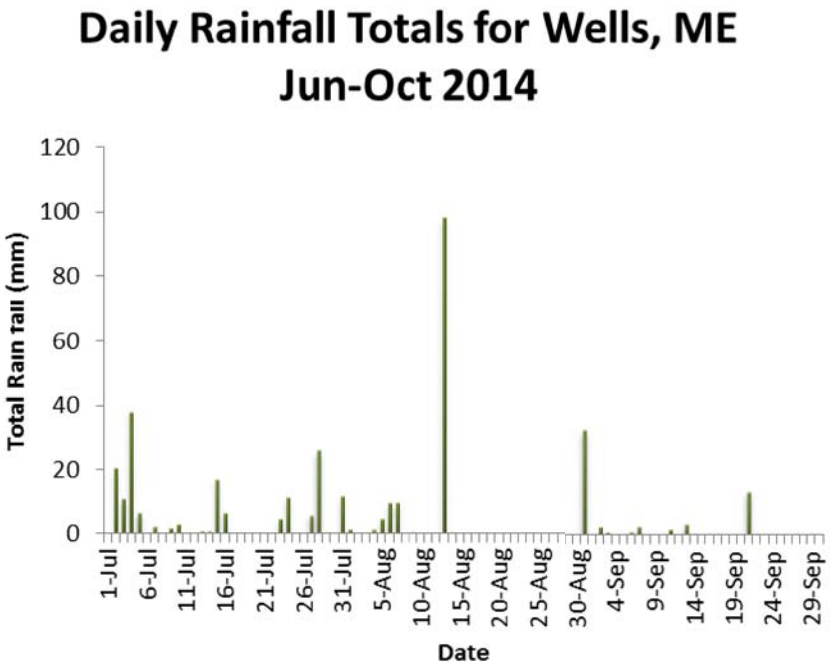
From June-October 2014, **12,524** crabs trapped, all sites combined.


DAMARISCOTTA
YARMOUTH
WELLS



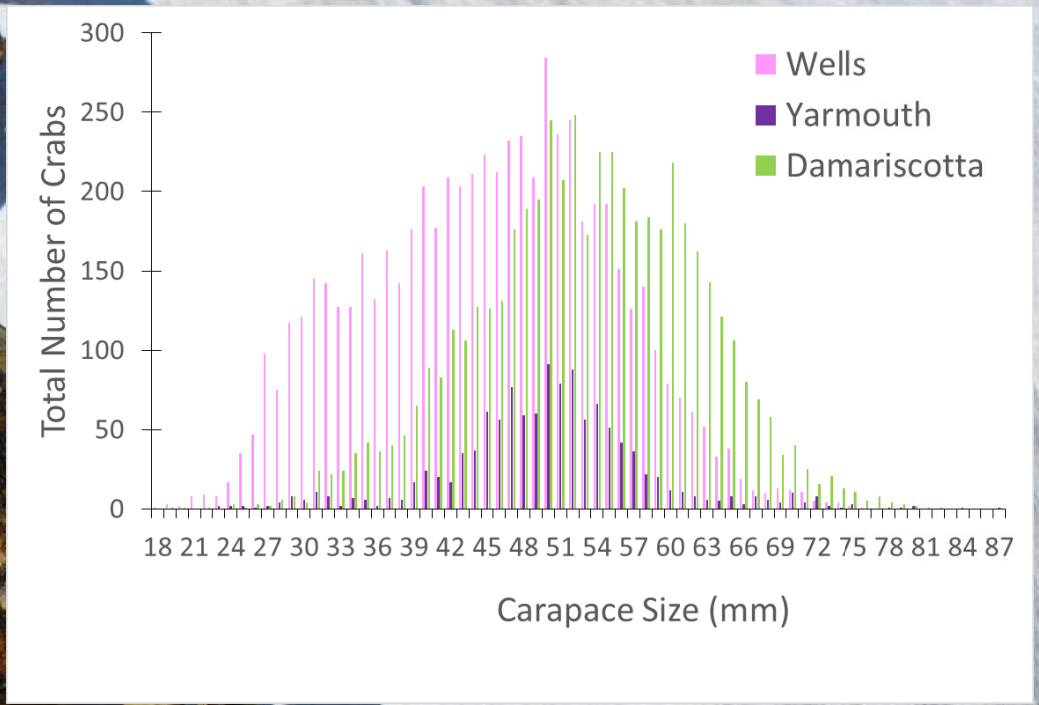
- Wells and Damariscotta: high, but variable catches
- Yarmouth: extremely low catches, until…



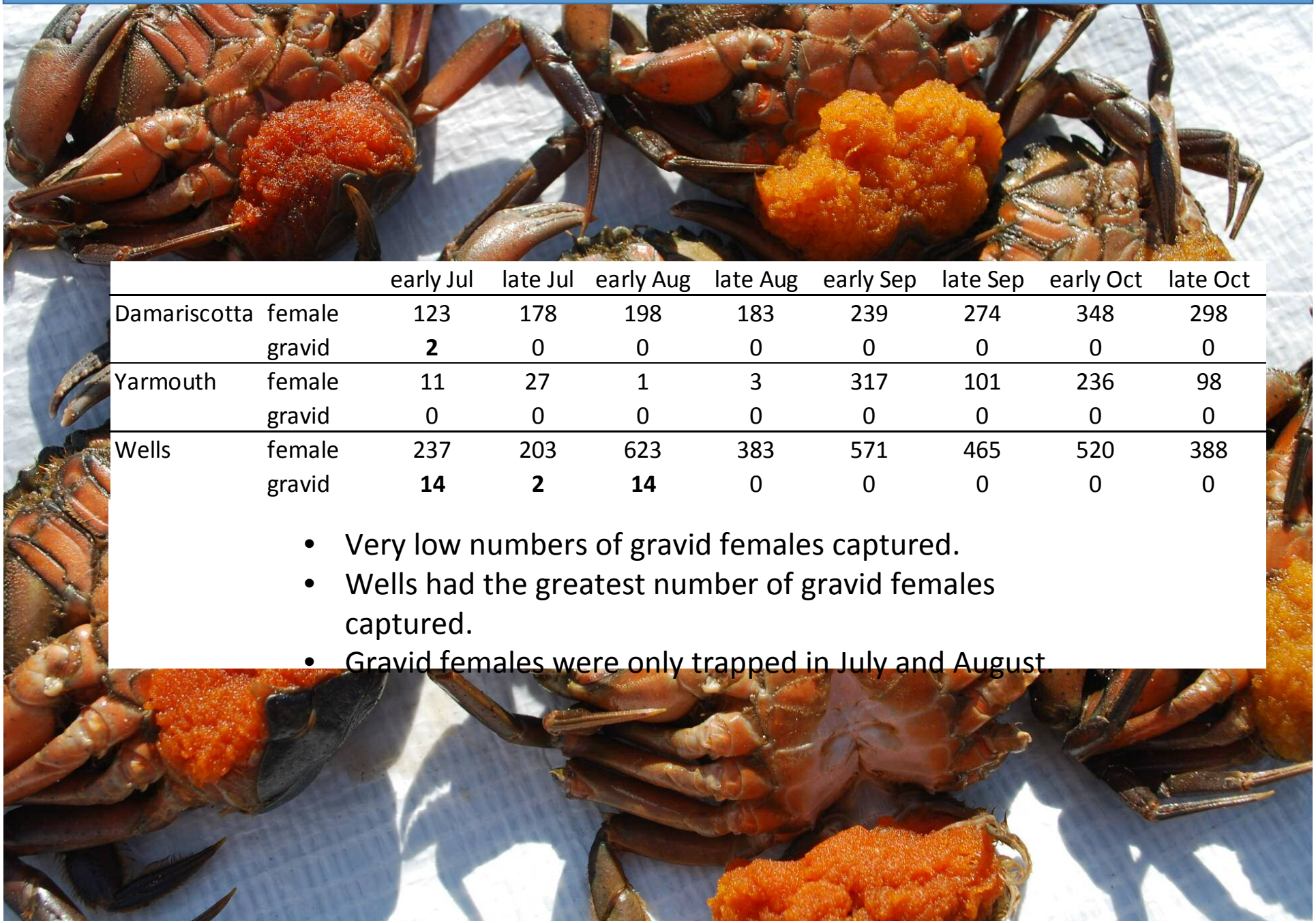


Wells Yarmouth Damariscotta

Wells



Damariscotta, Yarmouth

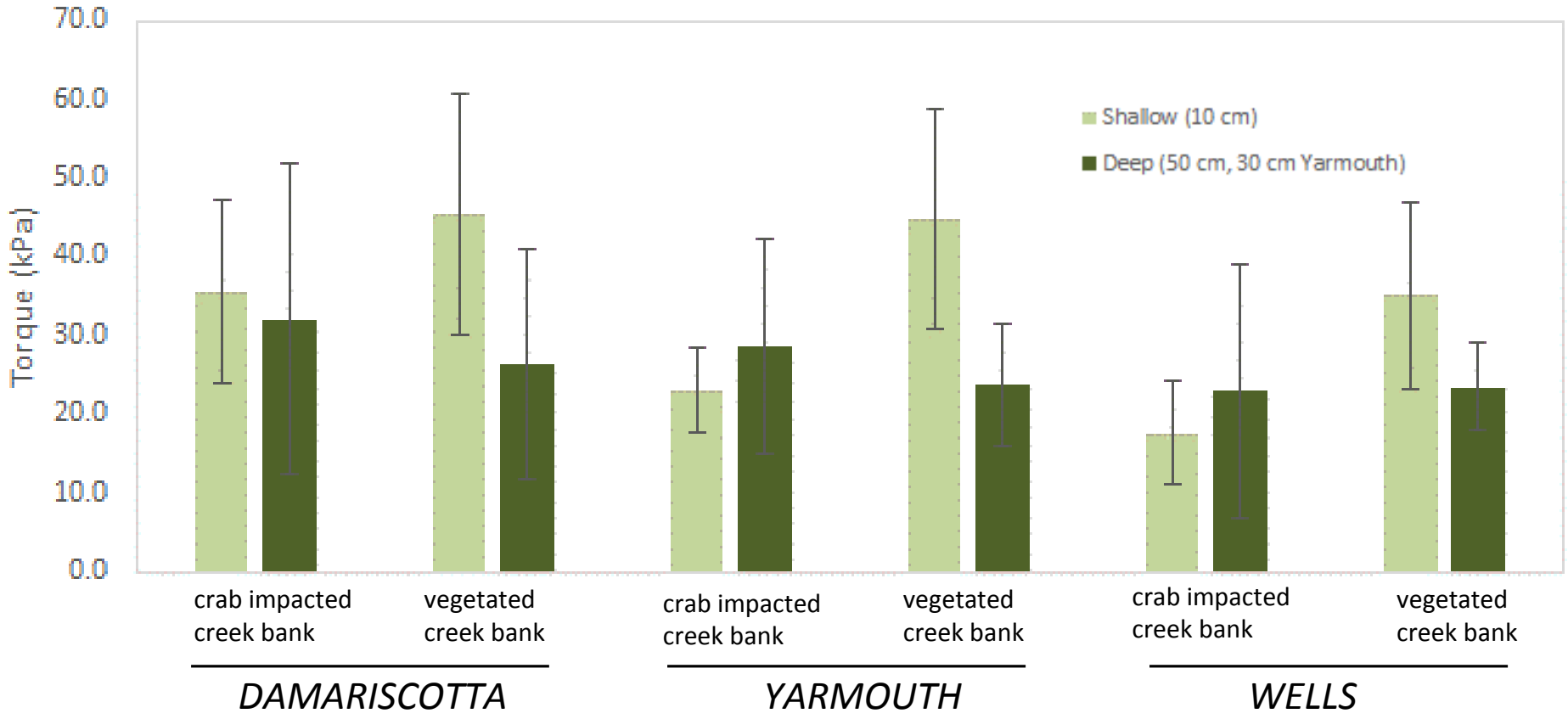


		early Jul	late Jul	early Aug	late Aug	early Sep	late Sep	early Oct	late Oct
Damariscotta	female	123	178	198	183	239	274	348	298
	gravid	**2**	0	0	0	0	0	0	0
Yarmouth	female	11	27	1	3	317	101	236	98
	gravid	0	0	0	0	0	0	0	0
Wells	female	237	203	623	383	571	465	520	388
	gravid	**14**	**2**	**14**	0	0	0	0	0

- Very low numbers of gravid females captured.
- Wells had the greatest number of gravid females captured.
- Gravid females were only trapped in July and August.

MARSH IMPACTS

Peat Stability Measurements



- In healthy marsh, shallow peat was stronger than deeper peat; in the crab impacted creek bank, there was no difference with depth.
- Crab impacted creek banks were more erodible than healthy, reference sites.
- Wells appears to be more erodible than other sites.

Cores

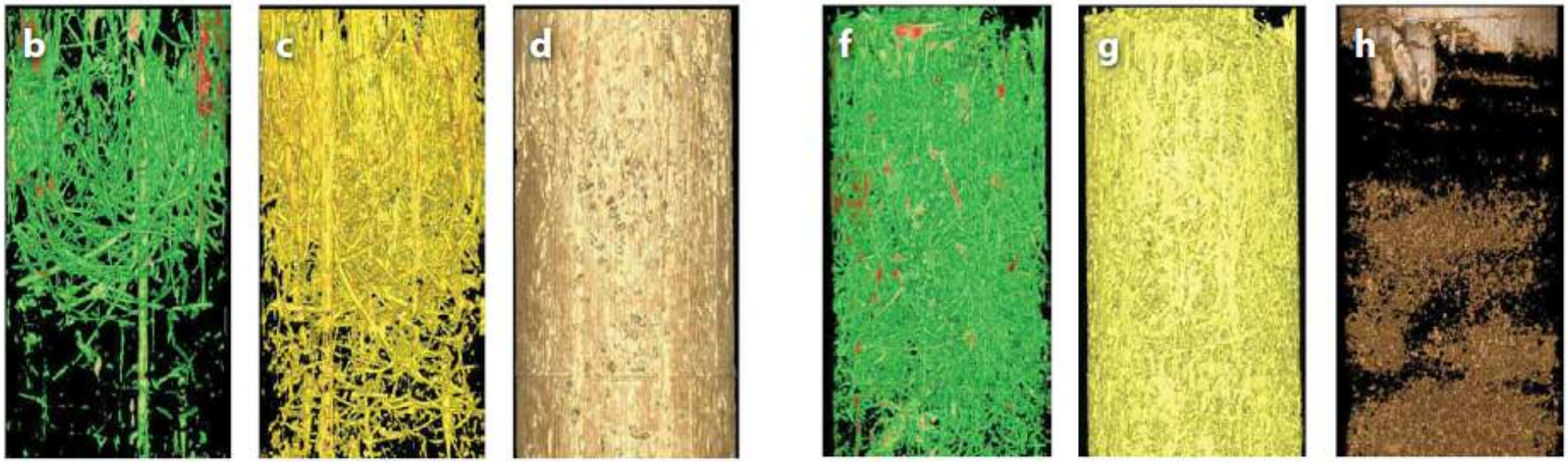
Ecological Applications, 21(6), 2011, pp. 2156–2171

Use of computed tomography imaging for quantifying coarse roots, rhizomes, peat, and particle densities in marsh soils

EARL DAVEY,[1] CATHLEEN WIGAND,[1,4] ROXANNE JOHNSON,[1] KAREN SUNDBERG,[2] JAMES MORRIS,[2] AND CHARLES T. ROMAN[3]

[1]*U.S. EPA, Office of Research and Development, National Health and Environmental Effects Research Laboratory, Atlantic Ecology Division, Narragansett, Rhode Island 02882 USA*
[2]*Belle W. Baruch Institute for Marine and Coastal Sciences, University of South Carolina, Columbia, South Carolina 29208 USA*
[3]*National Park Service, North Atlantic Coast Cooperative Ecosystem Studies Unit, University of Rhode Island, Narragansett, Rhode Island 02882 USA*

*differential x-ray absorption



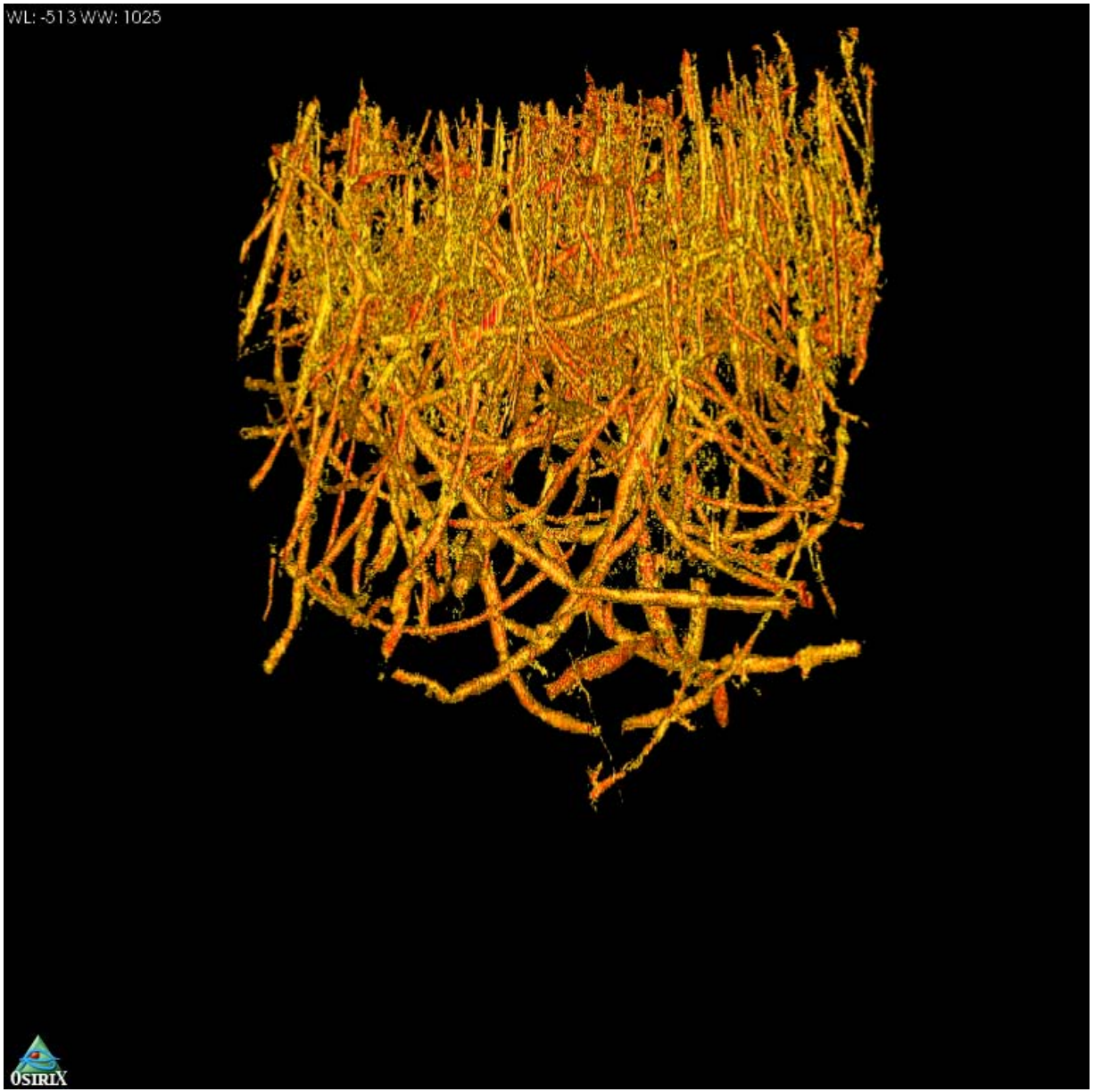
Blum, L.K., and E. Davey. 2013. Below the salt mars surface: Visualization of plant roots by computer-aided tomography. *Oceanography* 26(3):85–87.

Reference material	Calibration rod composition	Density (g/mL)
Air	plastic pipette with air sealed inside	0.0012
Water	plastic pipette with water sealed inside	1.00
34% colloidal silica	plastic pipette with 34% colloidal silica sealed inside	1.23
Glass	solid glass rod	2.20

Note: All standard density measures were found in the *Handbook of Chemistry and Physics* (Weast and Astle 1979) except for the colloidal silica, provided by Aldrich Chemical Supply.

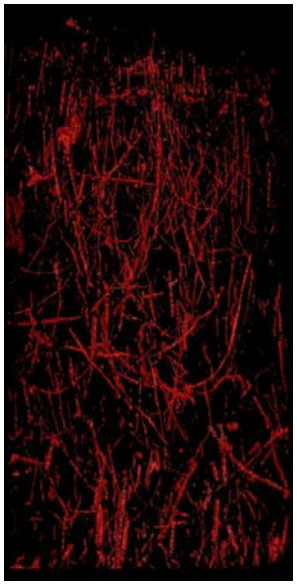
Earl Davey, US EPA

Southern Maine Health Care
October 7, 2014

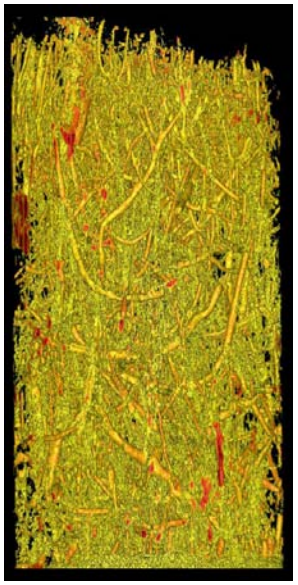

WL: -513 WW: 1025
OSIRIX

Maine 2014 BcCtR1Lung-Components

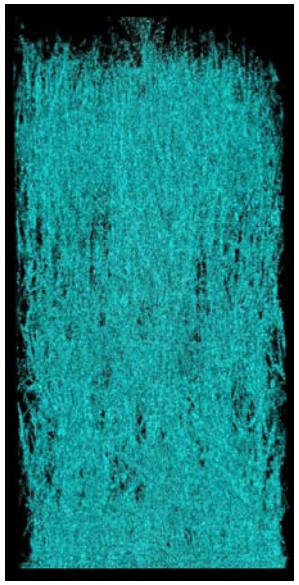
Gas(0.52%)
(-1024 to -955 HU)



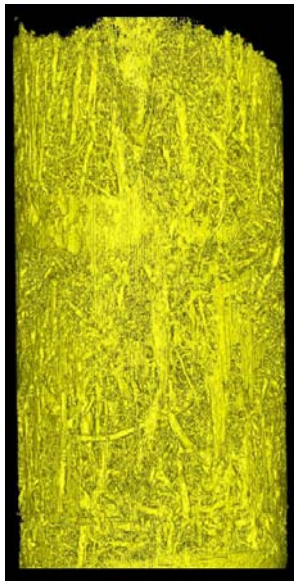
R&R(5.14%)
(-954 to -77 HU)



Water(2.31%)
(-76 to -16 HU)

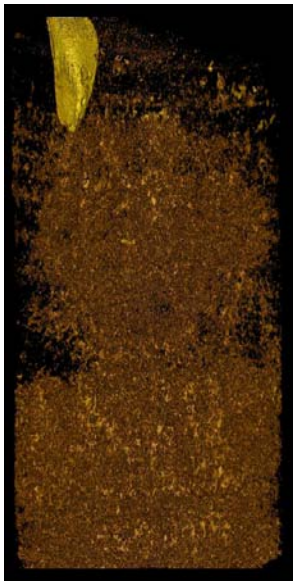


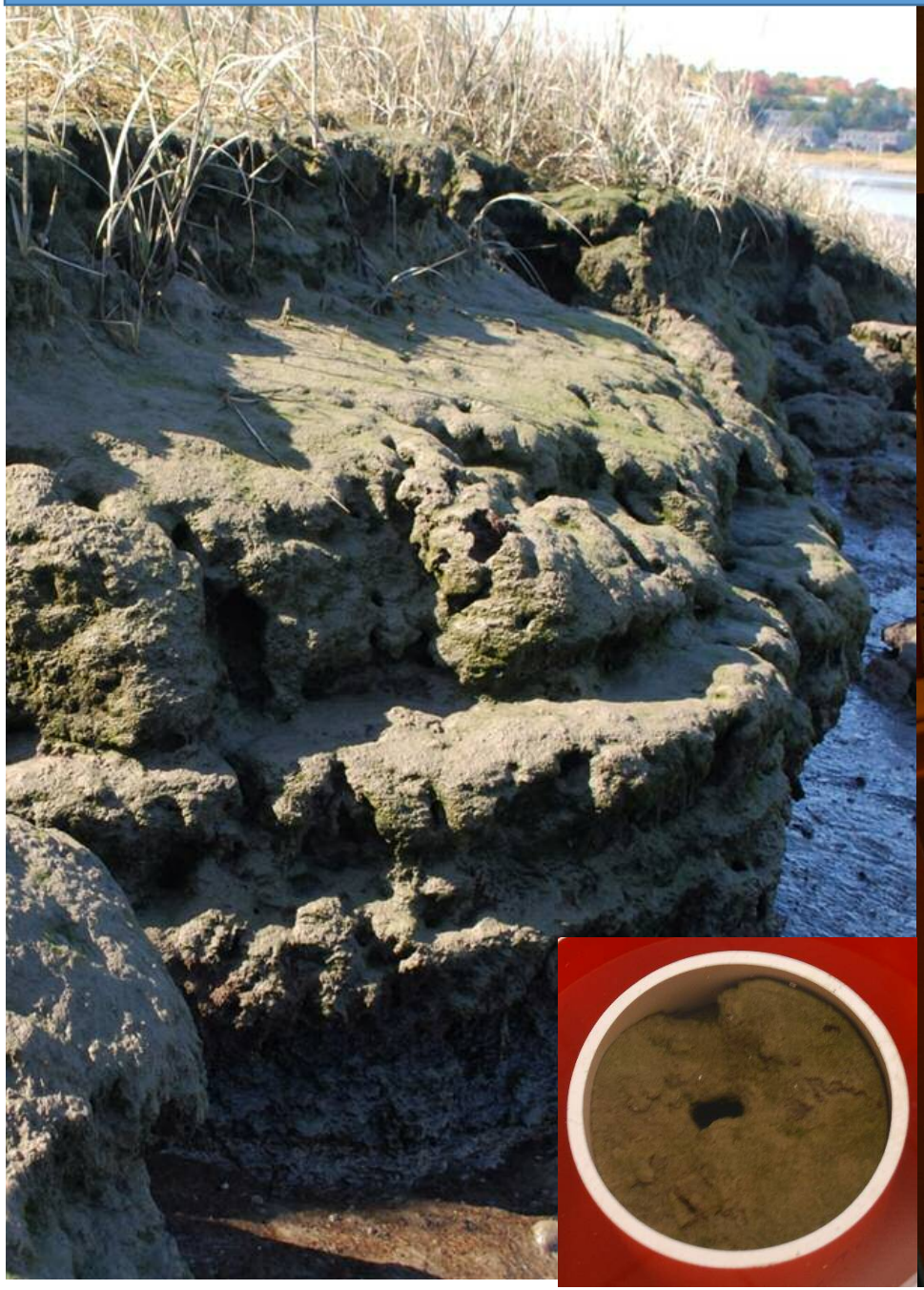
Peat(33.36%)
(-15 to 428 HU)

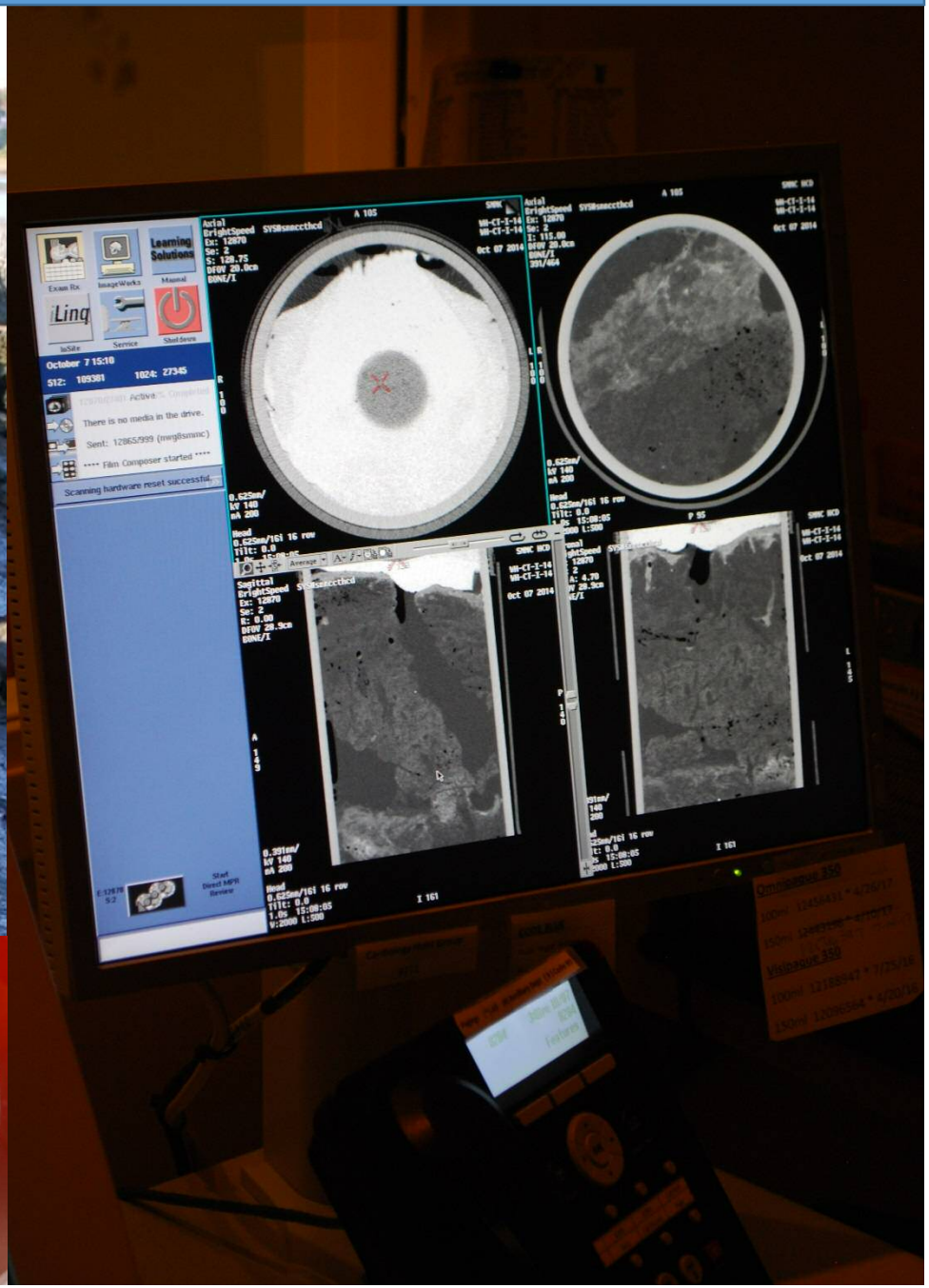


Part(50.56%)

Sand(8.02%)
(751 to 1672 HU)






Learning Solutions
There is no media in the drive.
Scanning hardware reset successful.


Broad Cove, Yarmouth, ME
October 2, 2014

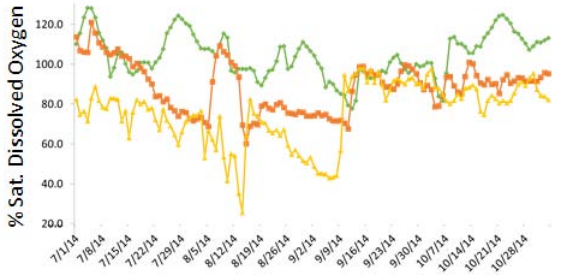

BrightSpeed

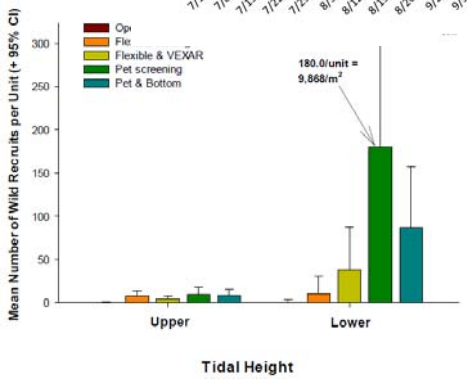

Sagittal
Coronal
Omnipaque 350

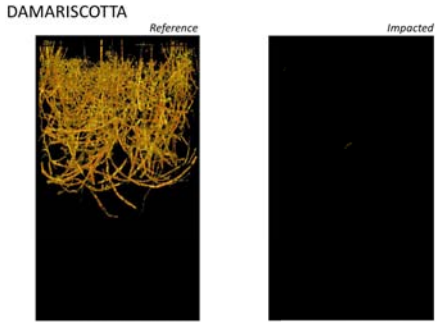
Courtesy of Earl Davey, US EPA

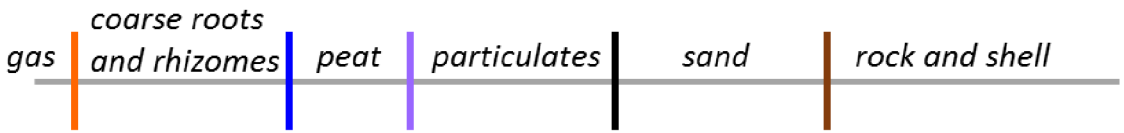
TO SUMMARIZE:

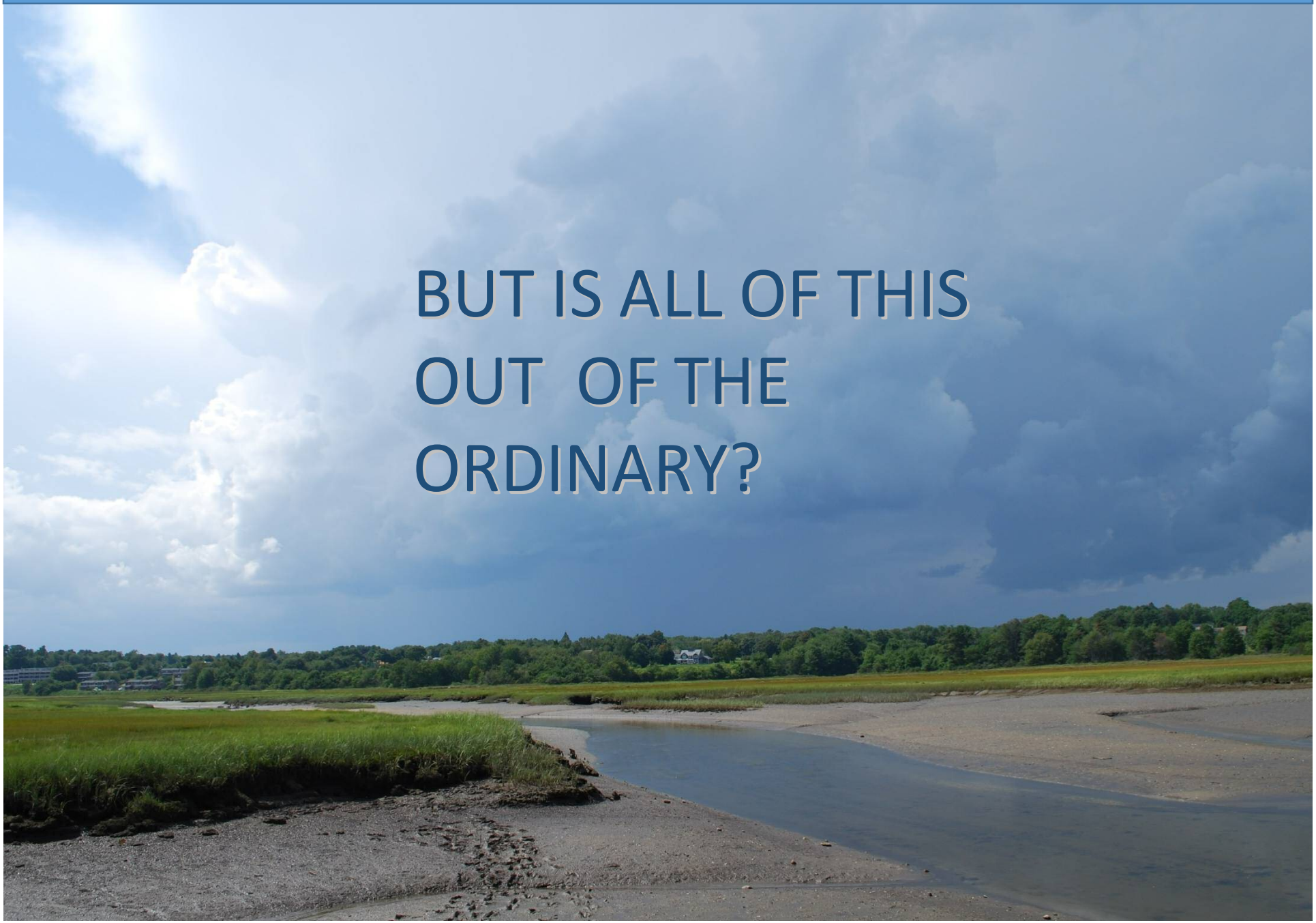
- Trapping data reveal there are lots of crabs, particularly in Wells.
- Environmental data indicate that between site differences in crab numbers may be related to water temperature and dissolved oxygen signals.
- Crabs are definitely impacting the softshell clam resource, at least in Wells.
- Marsh areas impacted by crabs have different sedimentological characteristics than nearby, reference sites.










BUT IS ALL OF THIS
OUT OF THE
ORDINARY?

"Now, in all things, as we know, experience is the best teacher." –Franklyn Goucher, Clam Commissioner, Town of Essex, MA, Spring 1951

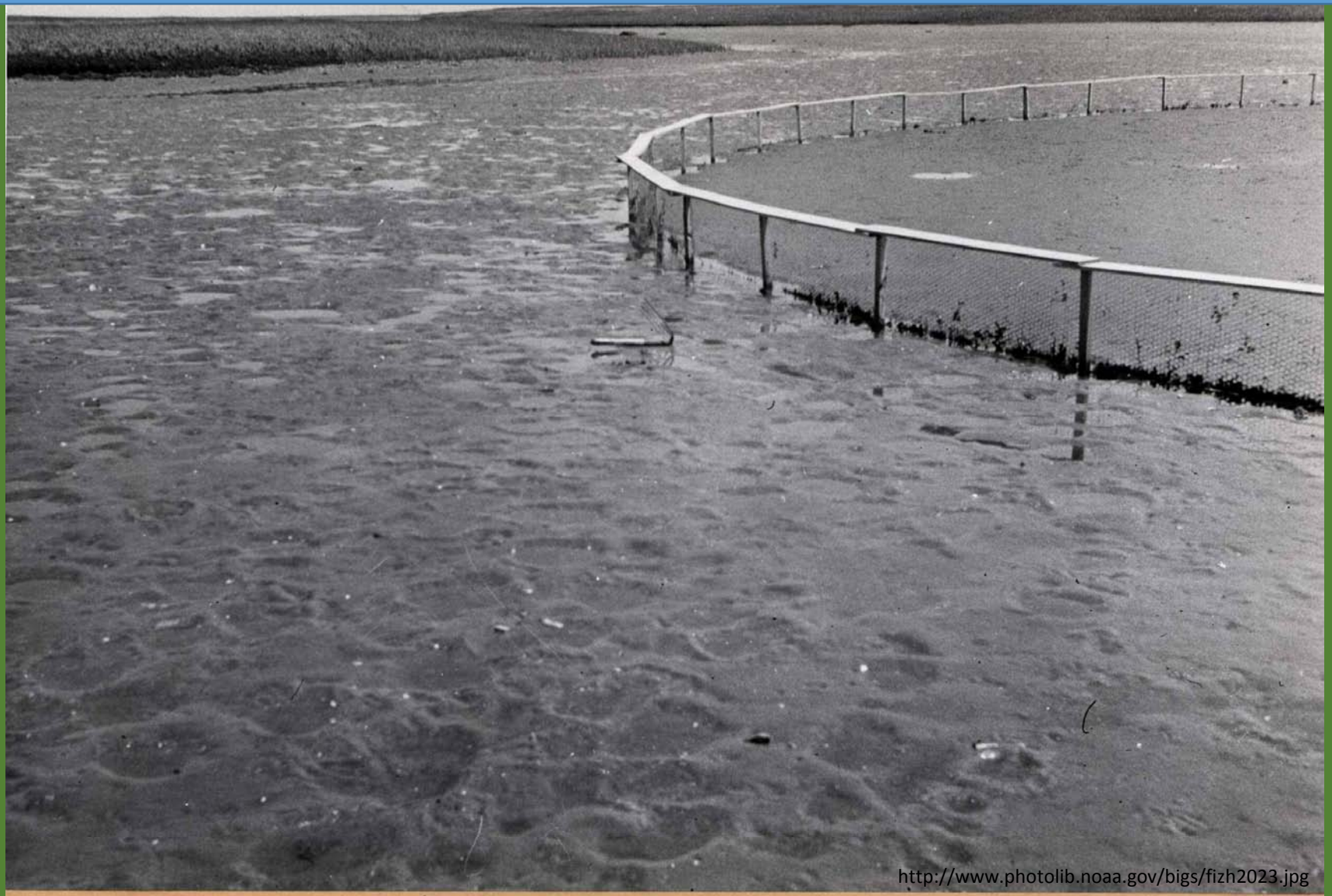
Green crabs which have become abundant north of Cape Cod during recent warm winter cycle are believed responsible for soft clam shortage.

1953

http://www.photolib.noaa.gov/bigs/fizh2020.jpg

58 bushels of green crabs trapped in three days at Ipswich, Massachusetts, in town effort to reduce crab population.

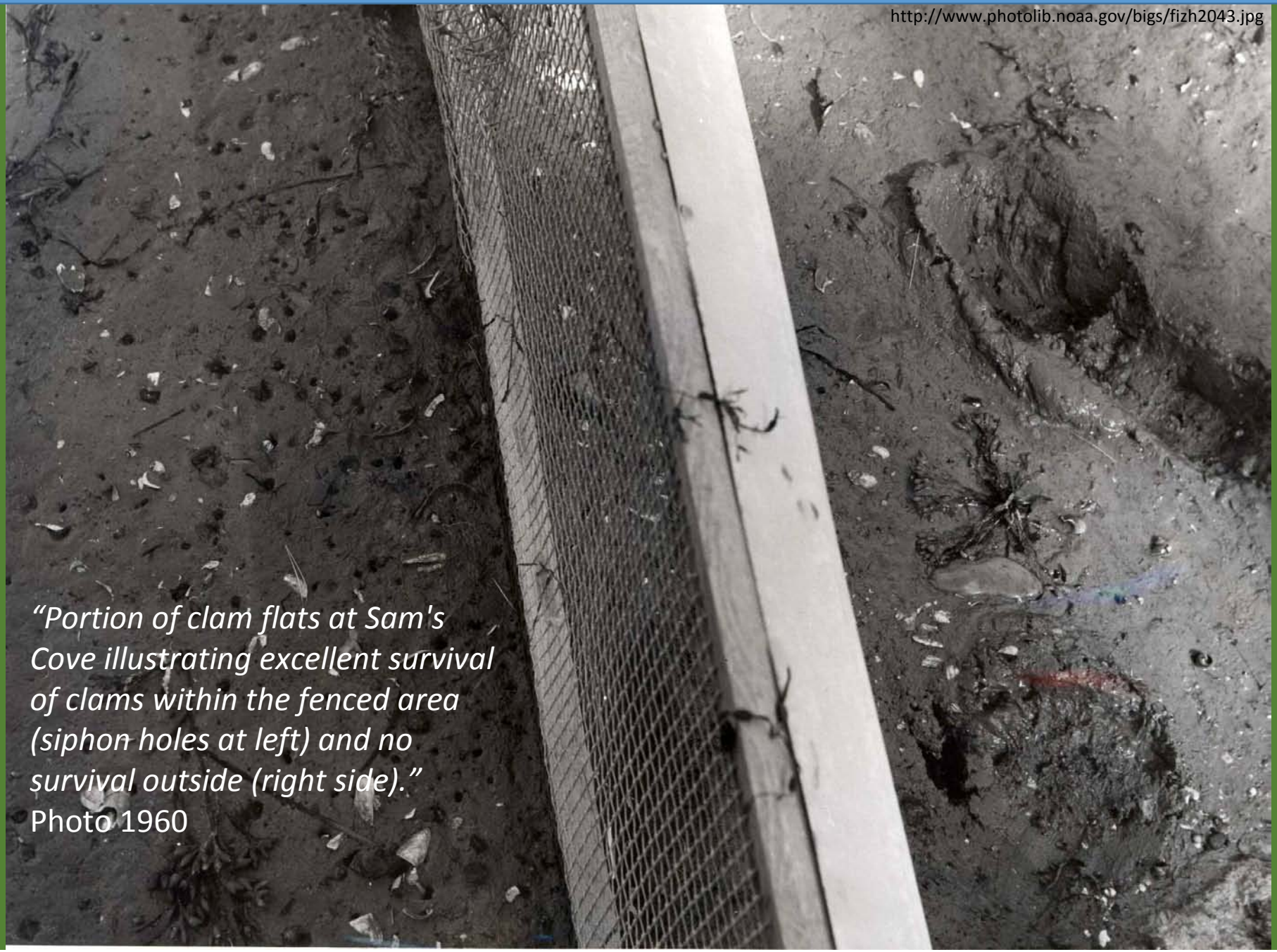
http://www.photolib.noaa.gov/bigs/fizh2017.jpg



http://www.photolib.noaa.gov/bigs/fizh2023.jpg

Green crab and horseshoe crab fence, June 1953, Plum Island Sound, near Newburyport, Massachusetts.

Note depressions made by the two predators, horseshoe and green crabs, are abundant outside and rare inside fence.



http://www.photolib.noaa.gov/bigs/fizh2043.jpg

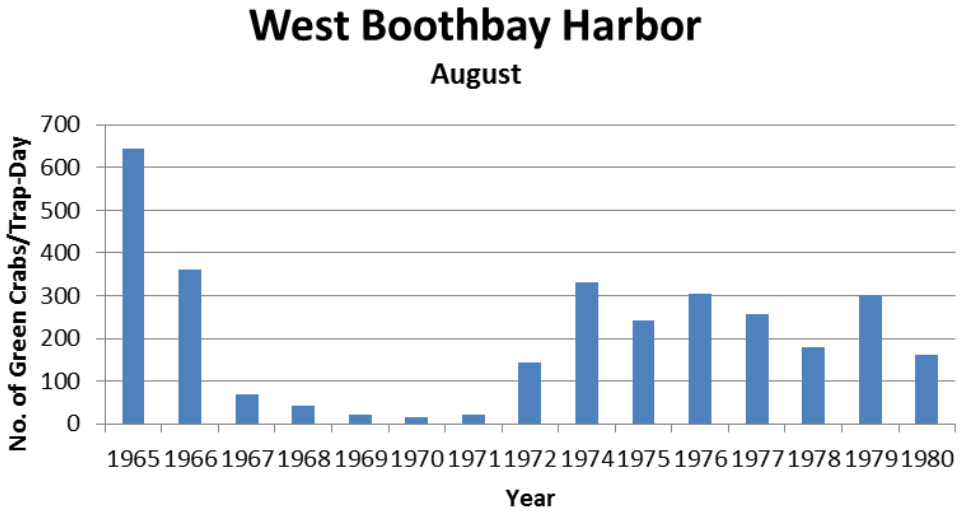
"Portion of clam flats at Sam's Cove illustrating excellent survival of clams within the fenced area (siphon holes at left) and no survival outside (right side)."
Photo 1960

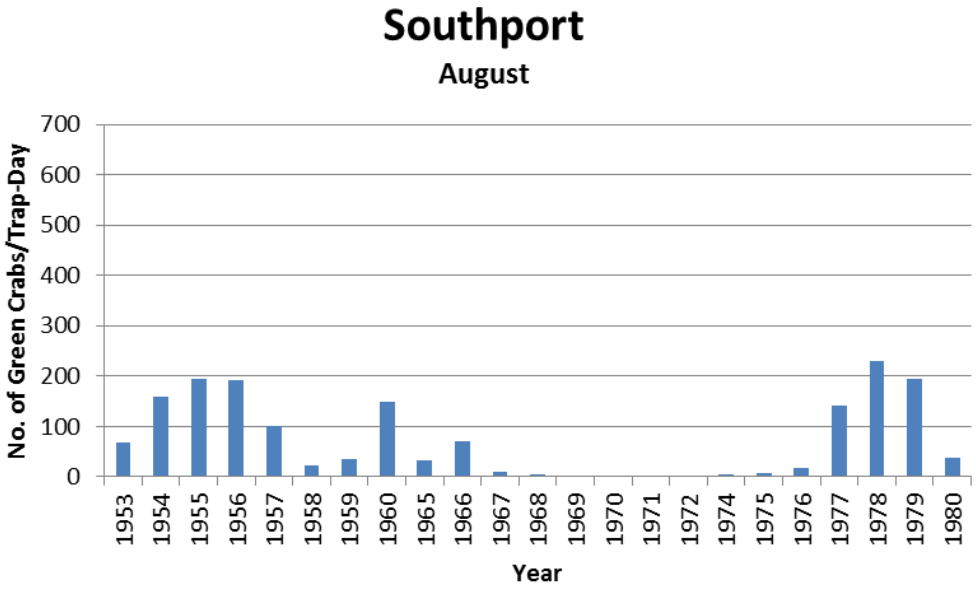
"In the tidal marshes in Wells, where many crabs overwinter intertidally in burrows in banks of Spartina sod…" –Welch 1968 Fishery Bulletin 67 (2): 337-345.

"Pesticide barrier to keep out green crabs." Jonesport, Maine 1960

http://www.photolib.noaa.gov/htmls/fizh2048.htm

Data: Maine Department of Marine Resources courtesy of Les White

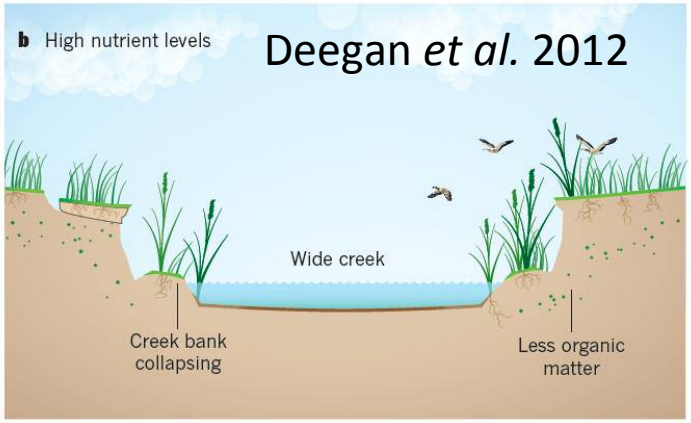





Responding to or driving marsh change?

INTERACTING DRIVERS?


http://www.moechenphotography.com/Color/i-NB8RHpW/2/S/Scaroborough%20Marsh%20Ice%20Flows-S.jpg



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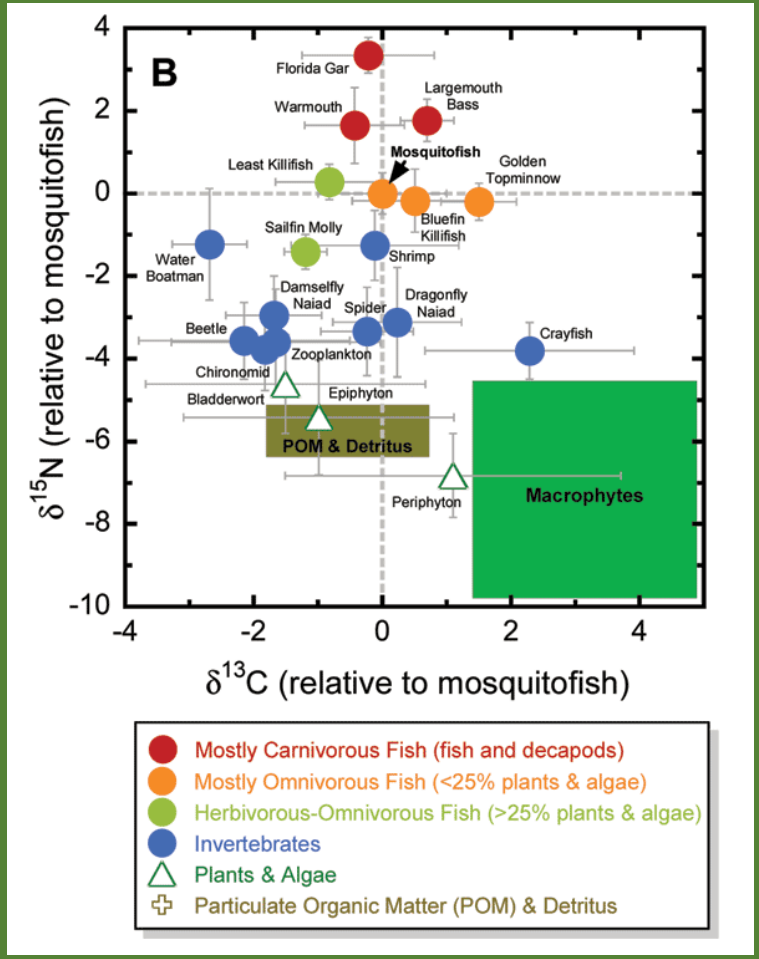
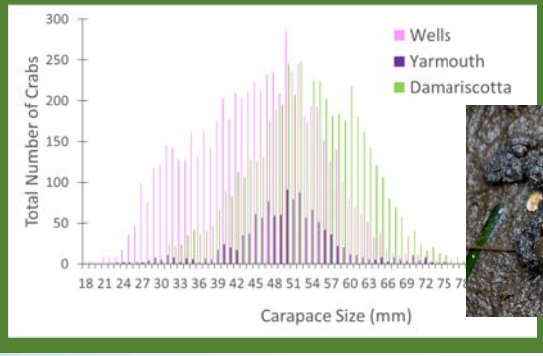


http://sofia.usgs.gov/publications/fs/2004-3138/

STABLE C and N ISOTOPES

CROSS-SITE/CROSS-SPECIES COMPARISONS OF CRAB IMPACTS and DRIVERS

Narragansett Bay Research Reserve



https://c1.staticflickr.com/5/4135/4884534361_5f9da30a47_b.jpg

COMPARING 2014 FYKE NET DATA TO HISTORICAL DATA FROM THE WELLS NERR

My Shameless Plug….

2015 L.L.Bean Guest Lecture Series:

"The Invasive Green Crab in Southern Maine; A tasty solution?"

Photo: llbean.com

Friday July 10th 7-8pm
L.L.Bean Flagship Store
Freeport, ME.


Questions?
JMILLER@WELLSNERR.ORG 207.646.1555 x122
Photo N. Charov
Photo N. Charov