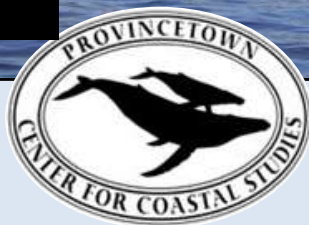
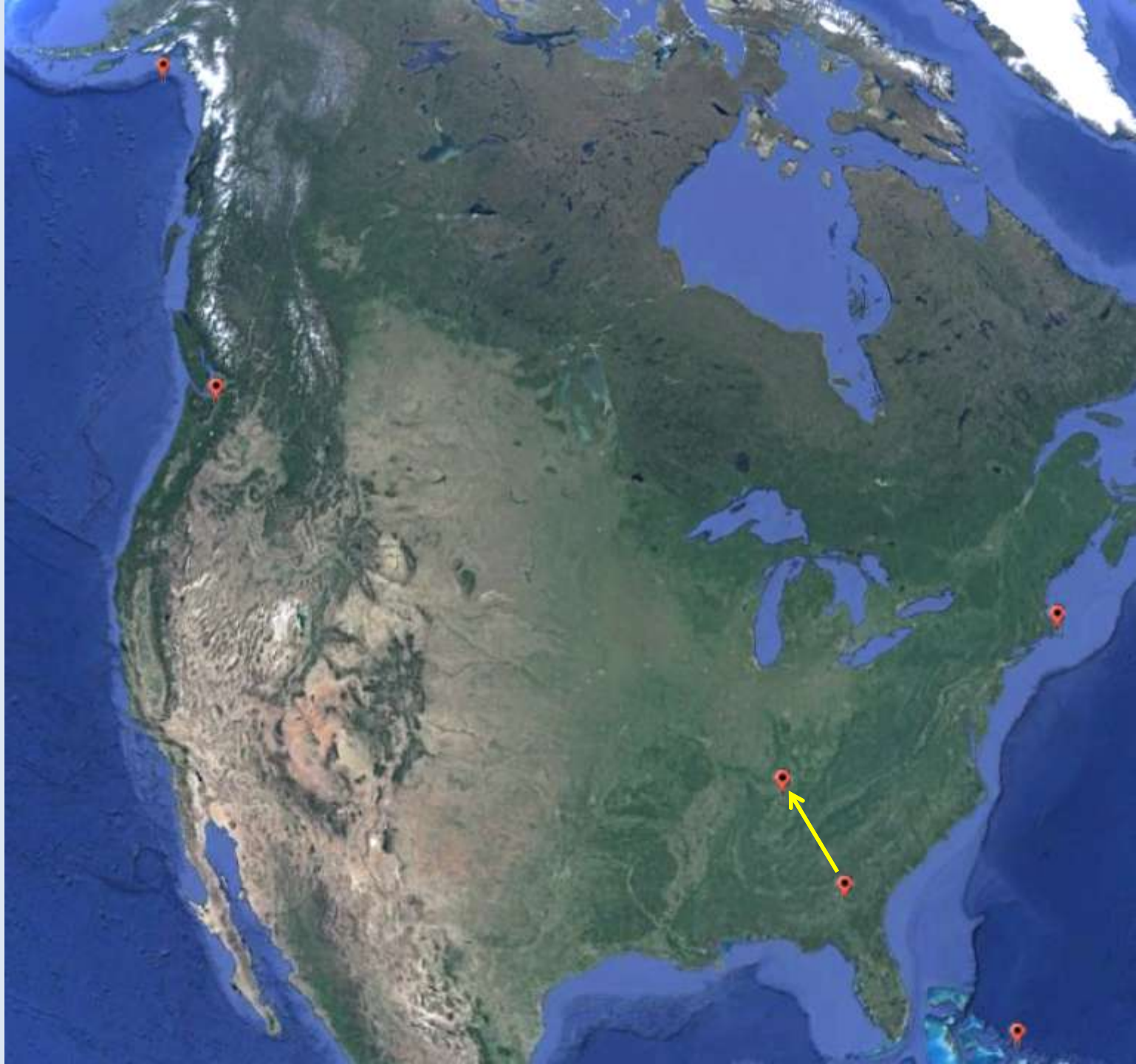
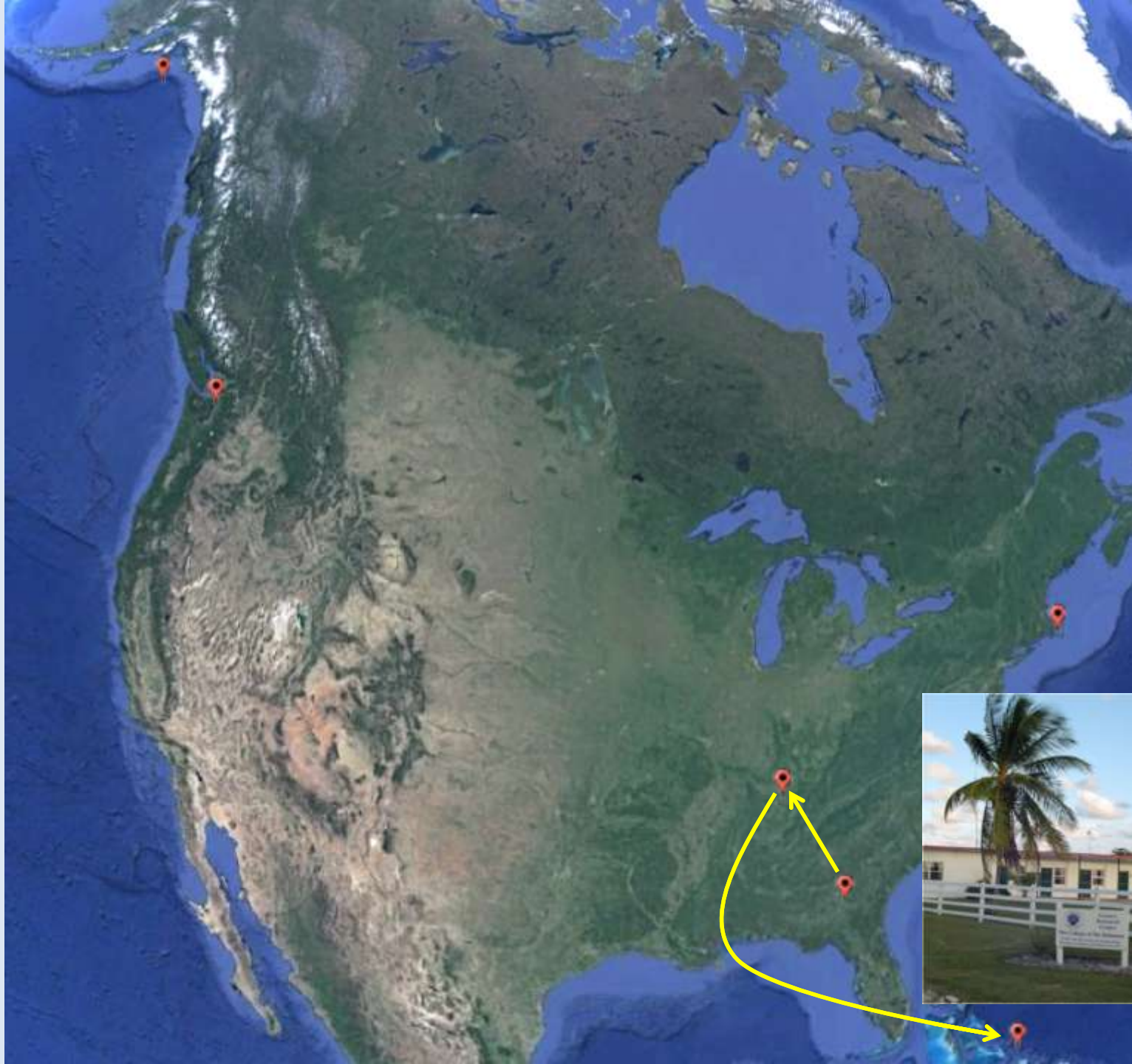
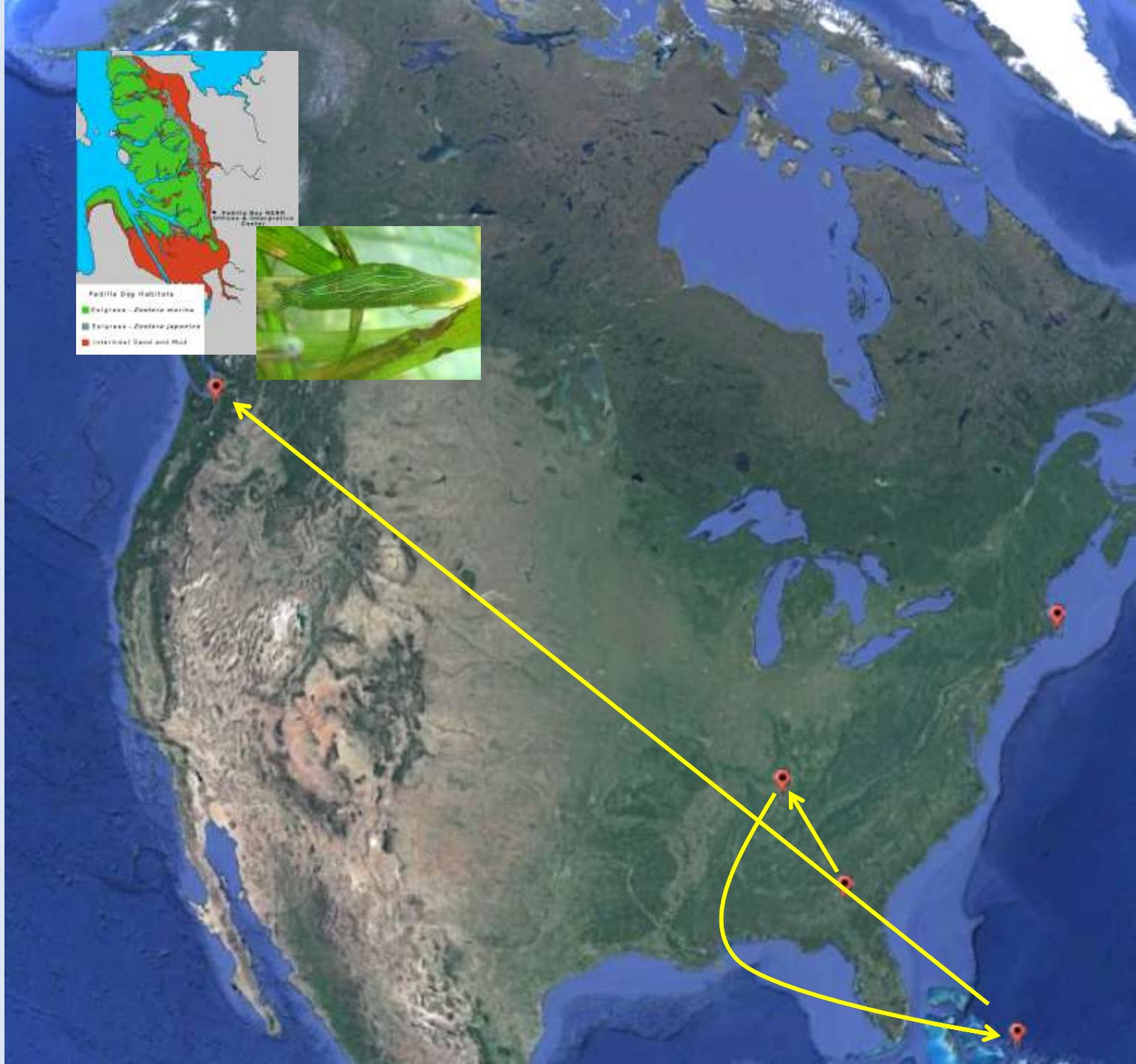


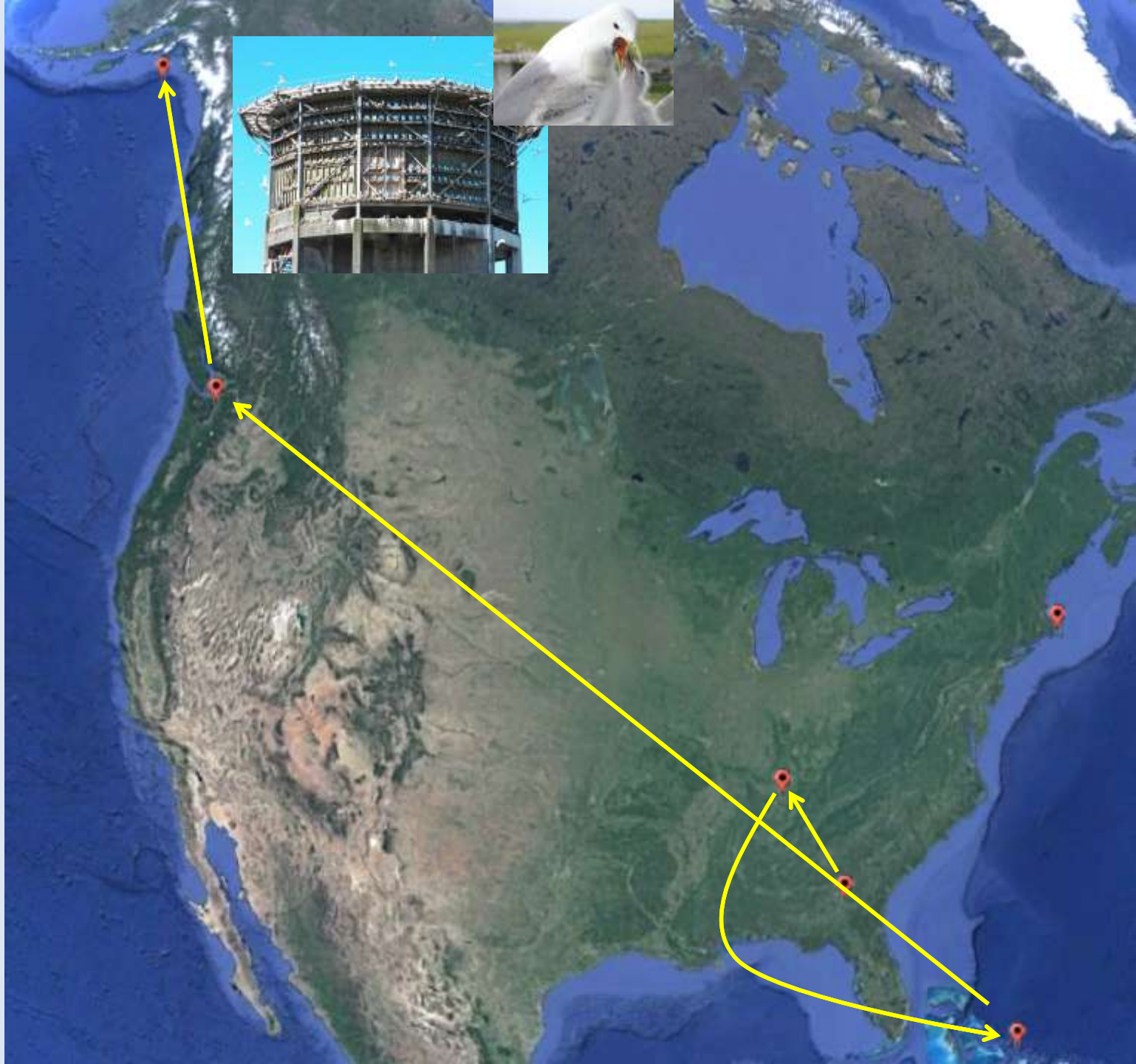
# What's Happening with Contaminants of Emerging Concern in Our Coastal Waters?

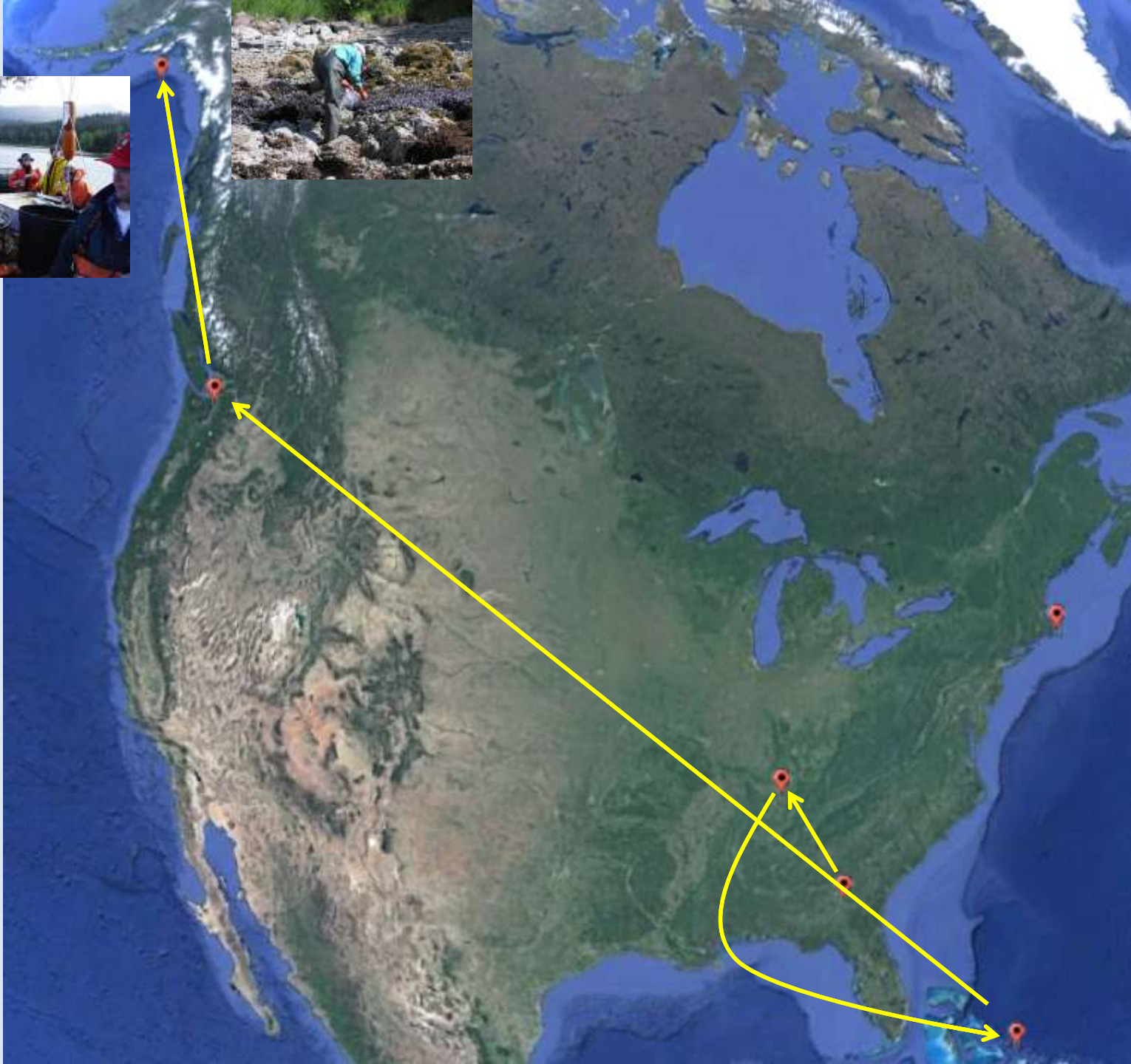


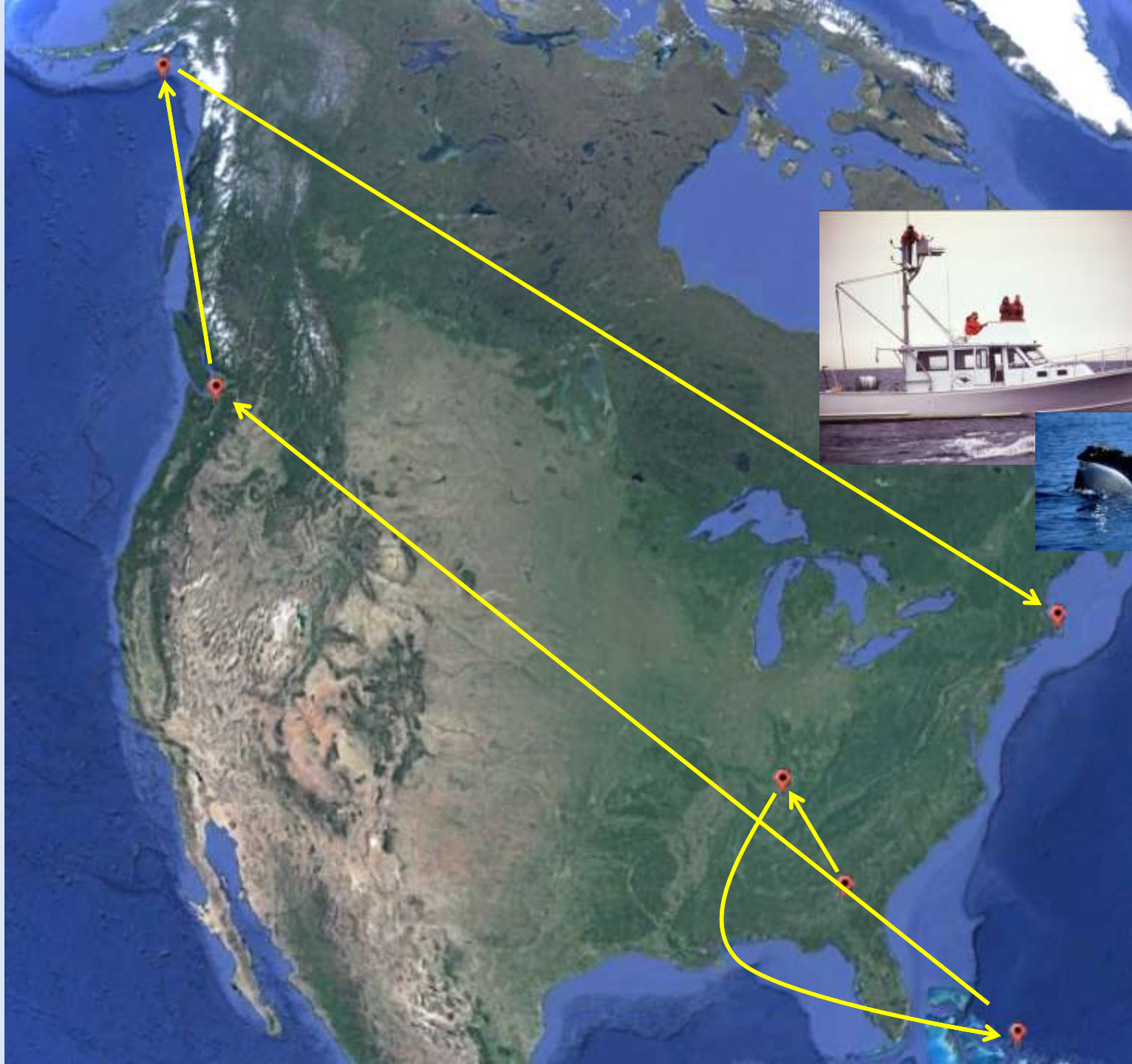


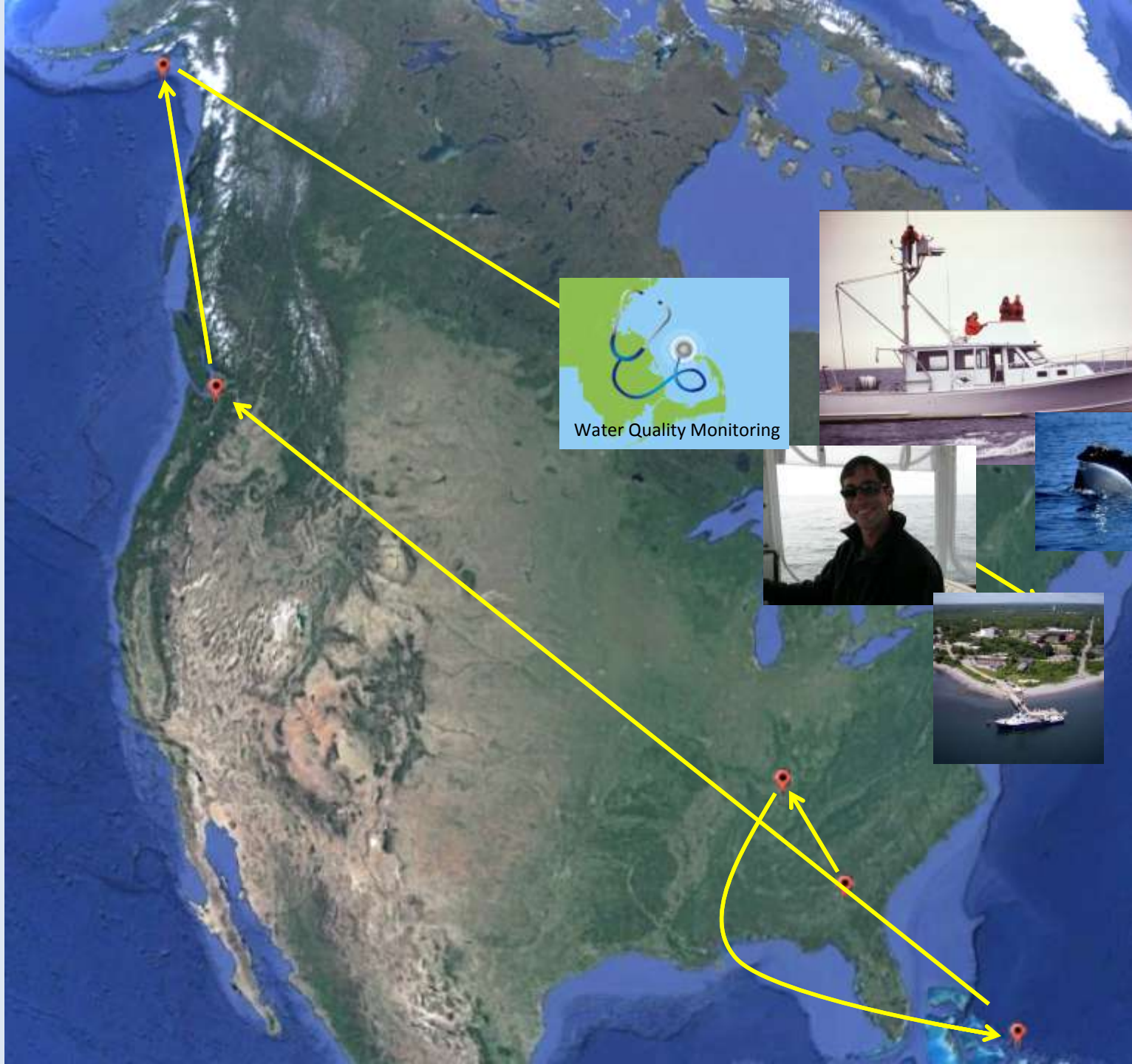












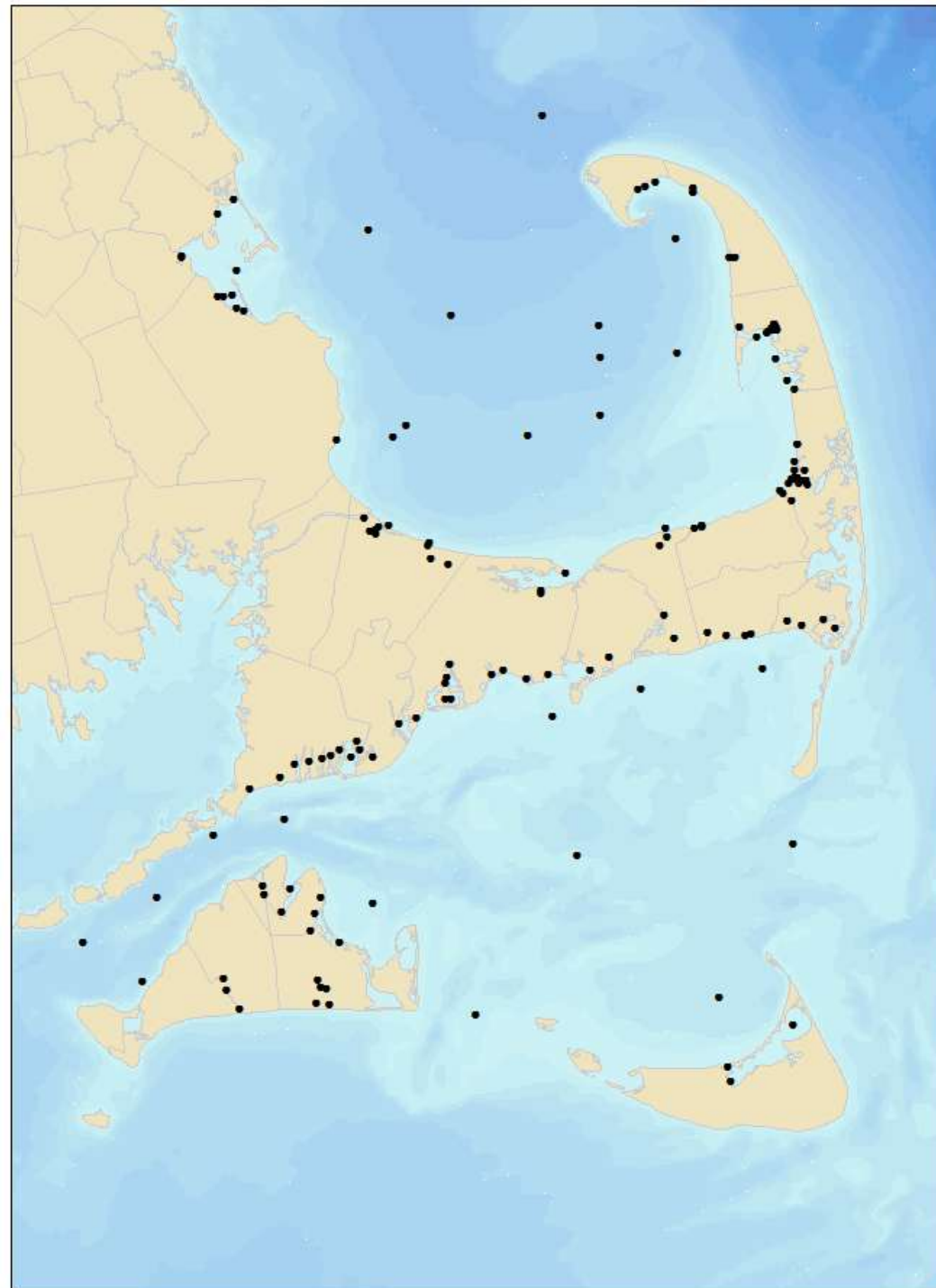
# Water Quality Parameters

## In Situ

- Temperature
- Salinity
- Dissolved Oxygen

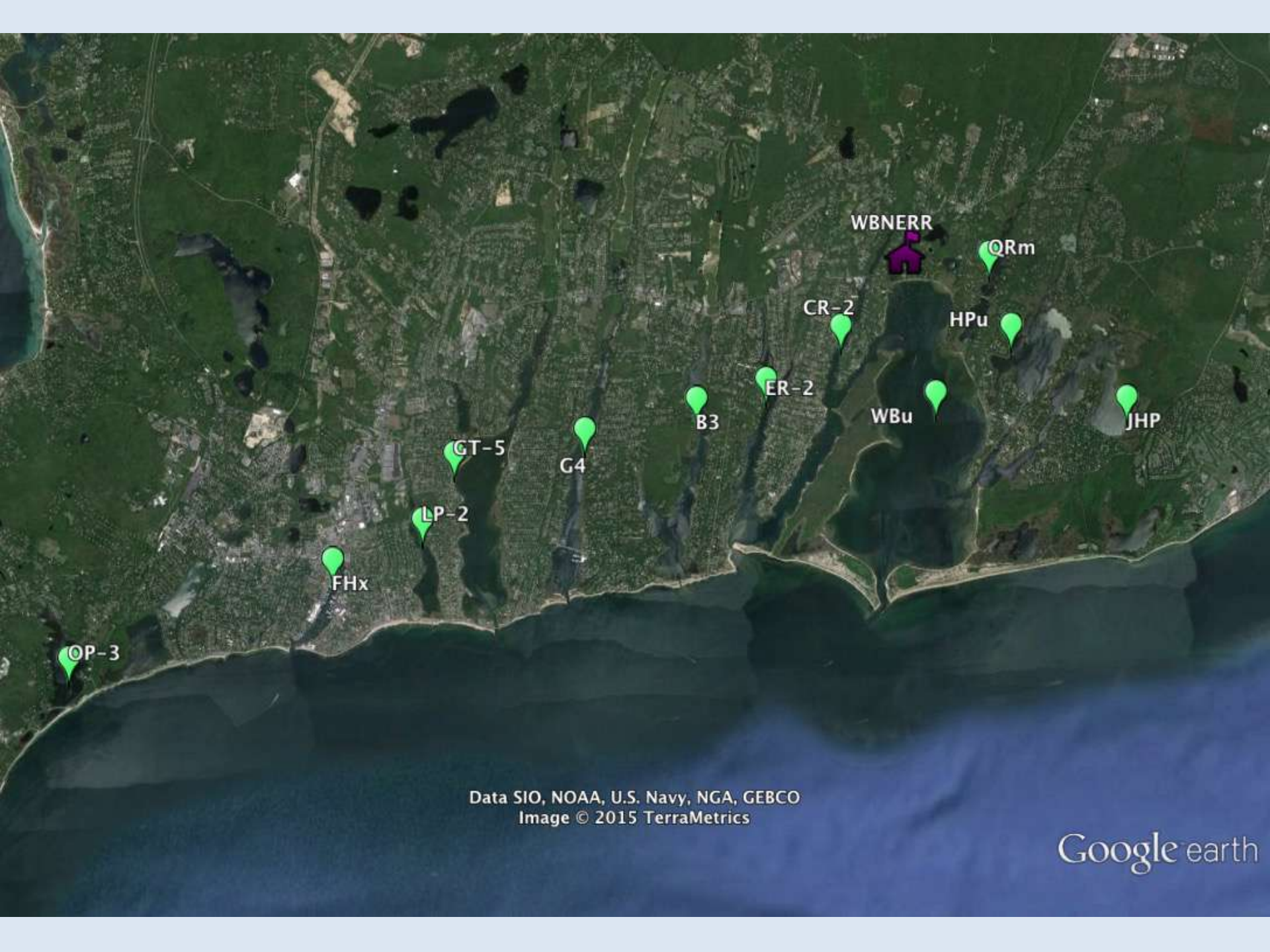
## Laboratory

- Nutrients
  - Nitrate+nitrite
  - Ammonium
  - Ortho-phosphate
  - Silicate
  - Total nitrogen
  - Total phosphorus
- Plant Pigments
  - Chlorophyll a
  - Pheophytin
- Turbidity



● Water Quality





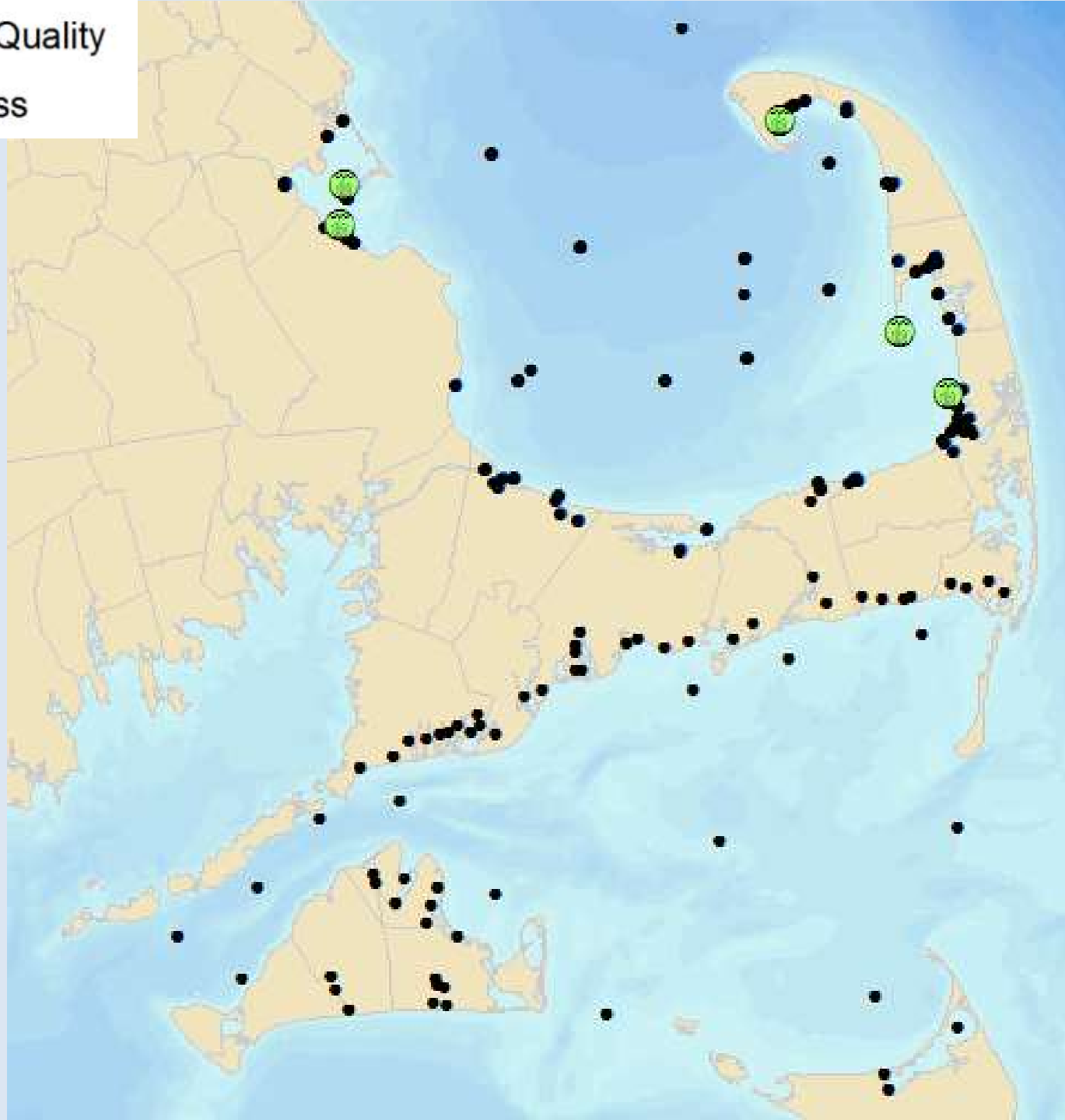
Data SIO, NOAA, U.S. Navy, NGA, GEBCO  
Image © 2015 TerraMetrics

Google earth

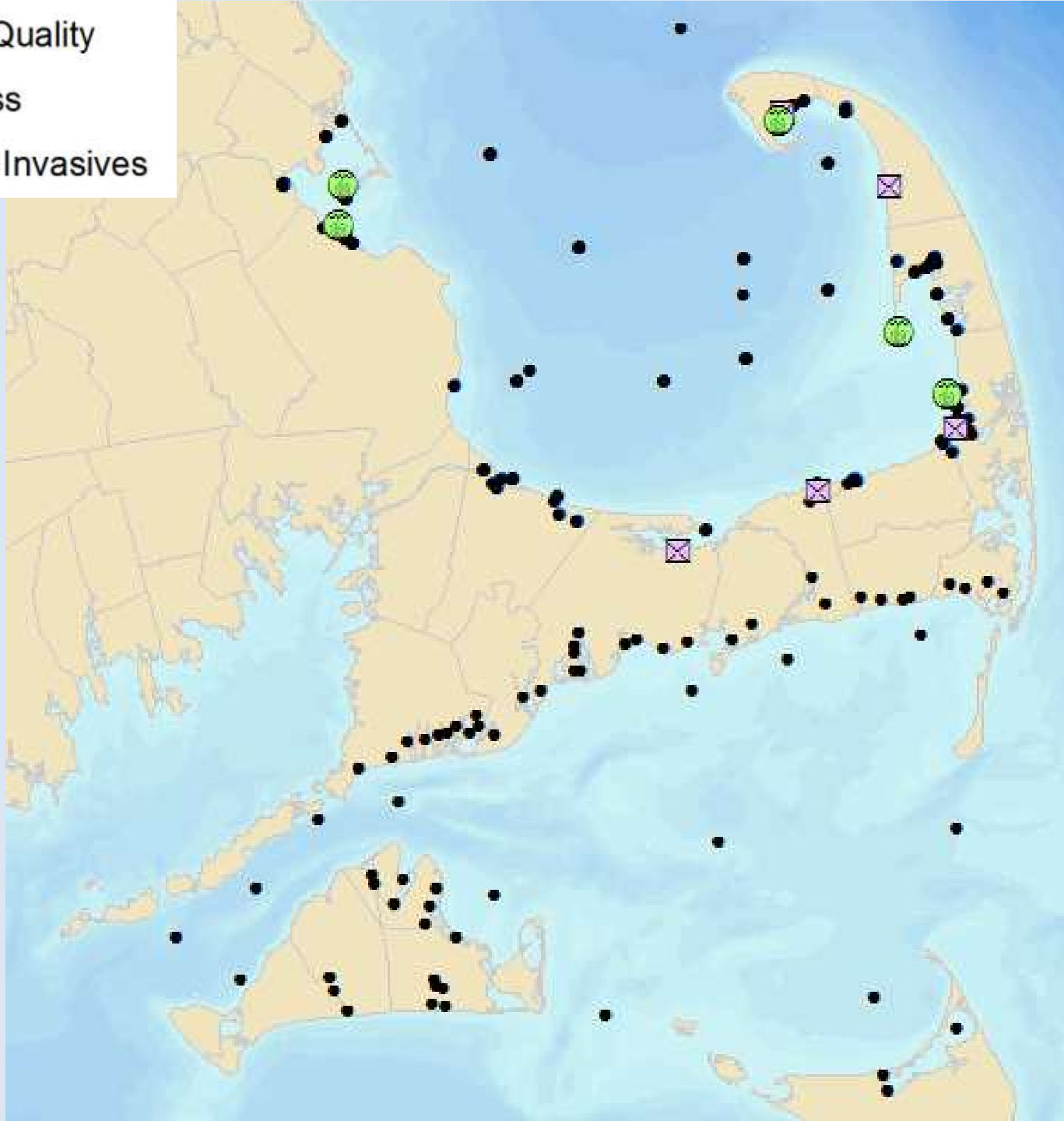
● Water Quality



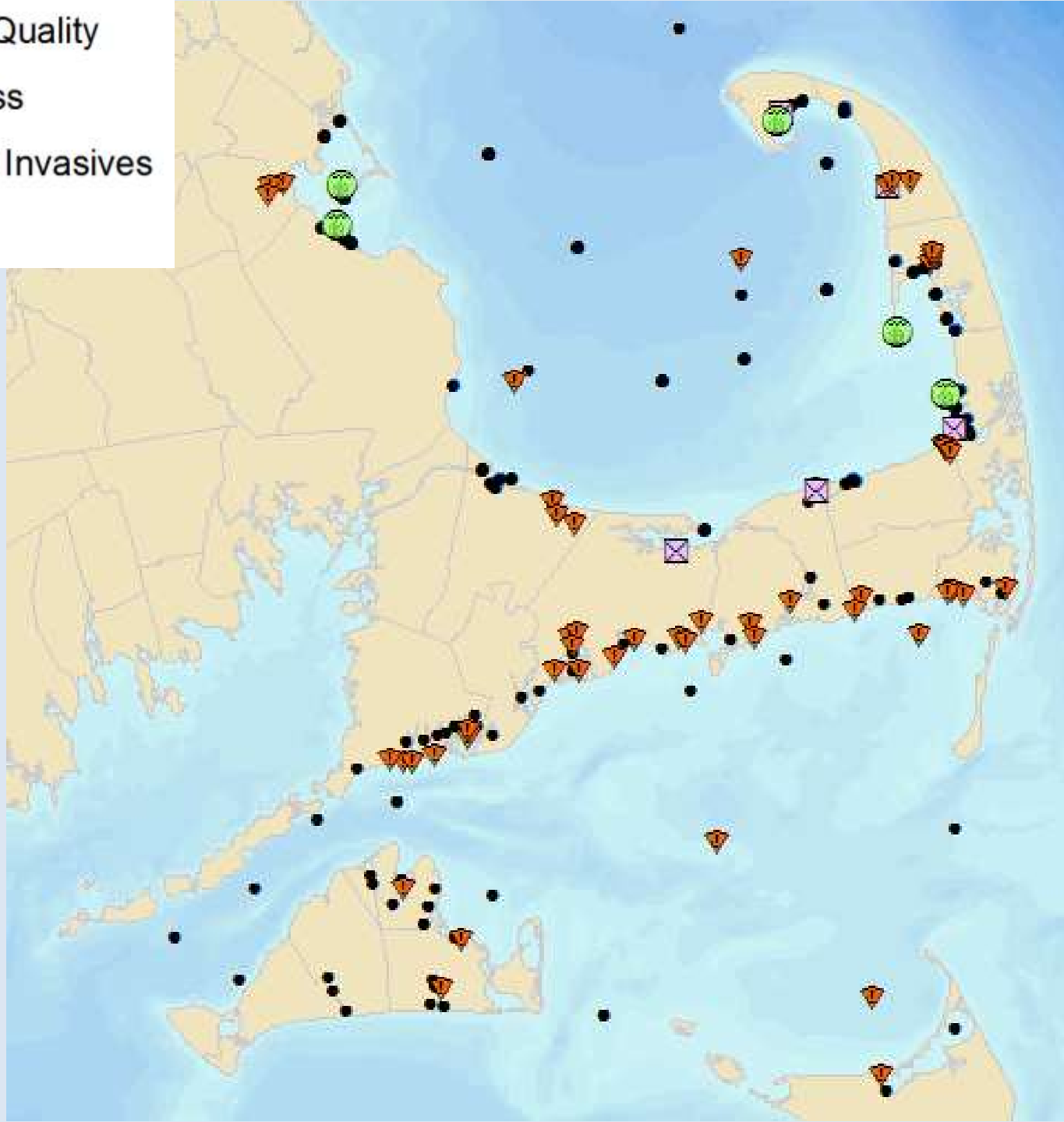
Eelgrass



- Water Quality
- Eelgrass
- ⊠ Marine Invasives



- Water Quality
- Eelgrass
- Marine Invasives
- ▲ CECs

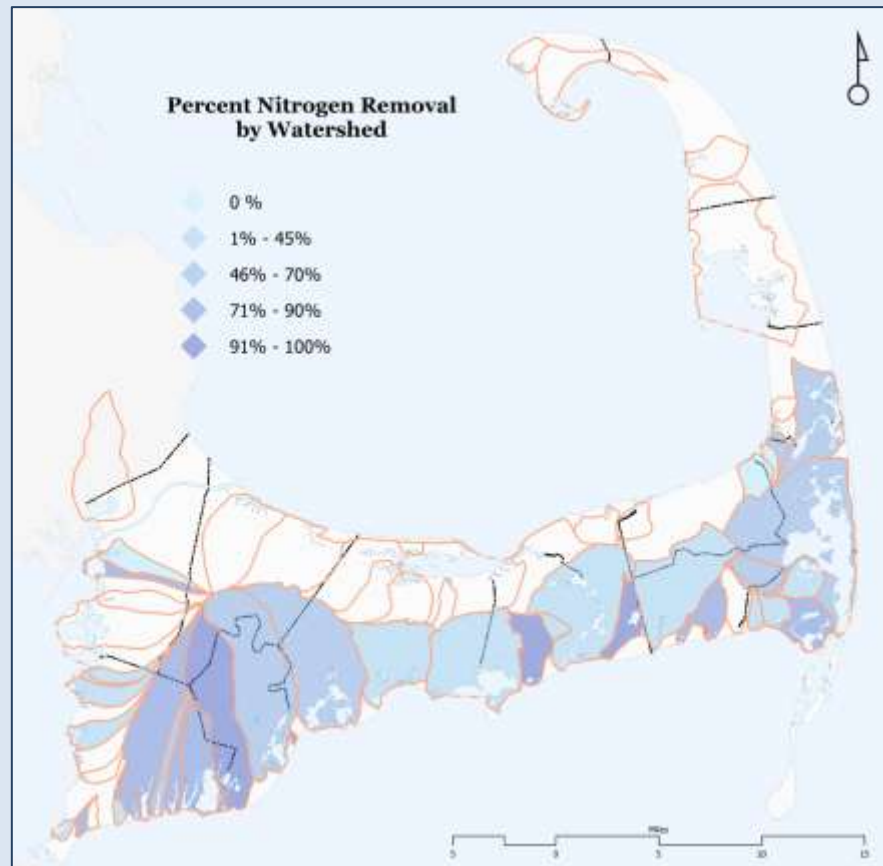


# Contaminants of Emerging Concern



# Cape Cod and the Islands

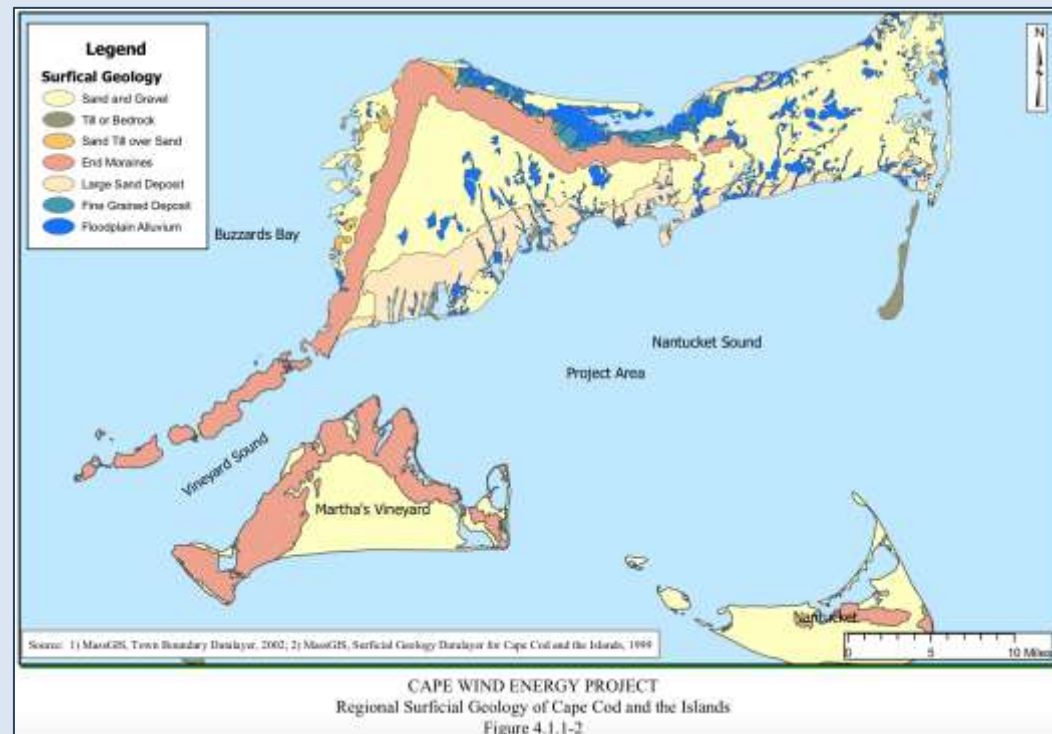
- Eutrophication of coastal waters



SOURCE: Cape Cod Commission GIS and  
the Massachusetts Estuaries Project

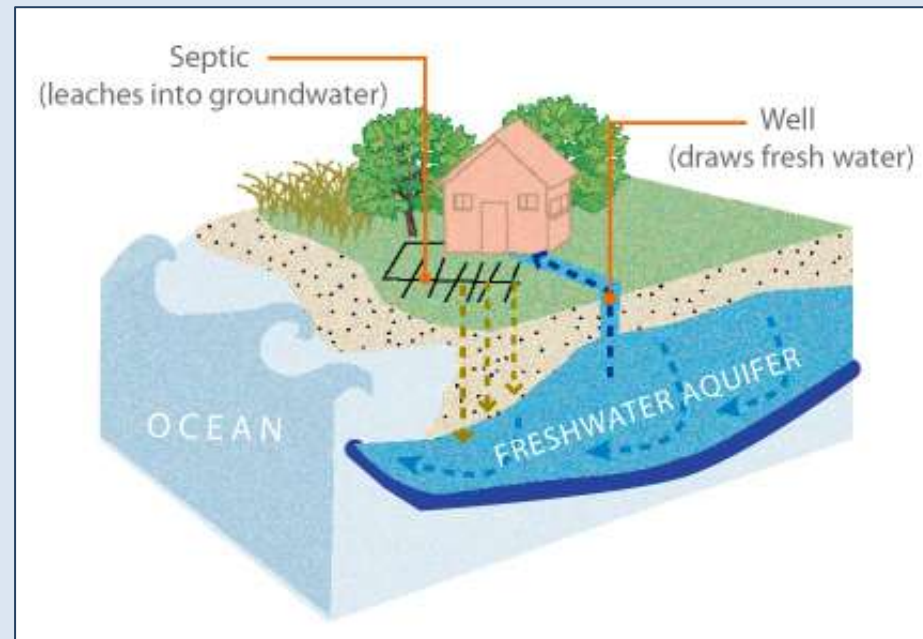
# Cape Cod and the Islands

- Eutrophication of coastal waters
- Sand and gravel
  - High porosity
  - Low organic carbon



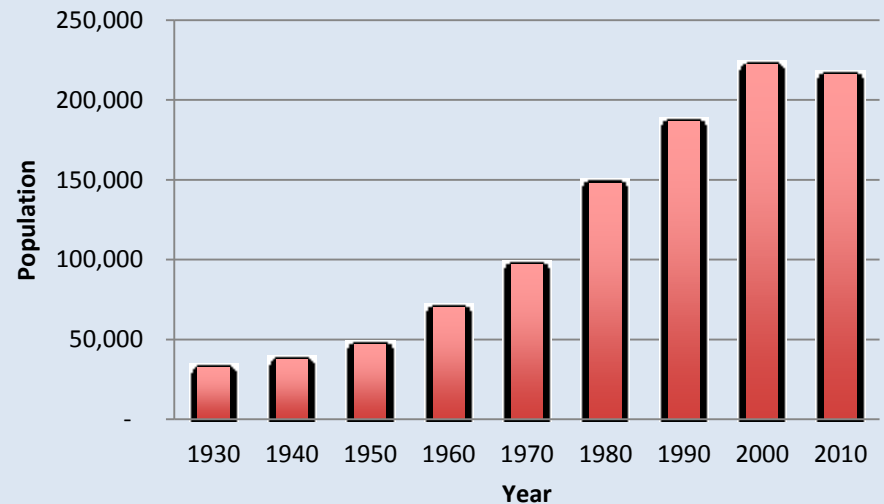
# Cape Cod and the Islands

- Eutrophication of coastal waters
- Sand and gravel
- Septic systems
  - 85% of Cape residents
  - Major sources of nitrogen inputs into coastal embayments



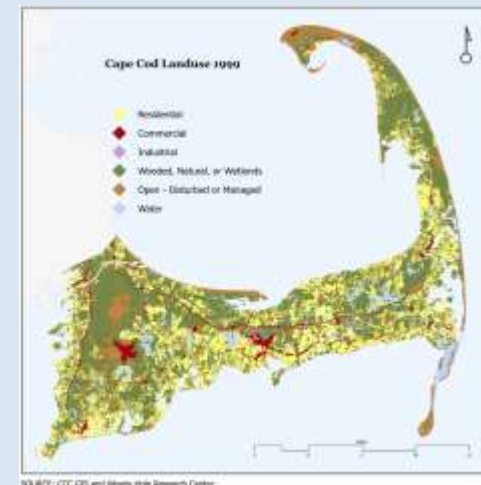
# Cape Cod and the Islands

- Eutrophication of coastal waters
- Sand and gravel
- Septic systems
- Growing Population



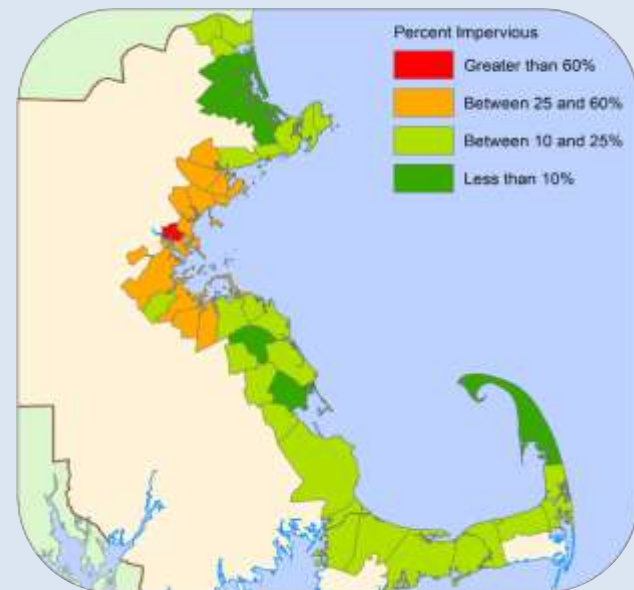
# Cape Cod and the Islands

- Eutrophication of coastal waters
- Sand and gravel
- Septic systems
- Growing Population
  - Change in Land Use



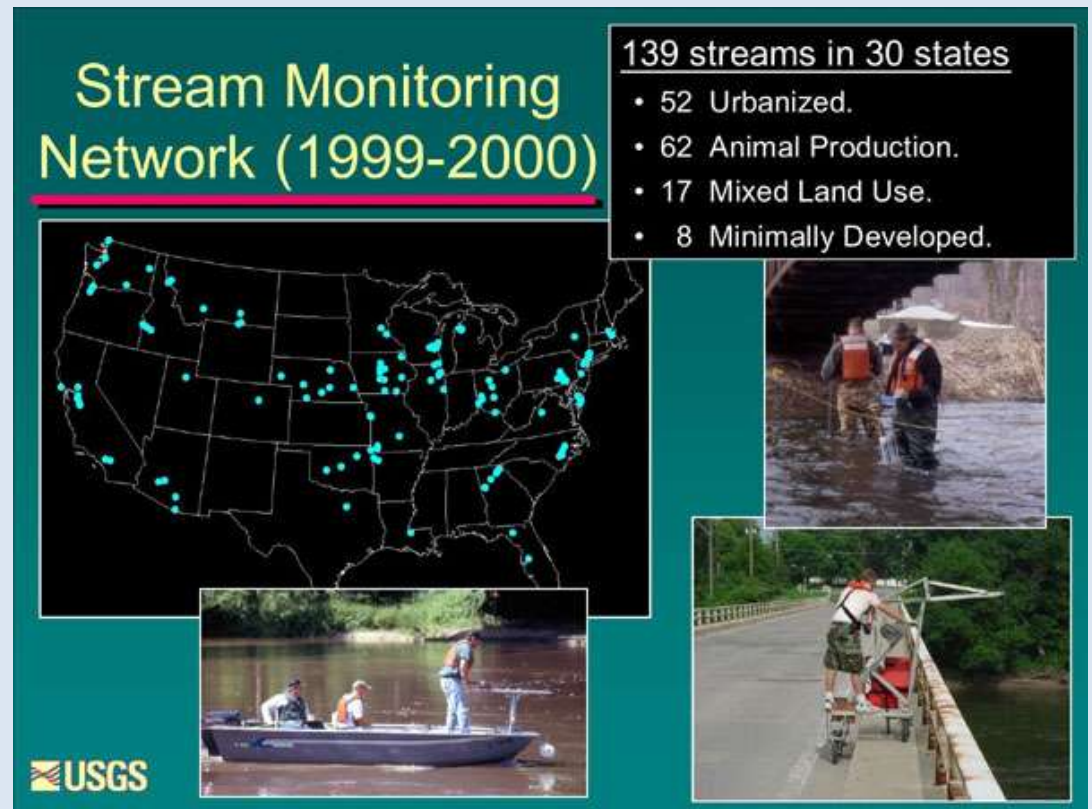
# Cape Cod and the Islands

- Eutrophication of coastal waters
- Sand and gravel
- Septic systems
- Growing Population
  - Change in Land Use
  - Increased Impervious Surfaces



# Contaminants of Emerging Concern in the Environment

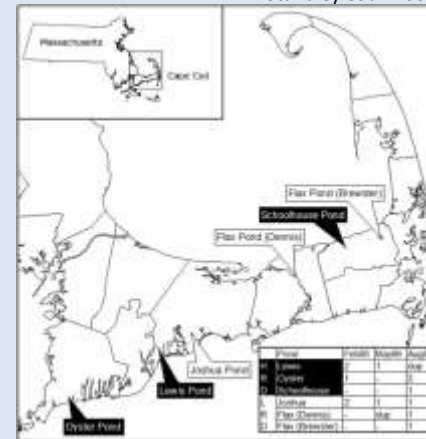
- USGS (2002)



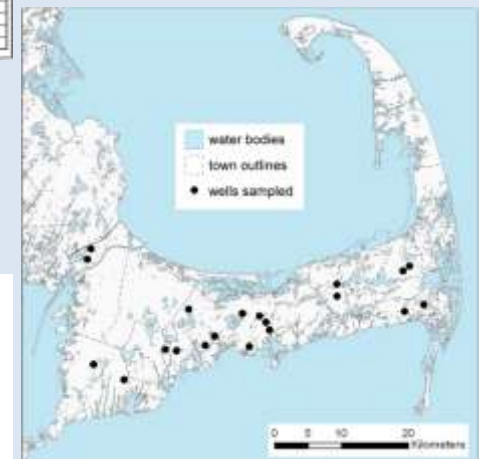
# Contaminants of Emerging Concern in the Environment

- USGS (2002)
- Silent Spring Institute
  - ponds (2006)
  - public wells (2010)
  - private wells (2011)

Standley et al. 2008

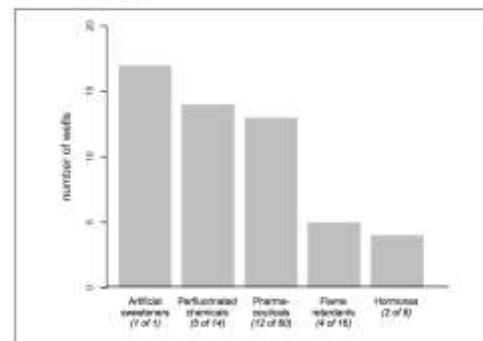


Schaider et al. 2014



SILENT SPRING INSTITUTE

Figure 2. Number of wells (out of 20) containing various classes of emerging contaminants. The numbers in parentheses indicate how many chemicals were found and how many were tested within each category.

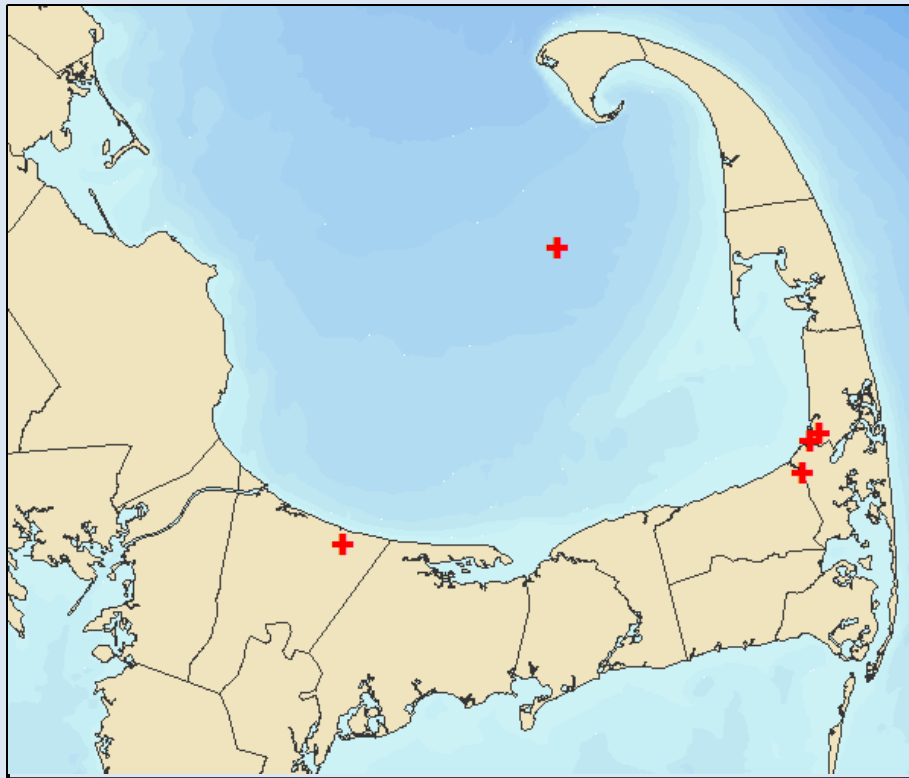


# Contaminants of Emerging Concern in the Environment

- USGS (2002)
- Silent Spring Institute
- Center for Coastal Studies
  - Coastal waters of Cape Cod and the Islands (2010-2014)

# Contaminants of Emerging Concern in Coastal Waters

- 2010: Detected



# Contaminants of Emerging Concern in Coastal Waters

- 2010: Detected
  - Low concentrations: ng/L (parts per trillion)

Concentration of carbamazepine = 7 ng/L

Dosage = 400 mg/day

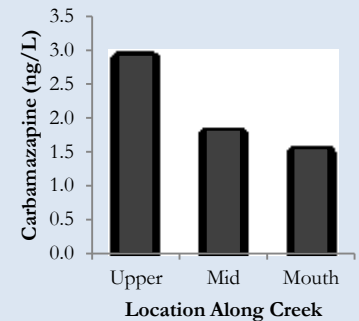
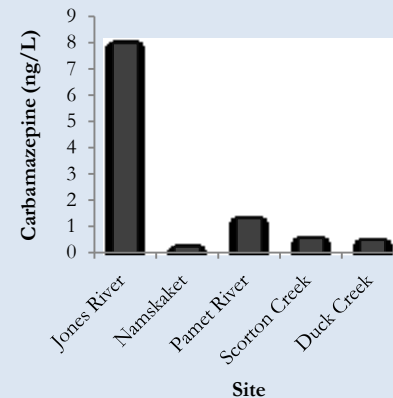
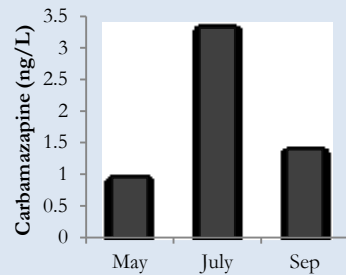
57,000,000 L

~23 Olympic size swimming pools



# Contaminants of Emerging Concern in Coastal Waters

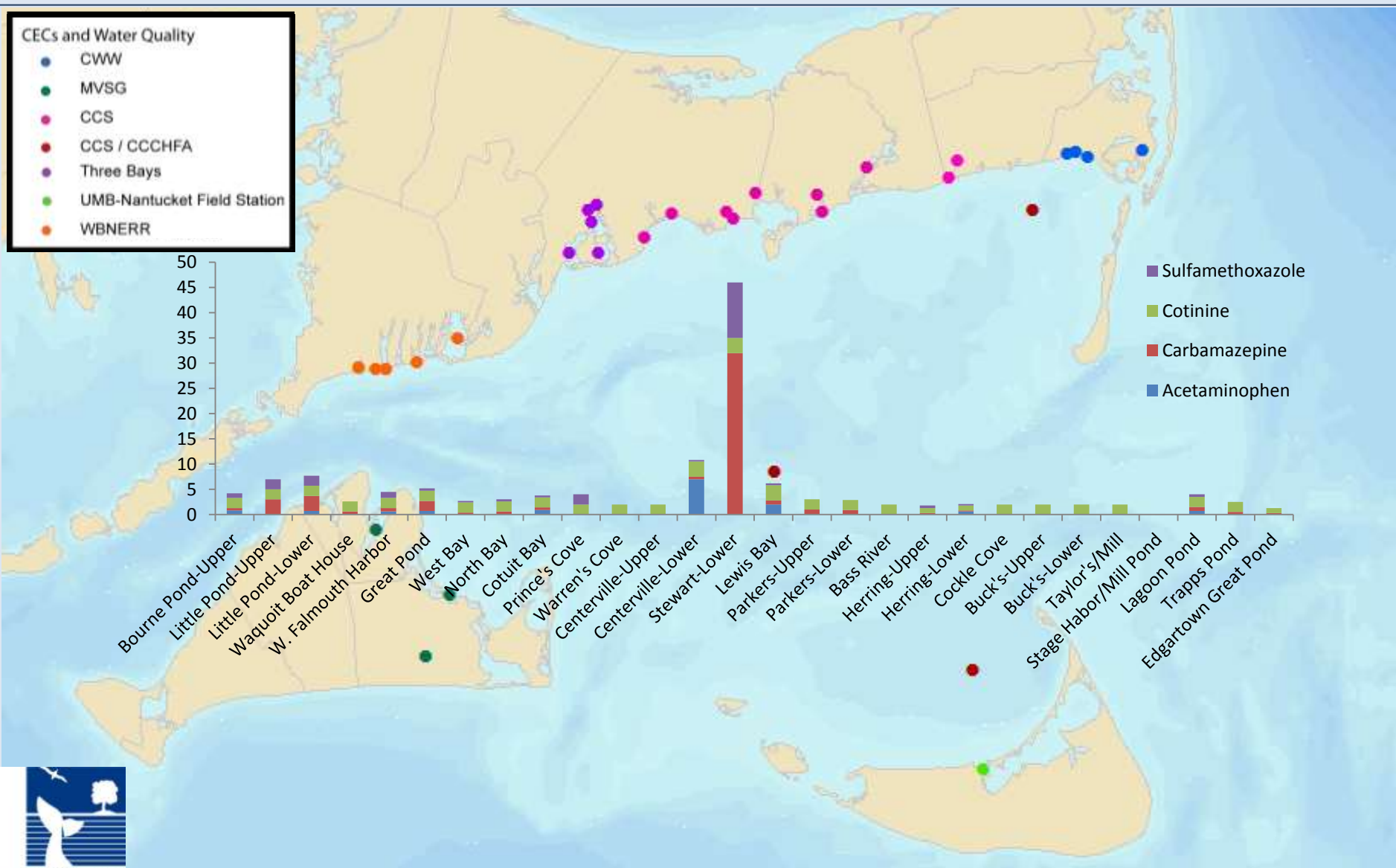
- 2010: Detected
- 2012: Spatial/temporal trends<sup>1,2</sup>



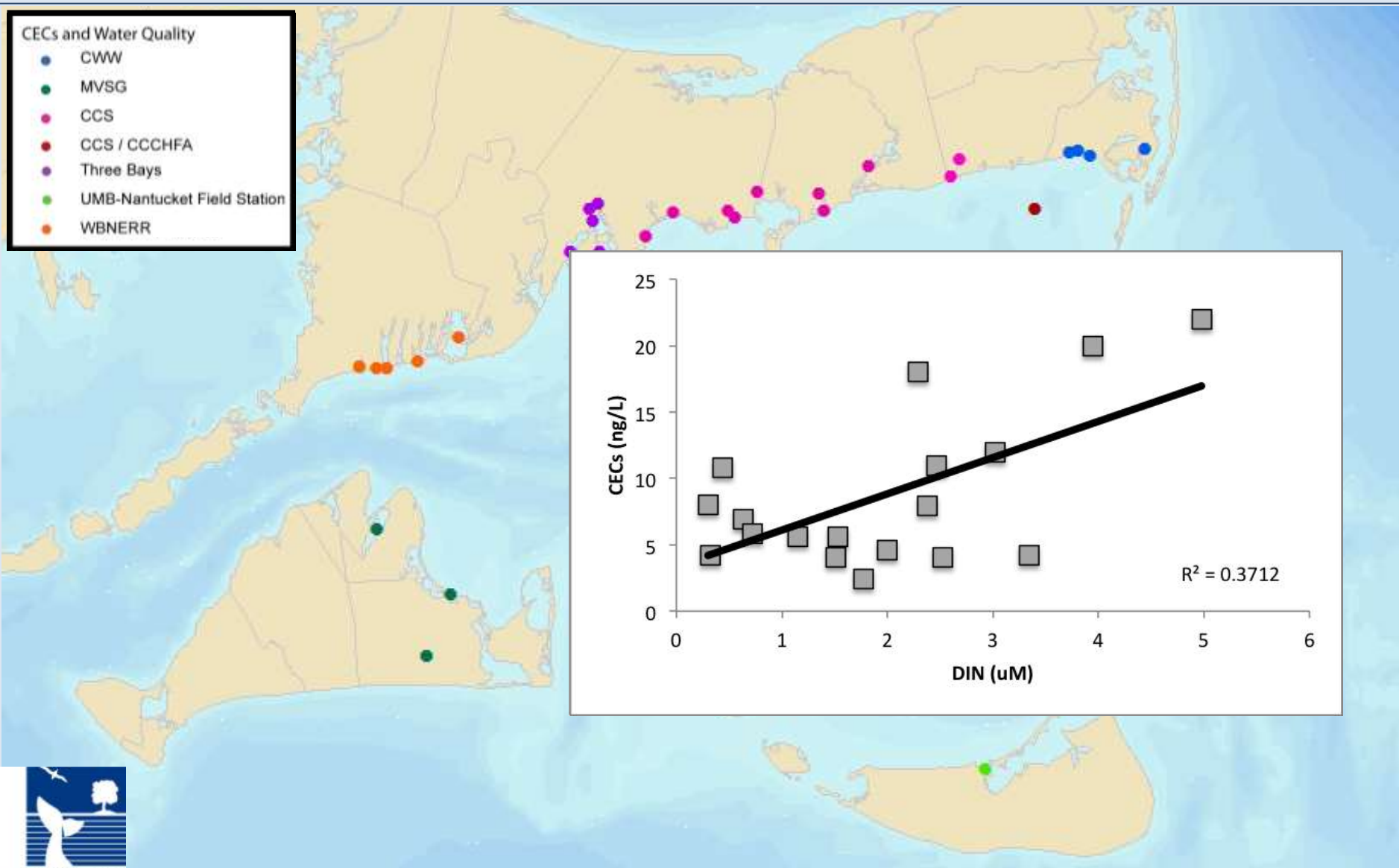
<sup>1</sup> Funding provided by Massachusetts Bays Program

<sup>2</sup> Funding provided by Massachusetts Environmental Trust

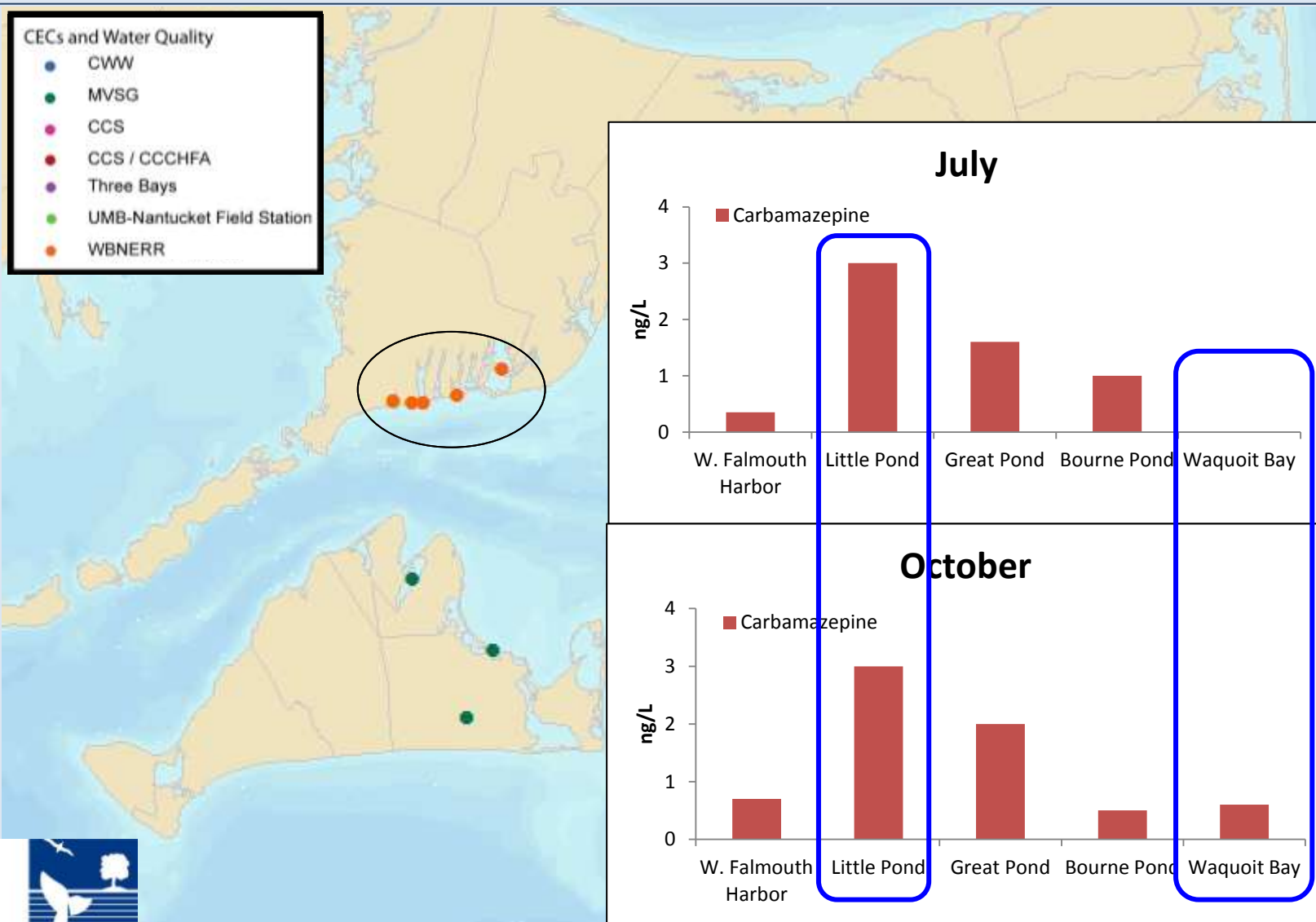
# Contaminants of Emerging Concern in Our Coastal Waters



# Contaminants of Emerging Concern in Our Coastal Waters



# Contaminants of Emerging Concern in Our Coastal Waters



# Contaminants of Emerging Concern

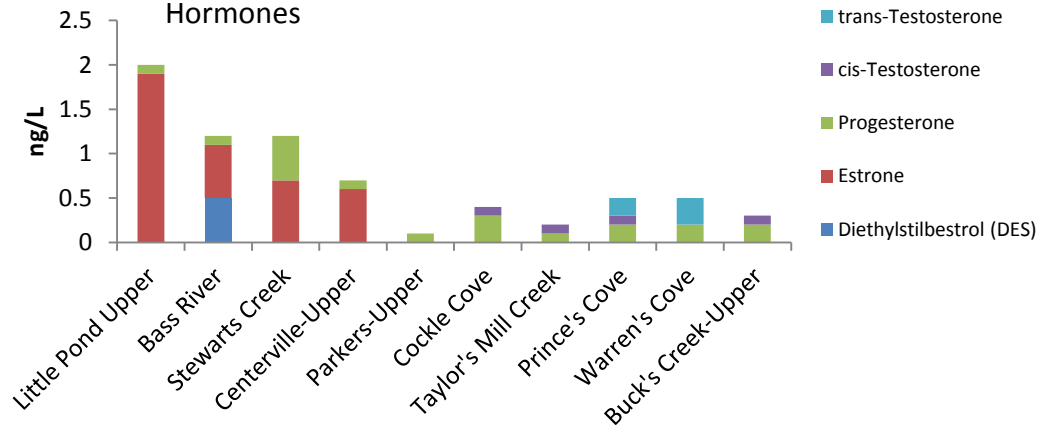
Hormones	Pharmaceuticals and Personal Care Products			
Diethylstilbestrol (DES)	Acetaminophen	Iopromide	Sulfamerazine	Gemfibrozil
17alpha-Estradiol	Antipyrine	Lasalocid	Sulfamethazine	Ibuprofen
17beta-Estradiol	Atenolol	Lincomycin	Sulfamethizole	Levothyroxine
Estriol	Azithromycin	Meprobamate	Sulfamethoxazole	Naproxen
Estrone	Bacitracin	Monensin	Sulfasalazine	Oxytetracycline
17alpha-Ethynyl estradiol	Caffeine	Narasin	Sulfathiazole	Penicillin G
Progesterone	Carbadox	Nicotine	Theobromine	Penicillin V
cis-Testosterone	Carbamazepine	Norfloxacin	Trimethoprim	Prednisone
trans-Testosterone	Ciprofloxacin	Oleandomycin	Tylosin	Salicylic acid
	Cotinine	Paraxanthine	Virginiamycin M1	Tetracycline
	DEET	Primidone	Bezafibrate	Theophylline
	Dexamethasone	Roxithromycin	Chloramphenicol	Triclocarban
	Diazepam	Salinomycin	Chlorotetracycline	Triclosan
	Diltiazem	Simvastatin	Clofibric acid	
	Enrofloxacin	Sulfachloropyridazine	Diclofenac	
	Erythromycin	Sulfadiazine	Dilantin	
	Fluoxetine (Prozac)	Sulfadimethoxine	Doxycycline	

# Contaminants of Emerging Concern in Our Coastal Waters

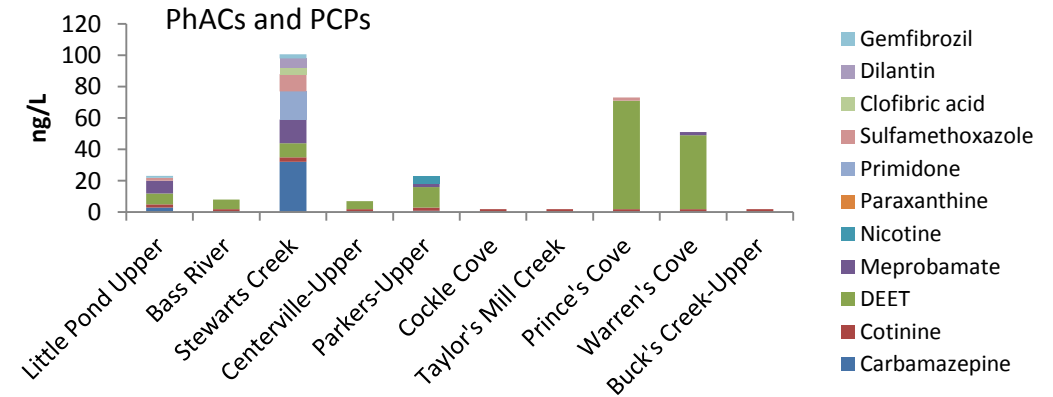
## CECs and Water Quality

- CWW
- MVSG
- CCS
- CCS / CCCHFA
- Three Bays
- UMB-Nantucket Field Station
- WBNERR

## Hormones



## PhACs and PCPs



# Contaminants of Emerging Concern in Coastal Waters

- 2010: Detected
- 2012: Spatial/temporal trends and relationships<sup>1,2</sup>
- 2014: Passive Samplers / Bioaccumulation<sup>2</sup>

<sup>1</sup> Funding provided by Massachusetts Bays Program

<sup>2</sup> Funding provided by Massachusetts Environmental Trust

Atlantic Oysters



POCIS Membranes



# POCIS / AQUASENSE-P

- Polar Organic Chemical Integrative Sampler<sup>1</sup>
- Hydrophilic (water-soluble) contaminants
  - prescription and OTC drugs, steroids, pesticides, hormones, antibiotics, personal care products
- Time-weighted average concentration over extended periods



USGS / EST

<sup>1</sup> Alvarez et al. (2004) Development of a passive, in situ, integrative sampler for hydrophilic organic Contaminants in aquatic environments. Environmental Toxicology and Chemistry 23(7):1640-1648.

# Contaminants of Emerging Concern: Bioaccumulation





40 days later...

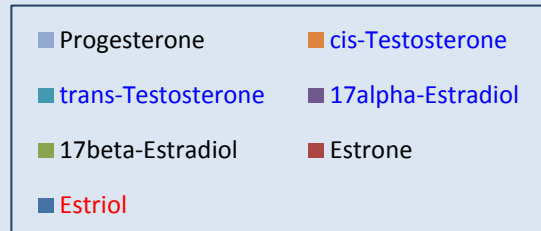


# Oysters

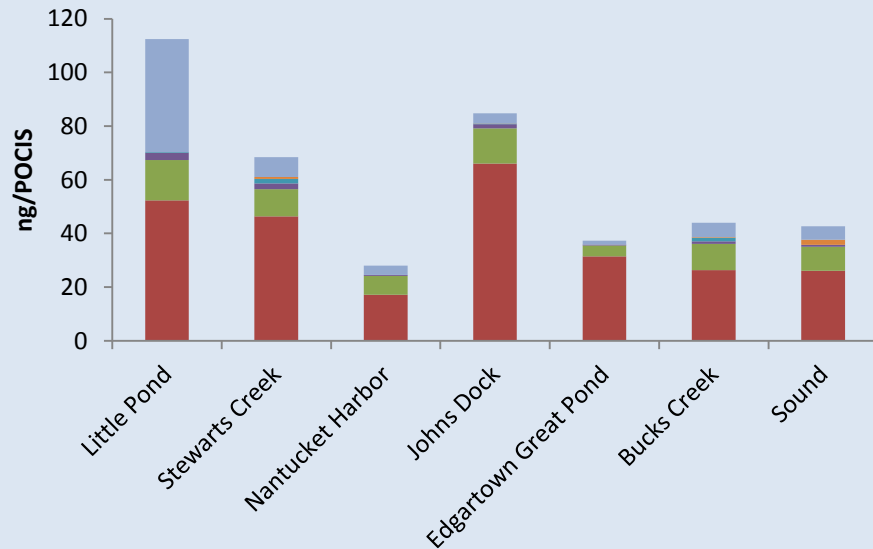
- Shell Height
- Weight
- Proximate Analysis
- Contaminants of Emerging Concern



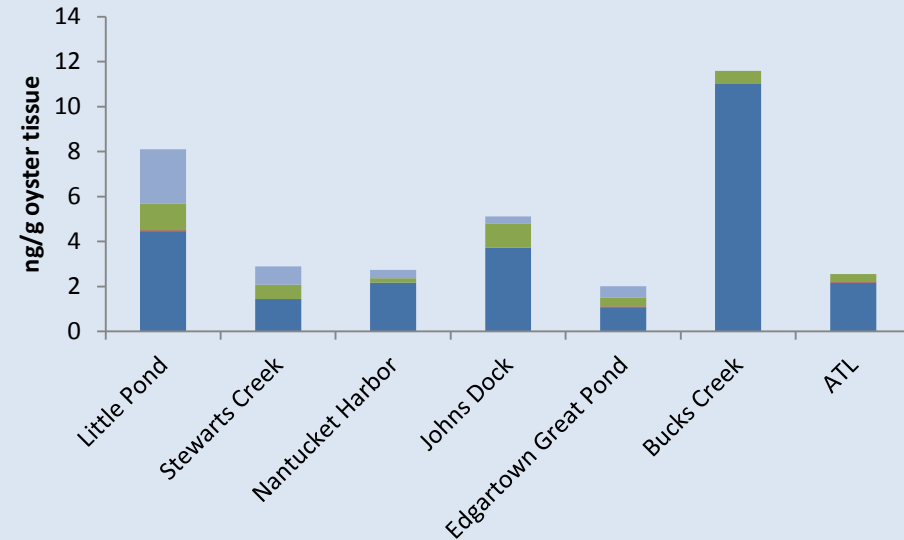
# Hormones



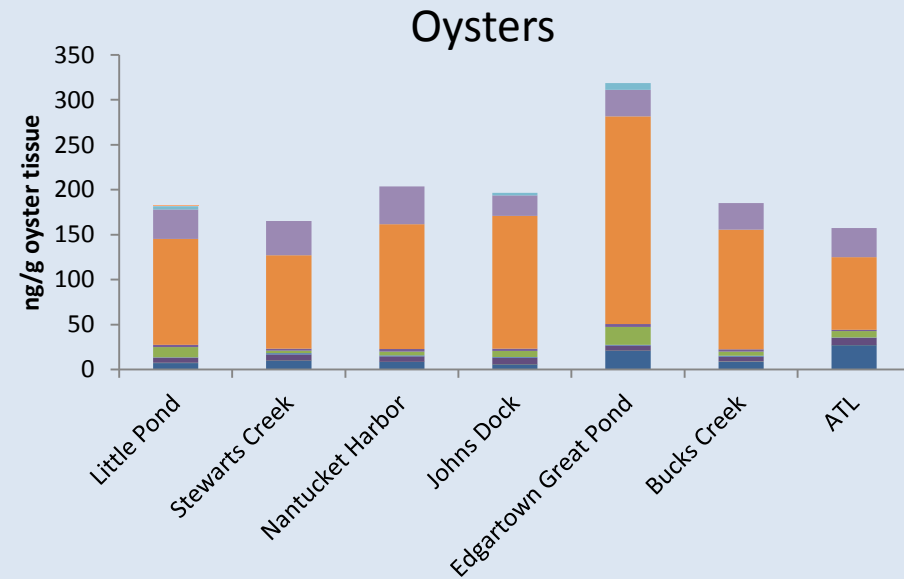
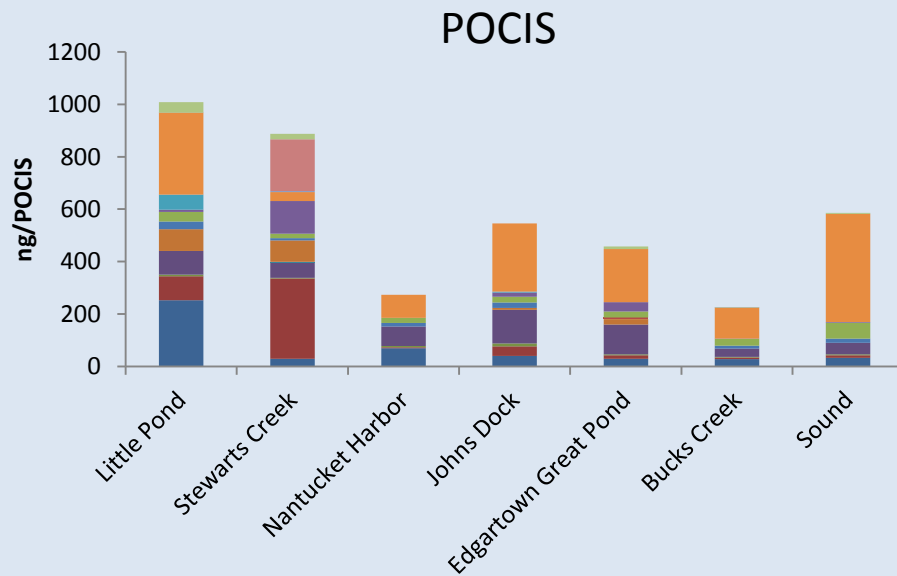
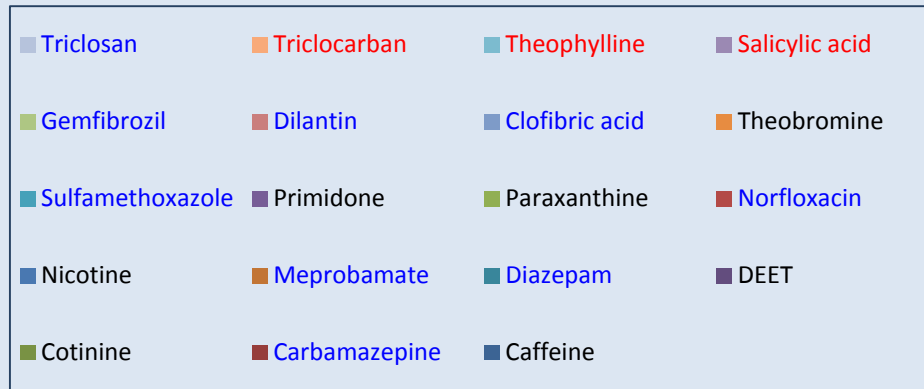
POCIS



Oysters



# Pharmaceuticals and Personal Care Products

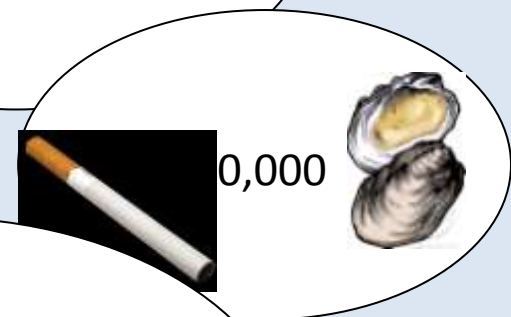


# Pharmaceuticals and Personal Care Products

Chemical	Main Uses
Caffeine	stimulant
Carbamazepine	anti-convulsant medication used to treat epilepsy and bipolar disorder
Cotinine*	breakdown product of nicotine
DEET*	insect repellent. Approved by EPA for application directly to skin; limited evidence of toxicity
Diazepam (Valium)	used to treat a variety of conditions including anxiety, panic attacks, insomnia and seizures
Meprobamate*	anti-anxiety medication
Nicotine	stimulant
Norfloxacin	synthetic chemtherapeutic antibacterial agent, commonly used to treat urinary tract infections
Paraxanthine	metabolite of caffeine
Primidone	anti-convulsant medication used to control seizures
Sulfamethoxazole	antibiotic, commonly used to treat urinary tract infections and pneumonia
Theobromine	stimulant found in chocolate, tea and a number of other foods
Clofibric acid	herbicide
Dilantin	antiepileptic drug, used to treat partial seizures
Gemfibrozil	lipid regulator (lowers cholesterol and fatty acids in blood)
Salicylic acid	anti-acne and other skin treatments
Theophylline	used in the treatment of respiratory diseases such as COPD and asthma
Triclocarban	antibacterial and antifungal agent used in disinfectants, soaps and other household products
Triclosan	antibacterial and antifungal agent used in personal care products such as toothpaste

# Contaminants of Emerging Concern in Oysters

Analyte	ng / 15 g oyster	
	Average	Max
Caffeine	188.53	405.00
Cotinine	1.75	2.39
DEET	96.47	120.45
Nicotine	12.36	20.10
Paraxanthine	120.86	297.00
Primidone	37.48	49.05
Theobromine	2043.43	3465.00
Salicylic acid	486.43	628.50
Theophylline	66.65	109.20
Triclocarban	15.15	15.15



# Contaminants of Emerging Concern: Bottom line and implications

- CECs are present in our coastal waters

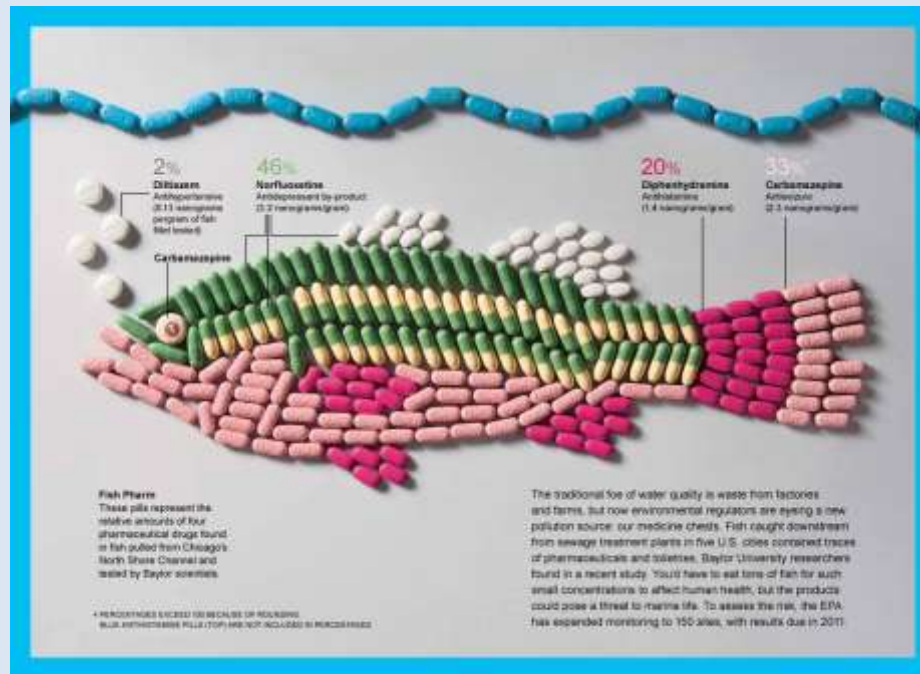
# Contaminants of Emerging Concern: Bottom line and implications

- CECs are present in our coastal waters
- Concentrations are linked to the degree of human use



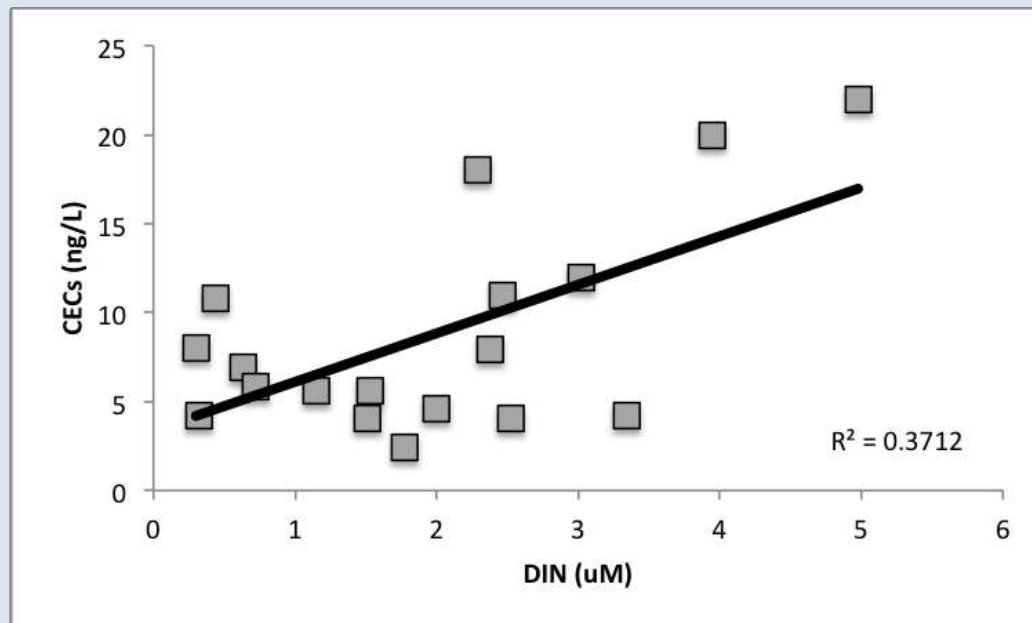
# Contaminants of Emerging Concern: Bottom line and implications

- CECs are present in our coastal waters
- Concentrations are linked to the degree of human use
- Evidence of bioaccumulation of some (but not all) CECs



# Contaminants of Emerging Concern: Bottom line and implications

- CECs are present in our coastal waters
- Concentrations are linked to the degree of human use
- Evidence of bioaccumulation of some (but not all) CECs
- Closely associated with wastewater

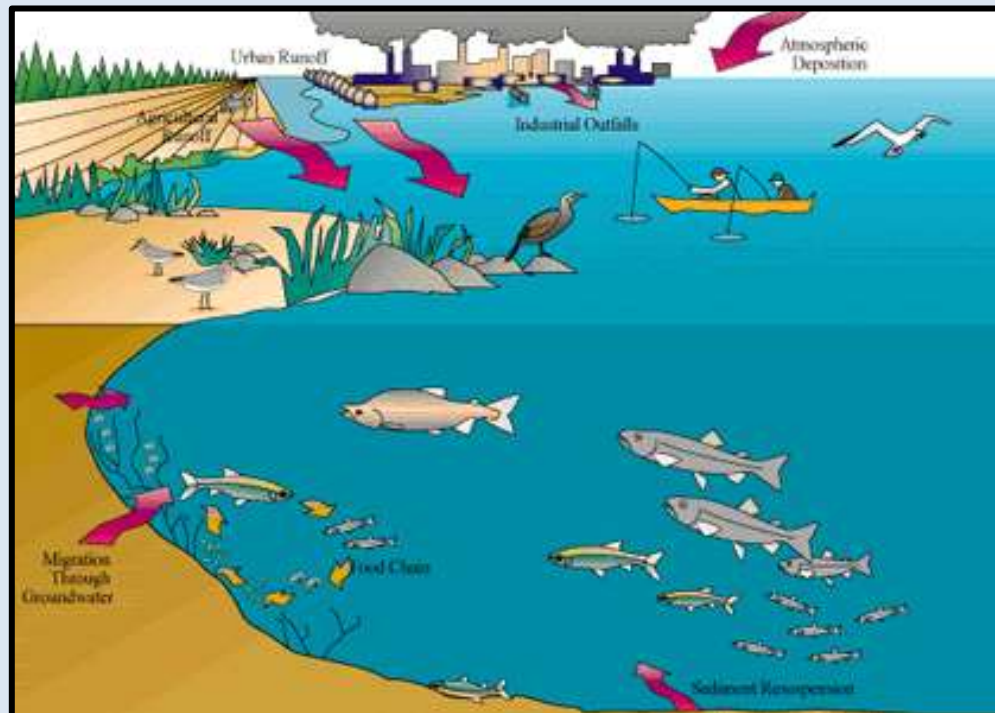


# Contaminants of Emerging Concern: Bottom line and implications

- Need to establish baseline data

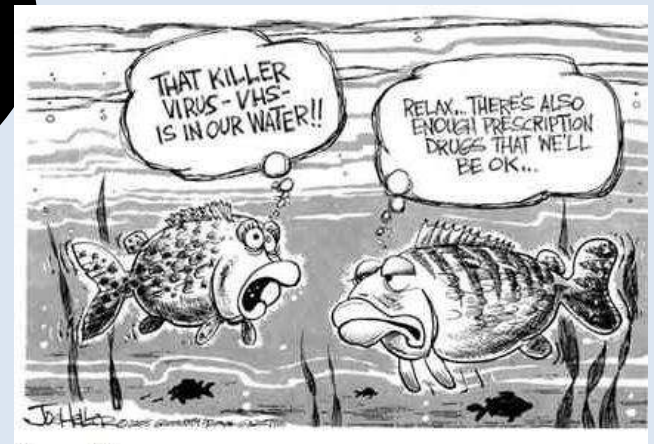
# Contaminants of Emerging Concern: Bottom line and implications

- Need to establish baseline data
- Occurrence, fate, transport, toxicity and persistence



# Contaminants of Emerging Concern: Bottom line and implications

- Need to establish baseline data
- Occurrence, fate, transport, toxicity and persistence
- Environmental impacts

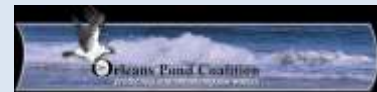
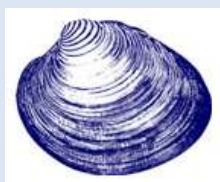


# Contaminants of Emerging Concern: Bottom line and implications

- Largely unregulated but beginning to receive attention



# Partners / Collaborators / Funders



# Contaminants of Emerging Concern: Bottom line and implications

- CECs are present in our coastal waters
- Concentrations are linked to the degree of human use
- Evidence of bioaccumulation of some (but not all) CECs
- Closely associated with wastewater
- Need to establish baseline data
- Occurrence, fate, transport, toxicity and persistence
- Environmental impacts
- Largely unregulated but beginning to receive attention
  - Federal
  - State

