What is total alkalinity, and why is it important?

"the number of moles of hydrogen ion equivalent to the excess of proton acceptors over proton donors…" (Dickson 1981)

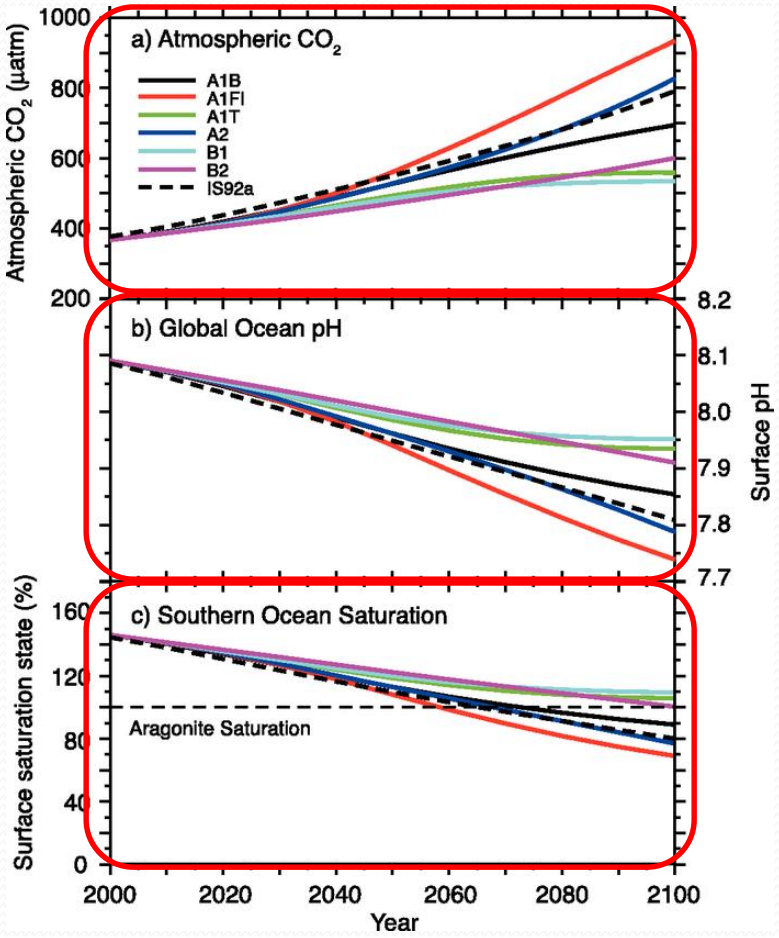
The capacity of ocean water to neutralize acid

OR

The chemical buffering capacity of the ocean.

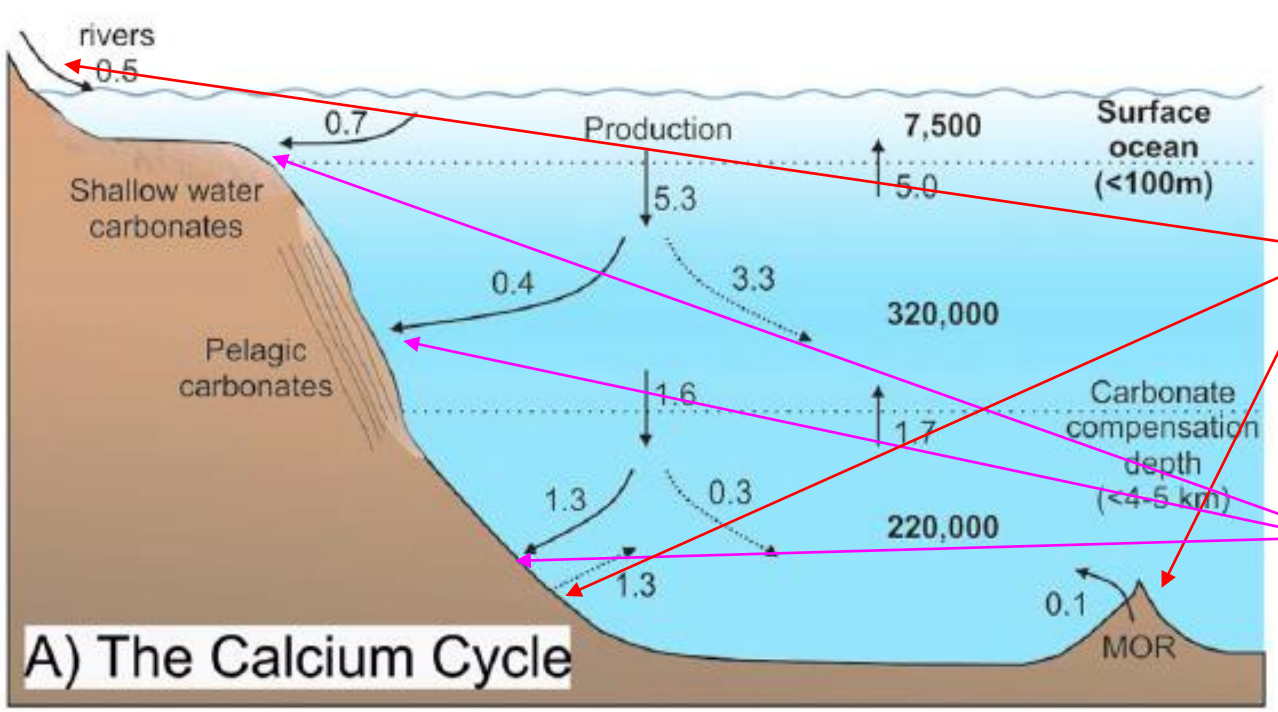
OR

The ability of seawater to resist acidification.



Meehl et al. 2007

What does the ocean alkalinity cycle look like?

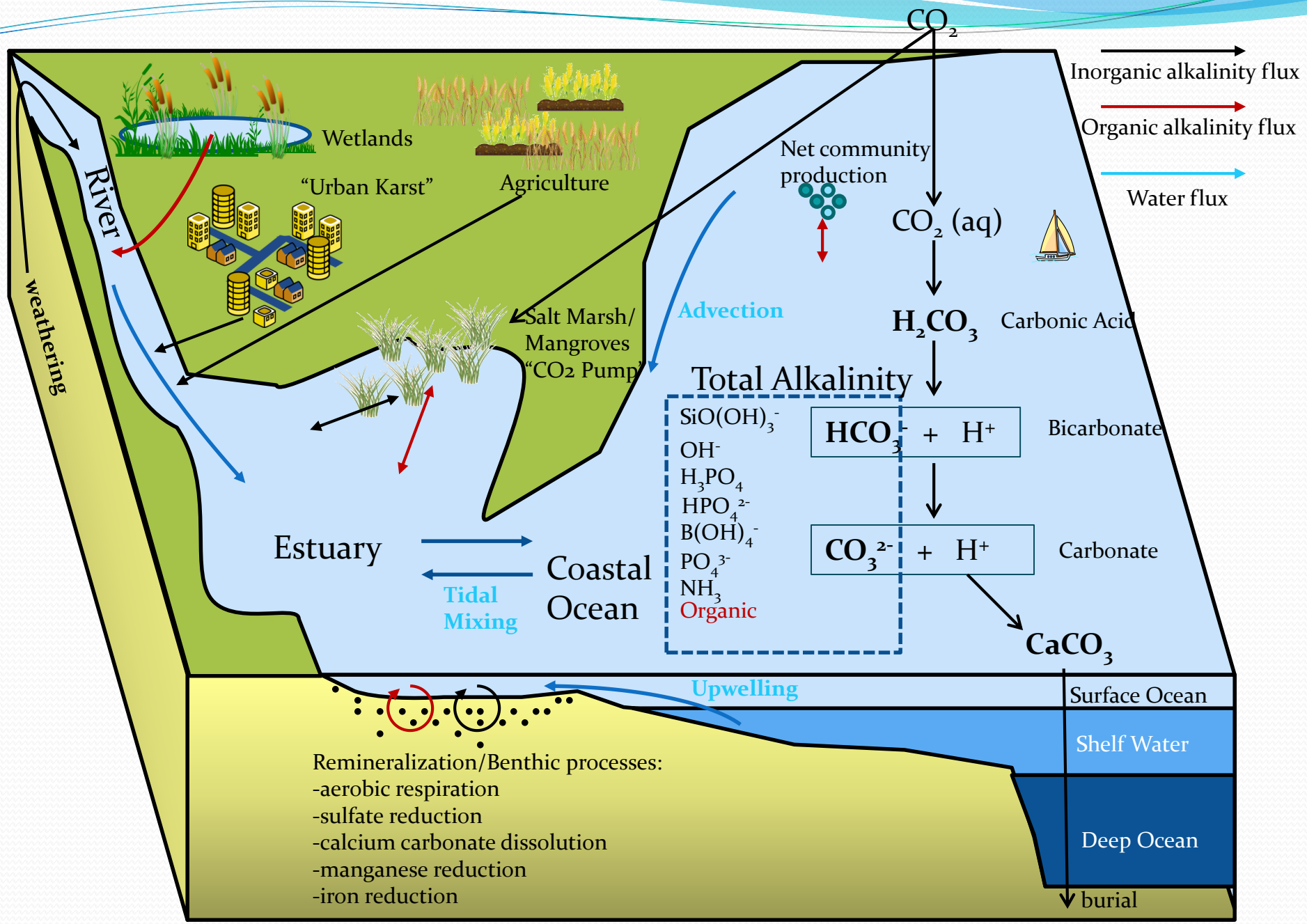


Renforth and Henderson 2017

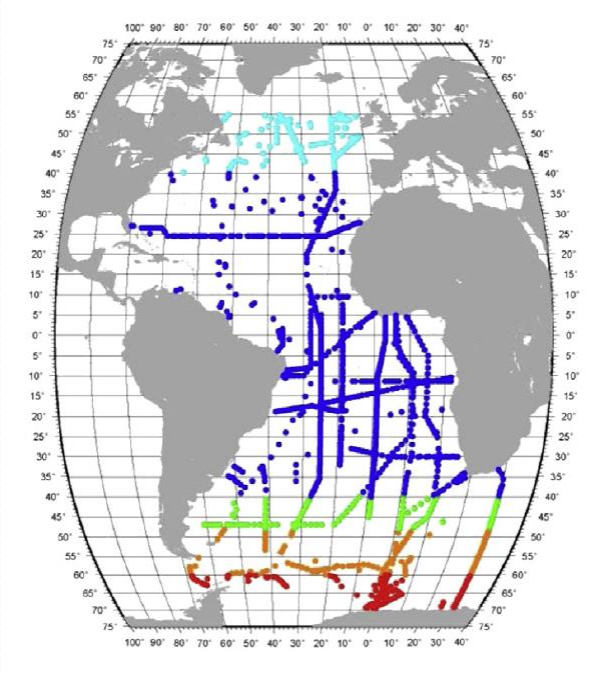
The ocean alkalinity cycle looks a lot like the calcium cycle:

- Inputs from land and seafloor
- Movement between surface and deep waters
- Removal due to carbonate mineral deposition

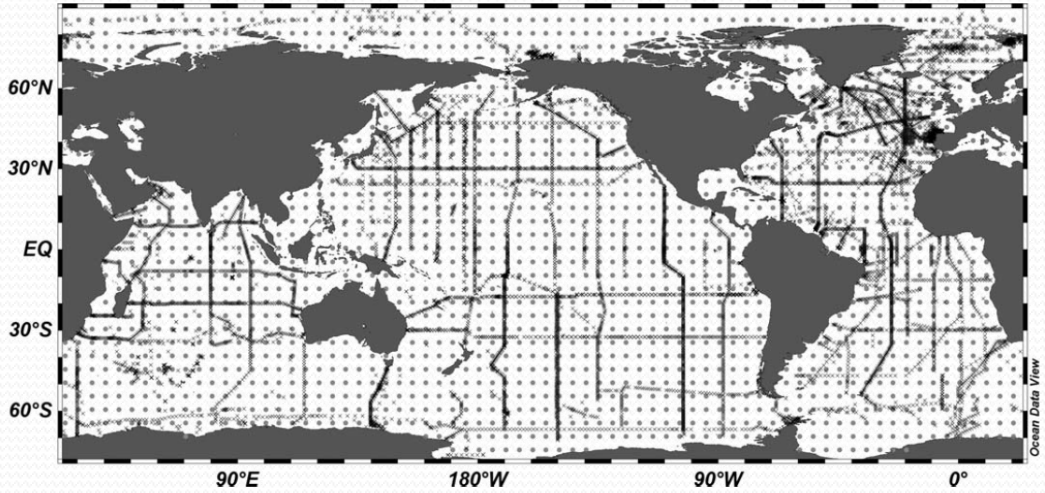
The alkalinity/pH cycle gets complicated closer to shore



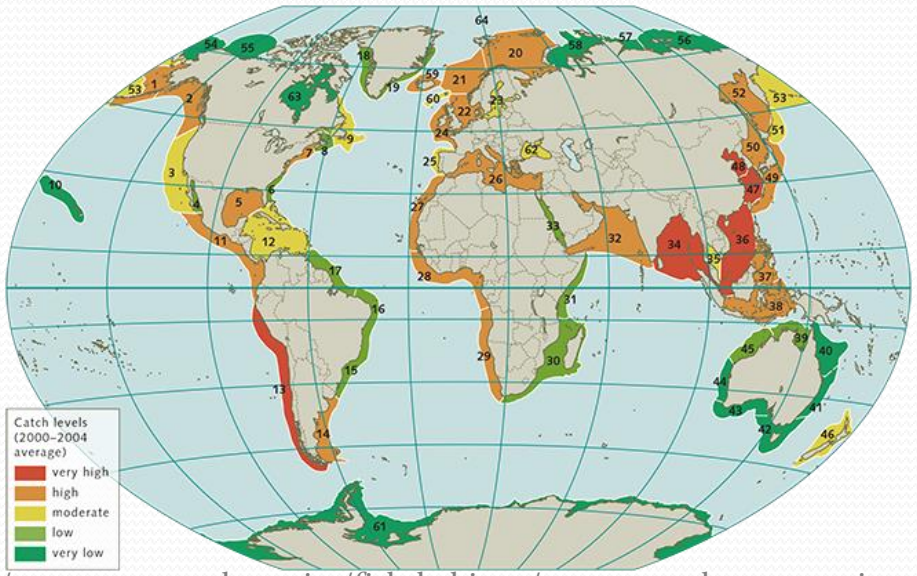
Where can we estimate alkalinity…and where are the fish?



Takahashi et al. 2014, "Climatological distributions of pH, pCO_2, total CO_2, alkalinity, and $CaCO_3$ saturation in the global surface ocean, and temporal changes at selected locations"

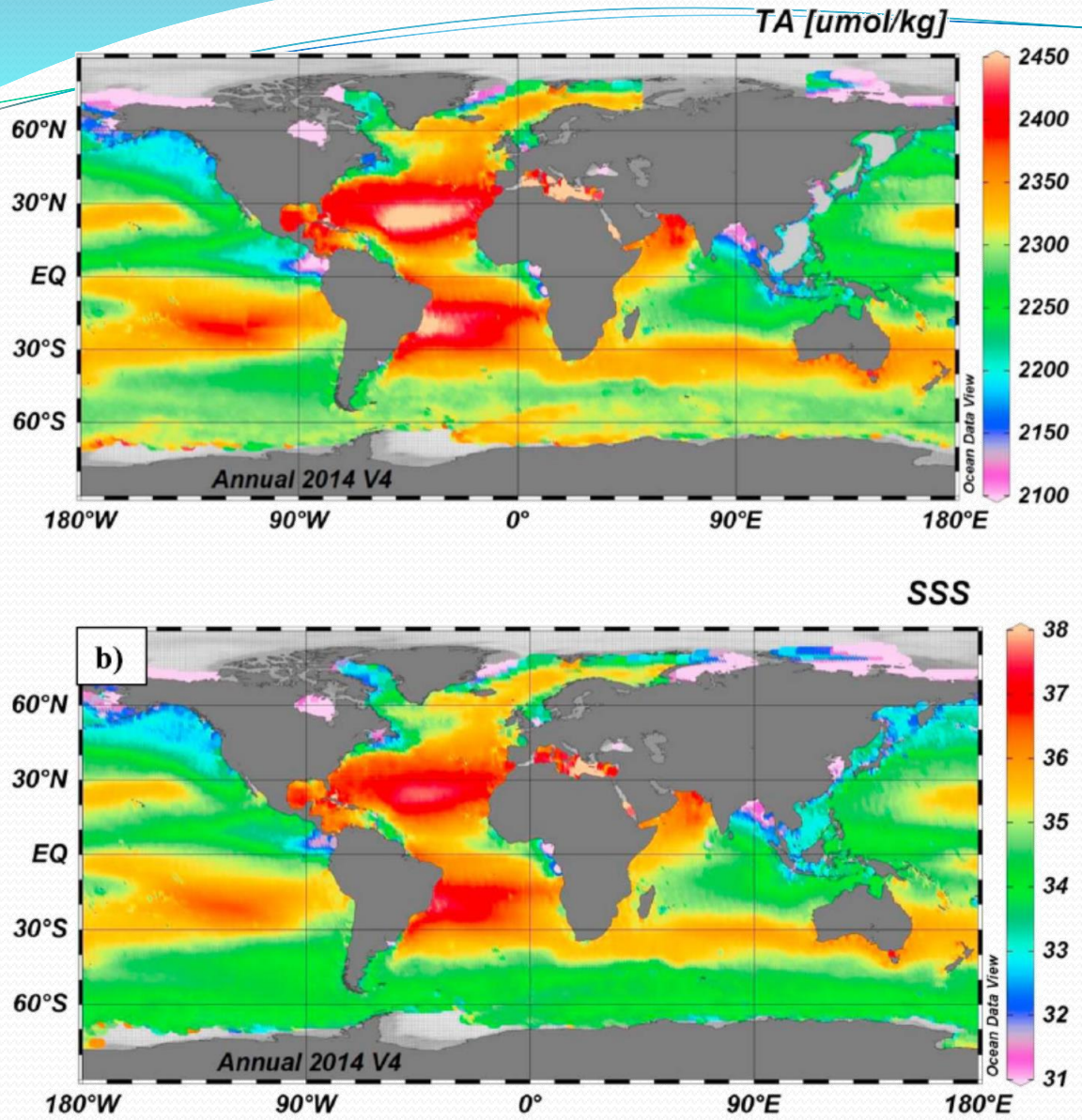


Carter et al. 2016, "Locally interpolated alkalinity regression for global alkalinity estimation" (LIAR(!))



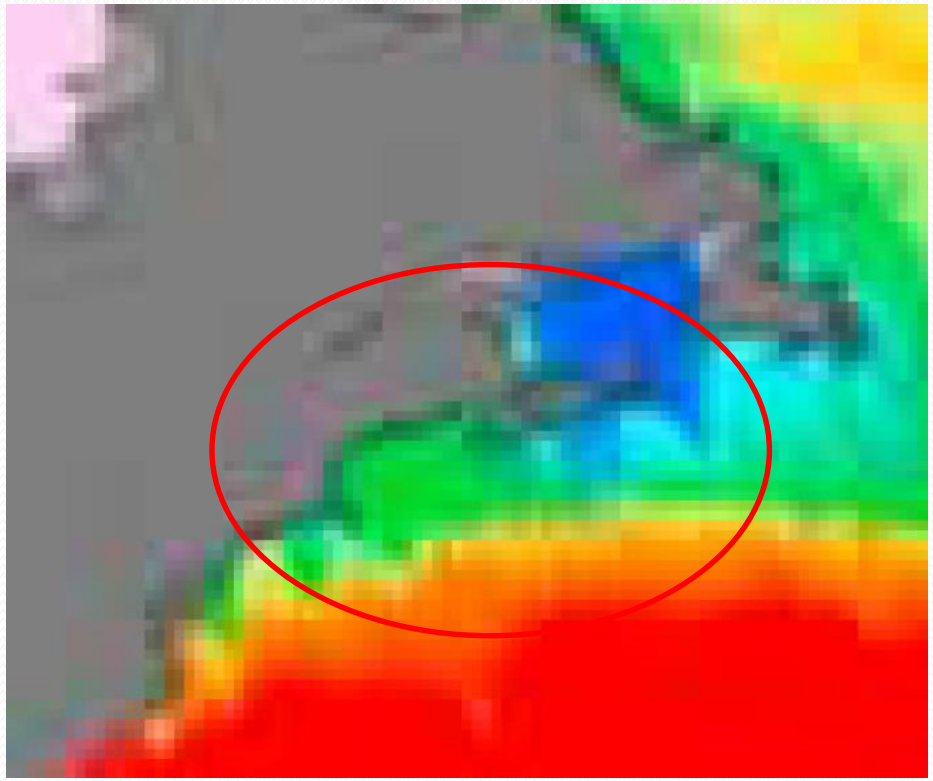
http://worldoceanreview.com/en/wor-2/ecosystems-and-species/fish-habitats/near-coastal-ocean-regions/

Estimating Total Alkalinity

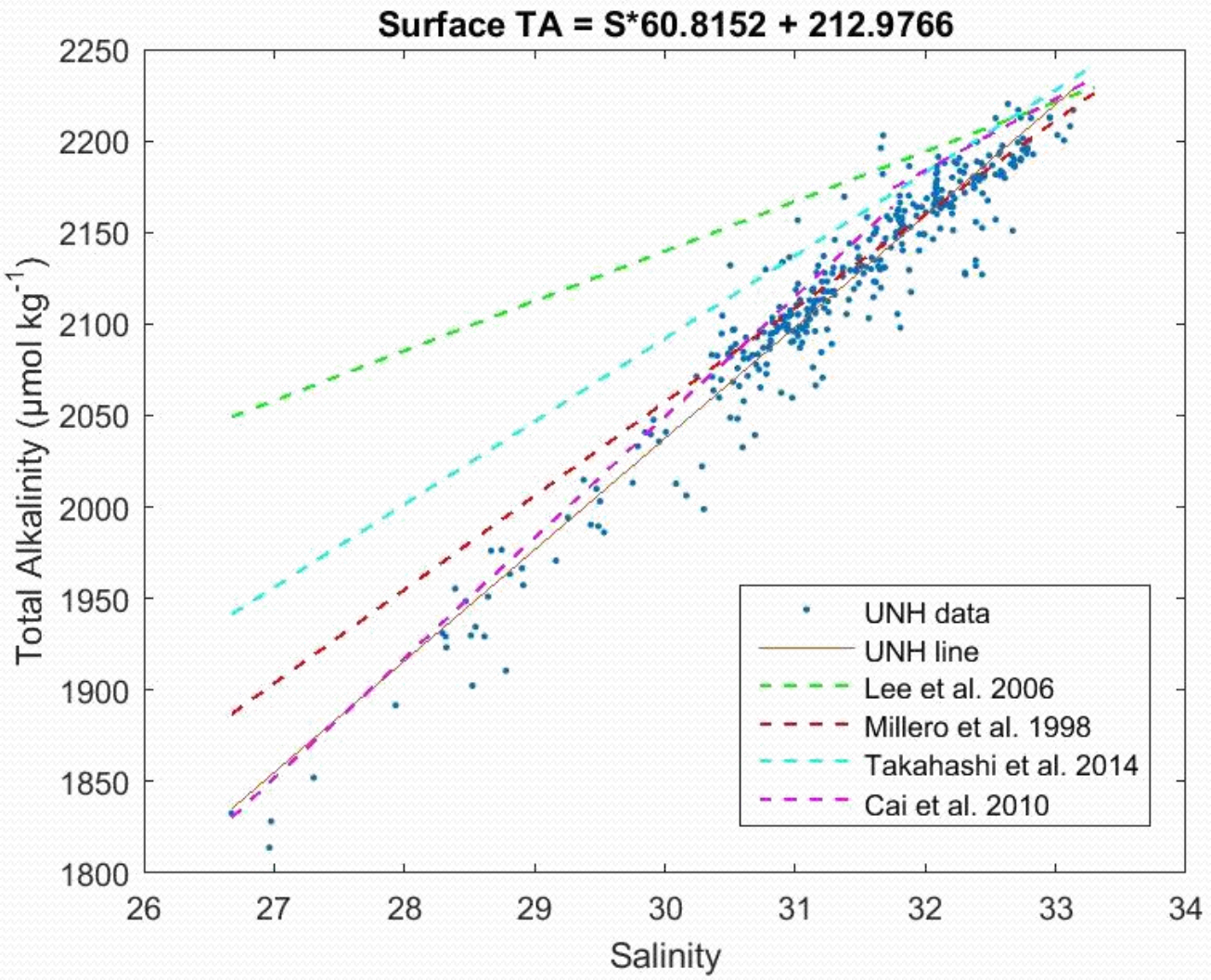


Fine et al. 2017

Conveniently, alkalinity tends to be broadly associated with salinity, which is easier to measure, even from space!

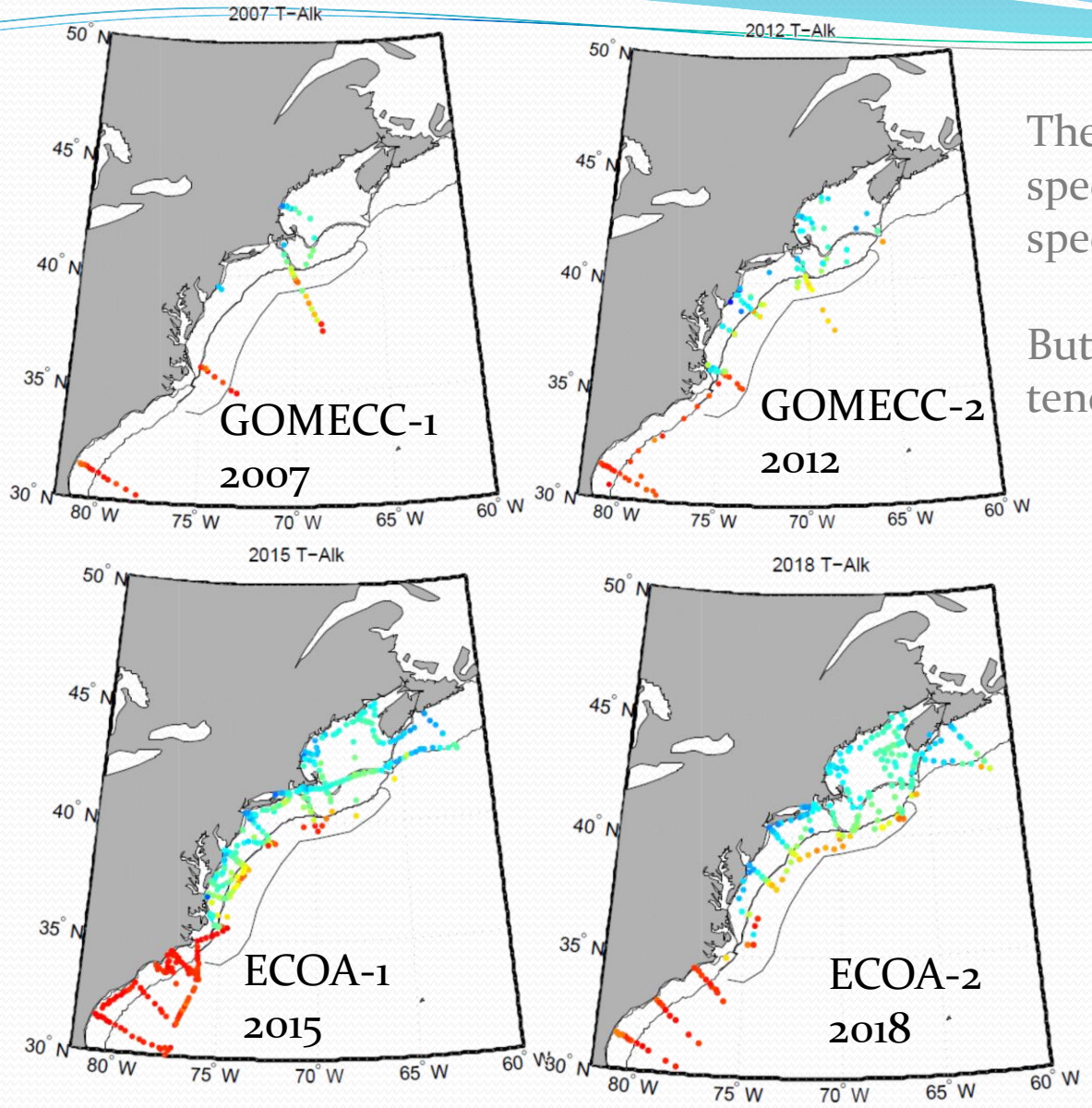


Tools for estimating Gulf of Maine Total Alkalinity



There are some salinity-alkalinity tools specific to the North Atlantic, and others specific to the Gulf of Maine.

But they are based on limited data and tend to be sampled away from the shore.



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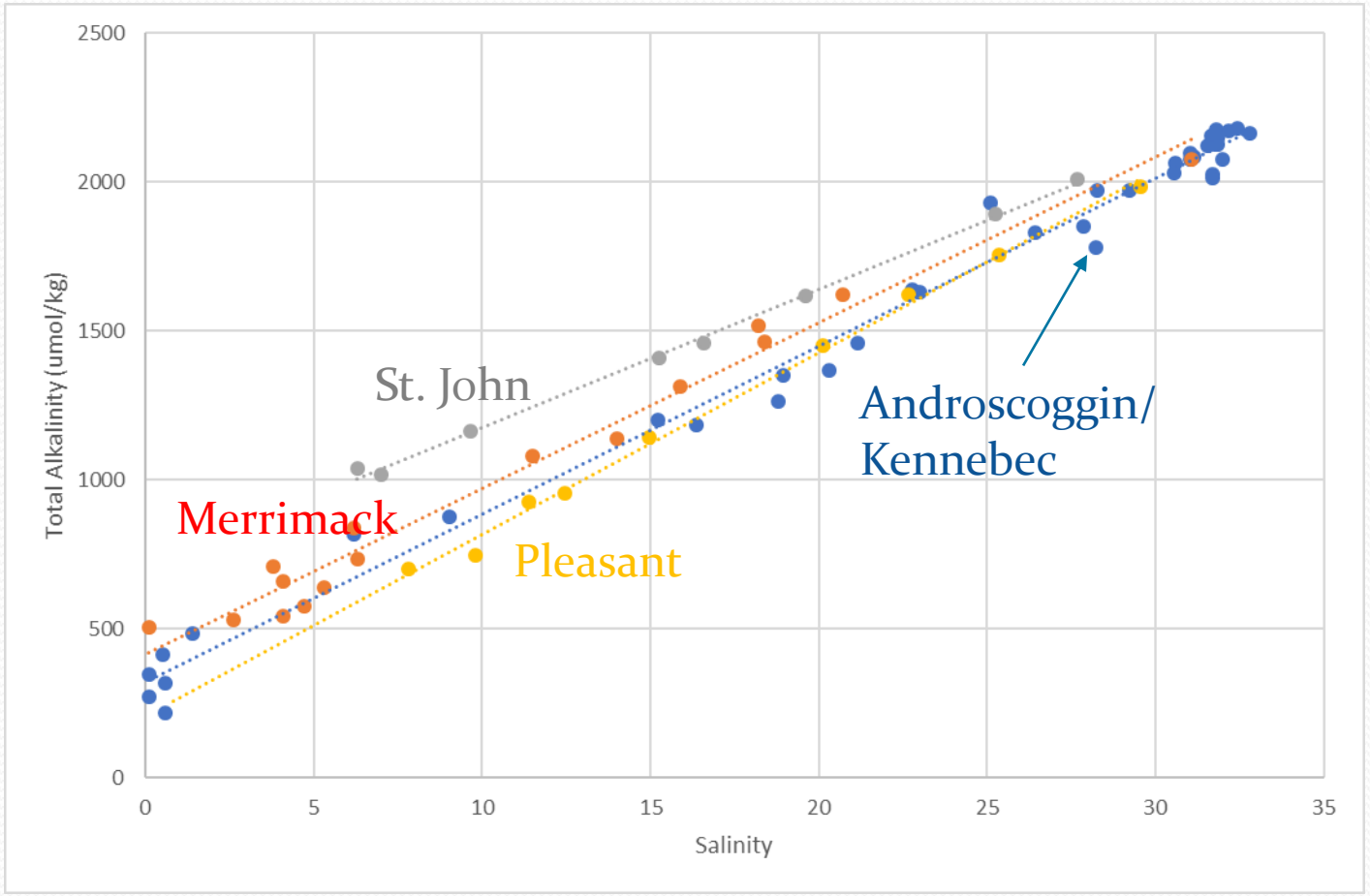
Tools for estimating Gulf of Maine Total Alkalinity

River	Location	Sampling Date	Latitude	Longitude	TAlk ($\mu eq\,l^{-1}$)
Merrimac	Lowell, MA	29 May 2008	42.66	−71.32	411.4
Kennebec	Richmond, ME	1 Jun 2008	44.09	−69.79	365.8
Aroostook	Washburn, ME	14 Jul 2008	46.78	−68.16	569.7
Canaan	Coles Island, NB	15 Jul 2008	46.92	−65.79	370.9
St. John	Fredericton, NB	15 Jul 2008	46.96	−66.64	730.4
Tobique	Tobique, NB	15 Jul 2008	46.79	−67.49	828.5
St. John	Perth, NB	15 Jul 2008	46.74	−67.71	884.7
Saco	Fryeburg, ME	15 Jul 2008	44.08	−70.91	232.5
Saco	Crawford Notch, NH	15 Jul 2008	44.18	−71.40	184.3
Kennebecasis	Norton, NB	16 Jul 2008	45.64	−65.70	956.7
Connecticut	Lancaster, NH	16 Jul 2008	44.46	−71.65	364.9
Androscoggin	Brunswick, ME	25 Aug 2008	43.92	−69.97	303.7
Pleasant	Columbia Falls, ME	21 Sep 2008	45.65	−67.73	128.9
Narraguagus	Cherryfield, ME	21 Sep 2008	44.61	−67.93	116.4
Penobscot	Milford, ME	5 Dec 2008	44.94	−68.64	305.6

We already know that Gulf of Maine rivers can carry very different alkalinity loads.

We know much less about how river alkalinity combines with coastal water masses and interacts with local processes to determine alkalinity in a local system.

Tools for estimating Gulf of Maine Total Alkalinity



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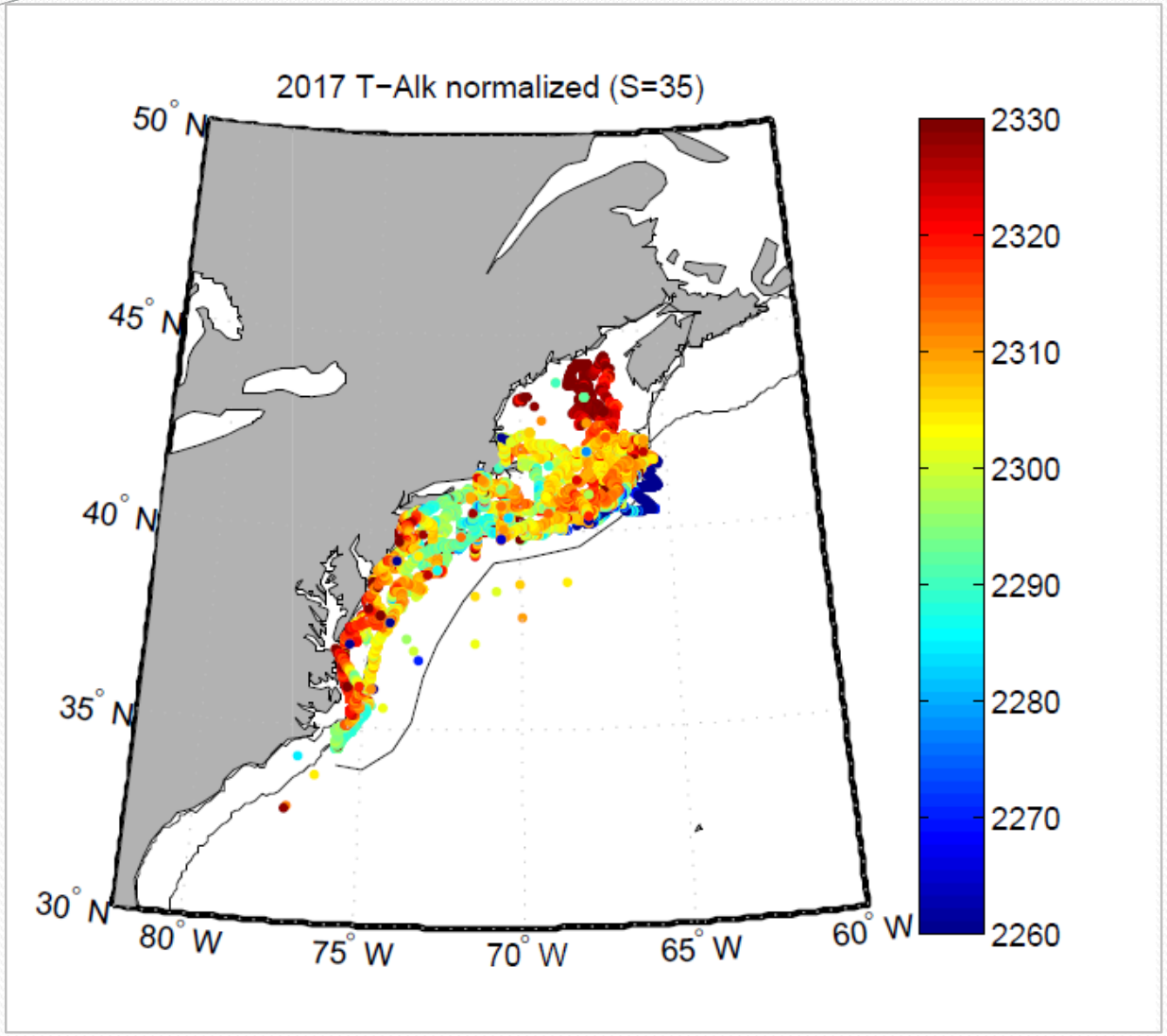

- Pairing alkalinity and salinity can potentially identify areas with relatively higher or lower buffering capacity
- Shell Day results will hopefully:
  - Allow groups to put alkalinity into a local perspective
  - Identify regions or systems of interest
  - Add to knowledge of salinity-alkalinity interactions in the New England regions

More discussion of alkalinity cane be found at: https://www.youtube.com/watch?v=1b2PptgVeR4

- Fine, R. A., D. A. Willey, and F. J. Millero. 2017. Global variability and changes in ocean total alkalinity from Aquarius satellite data. Geophysical Research Letters **44**: 261–267. doi:10.1002/2016GL071712
- Renforth, P., and G. Henderson. Assessing ocean alkalinity for carbon sequestration. Rev. Geophys. 2016RG000533. doi:10.1002/2016RG000533