

# The Value of Water Quality to Coastal Recreation in New England

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# Big Picture

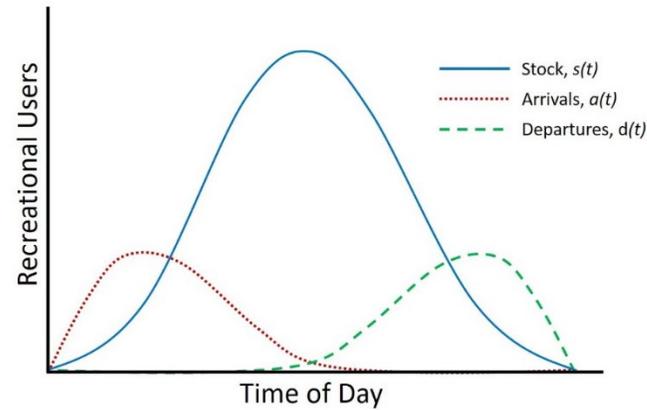
- Coastal waters have issues:
  - Nutrients and eutrophication
  - Bacteria
  - PFAS, PCBs
- Policies to address them:
  - NPDES
  - TMDLs
  - Stormwater (MS4)
  - Green Infrastructure
  - Superfund
  - Beach closure programs
- No recent studies of economic value of recreation and water quality in the region



# EPA ORD's Research Efforts

1. Estimating visitation
2. Estimating values per visit and values for changes in WQ
3. Combining with water quality data to evaluate policies or programs

<https://www.epa.gov/water-research/human-dimensions-water-quality-research>



|                  |                     | Compliance State   |   |
|------------------|---------------------|--|---|
|                  |                     | UNDER STANDARD   | OVER STANDARD   |
| Management State | SWIMMING ALLOWED    | Outcome A:<br>Correctly Identified Compliance                                | <b>Outcome B:<br/>Non-compliance &amp; Swim Area is Open</b><br>[Type II Error] |
|                  | SWIMMING PROHIBITED | <b>Outcome C:<br/>Compliance &amp; Swim Area is Closed</b><br>[Type I Error] | Outcome D:<br>Correctly Identified Non-Compliance                               |

# Past Research

## New England

Binkley and Hanemann (1978)-  
Boston Area

*Keep Paper Copy*

United States  
Environmental Protection  
Agency  
Office of Health and Ecological  
Effects  
Washington DC 20460  
EPA-600/5-78-010  
June 1978  
PA-257-719

 **The Recreation  
Benefits of  
Water Quality  
Improvements**

Analysis of Day  
Trips in an  
Urban Setting

McConnell (1986)- New Bedford

Opaluch et al. (1999)- Long Island

Parsons and Firestone (2018) –  
US East Coast

## Mid-Atlantic

Bockstael, Hanemann and Strand  
(1989)- Chesapeake Bay

 **Measuring the Benefits of  
Water Quality Improvements  
Using Recreation Demand  
Models: Part I**



Parsons, Massey and Tomasi (1999)- Mid  
Atlantic

Stefanovia (2009)- Mid Atlantic

Parsons et al. (2013) - Delaware

## California

Hilger and Hanemann (2008) – California

Lew (2002) – San Diego

Leggett et al. (2014) – Southern California

## Gulf Coast

Whitehead et al. (2018) – Northwest Florida

Glasgow and Train (2017) – Gulf Coast

English et al. (2018) – Gulf Coast



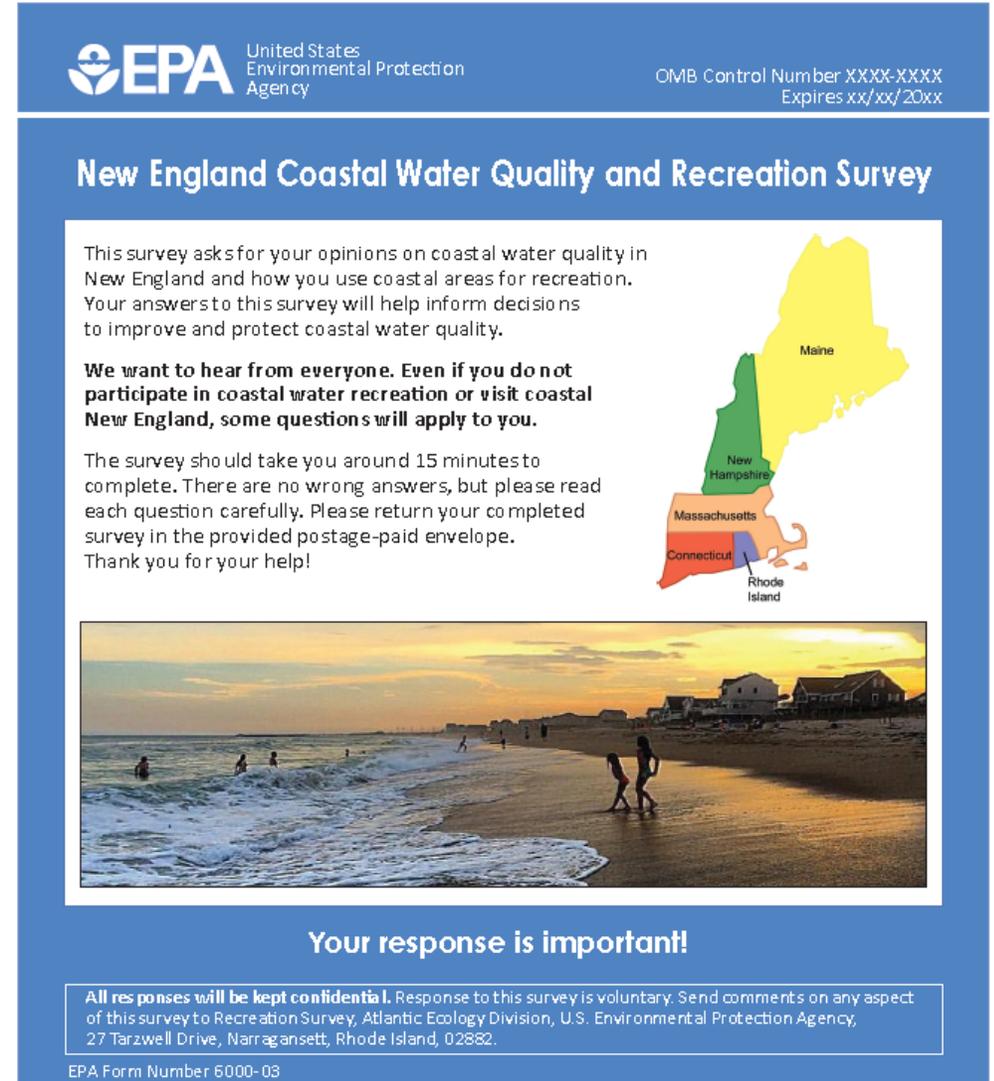
# Research Gap

- Recent non-market values for multiple water recreation activities (not just fishing)
- Recent values for New England as a function of water quality
  - Nutrient impacts
  - Remote sensing
- Flexible choice set
  - Not just beaches
- Water quality perceptions
- Sense of Place



# New England Coastal Recreation Survey

- Web and Mail Survey
  - Conducted in summer of 2018
  - Mailed to 9,520 households in New England
    - 1,437 responses (16% response rate)
    - Oversampled for Cape Cod
- Not limited to specific beaches / access points
  - Mapping functionality (and write-in for paper surveys) to capture any water access point
  - Aim is to capture a range of water quality and activities
- Information collected
  - Recreation participation and effort
  - Last trip profiles (single day and overnight)
  - Water quality perceptions
  - Sense of place
  - Demographics



 United States  
Environmental Protection  
Agency

OMB Control Number XXXX-XXXX  
Expires xx/xx/20xx

## New England Coastal Water Quality and Recreation Survey

This survey asks for your opinions on coastal water quality in New England and how you use coastal areas for recreation. Your answers to this survey will help inform decisions to improve and protect coastal water quality.

**We want to hear from everyone. Even if you do not participate in coastal water recreation or visit coastal New England, some questions will apply to you.**

The survey should take you around 15 minutes to complete. There are no wrong answers, but please read each question carefully. Please return your completed survey in the provided postage-paid envelope. Thank you for your help!

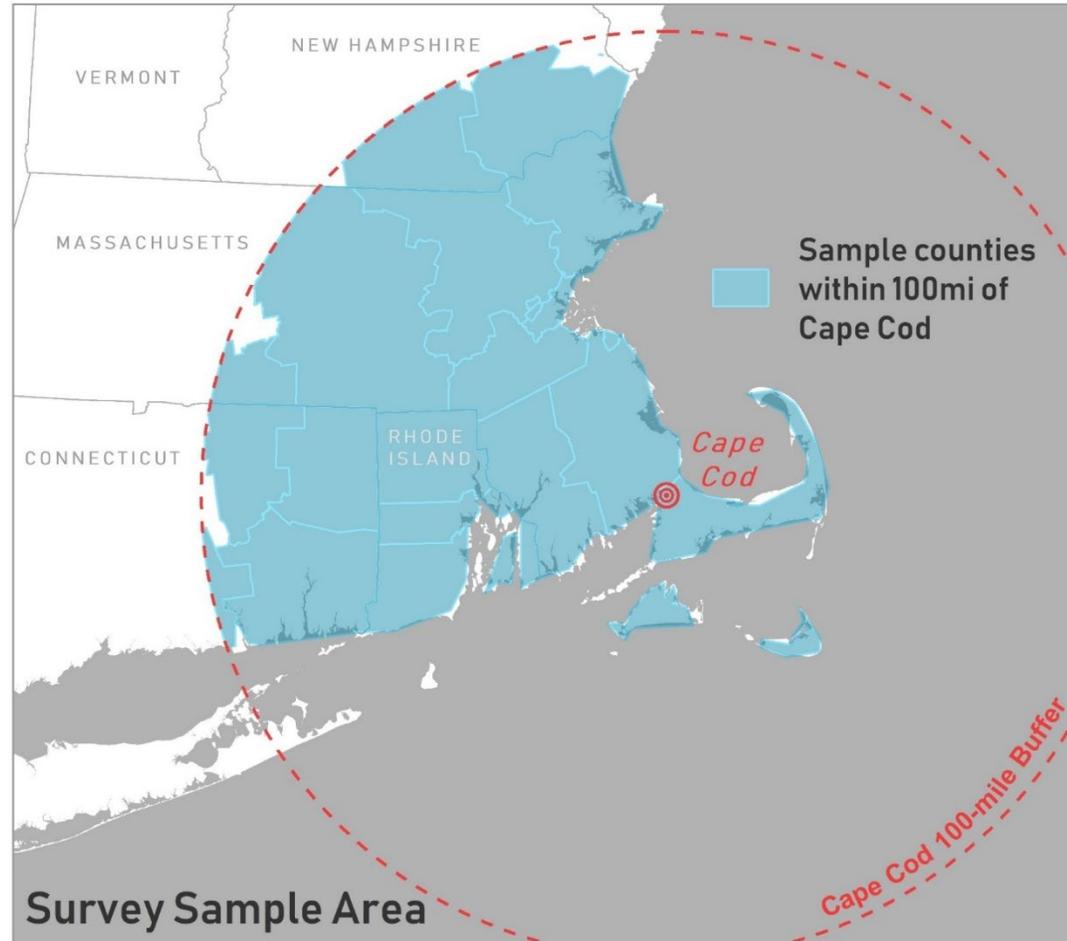


**Your response is important!**

All responses will be kept confidential. Response to this survey is voluntary. Send comments on any aspect of this survey to Recreation Survey, Atlantic Ecology Division, U.S. Environmental Protection Agency, 27 Tarzwell Drive, Narragansett, Rhode Island, 02882.

EPA Form Number 6000-03

# New England Coastal Recreation Survey



# Summary Stats

| N         | %     | Households in sample region   |
|-----------|-------|---|
| 2,422,594 | 71.2% | Households in sample region participated in saltwater recreation in New England in past 12 months |
| 982,085   | 28.8% | Households in sample region did not participate in past 12 months                                 |

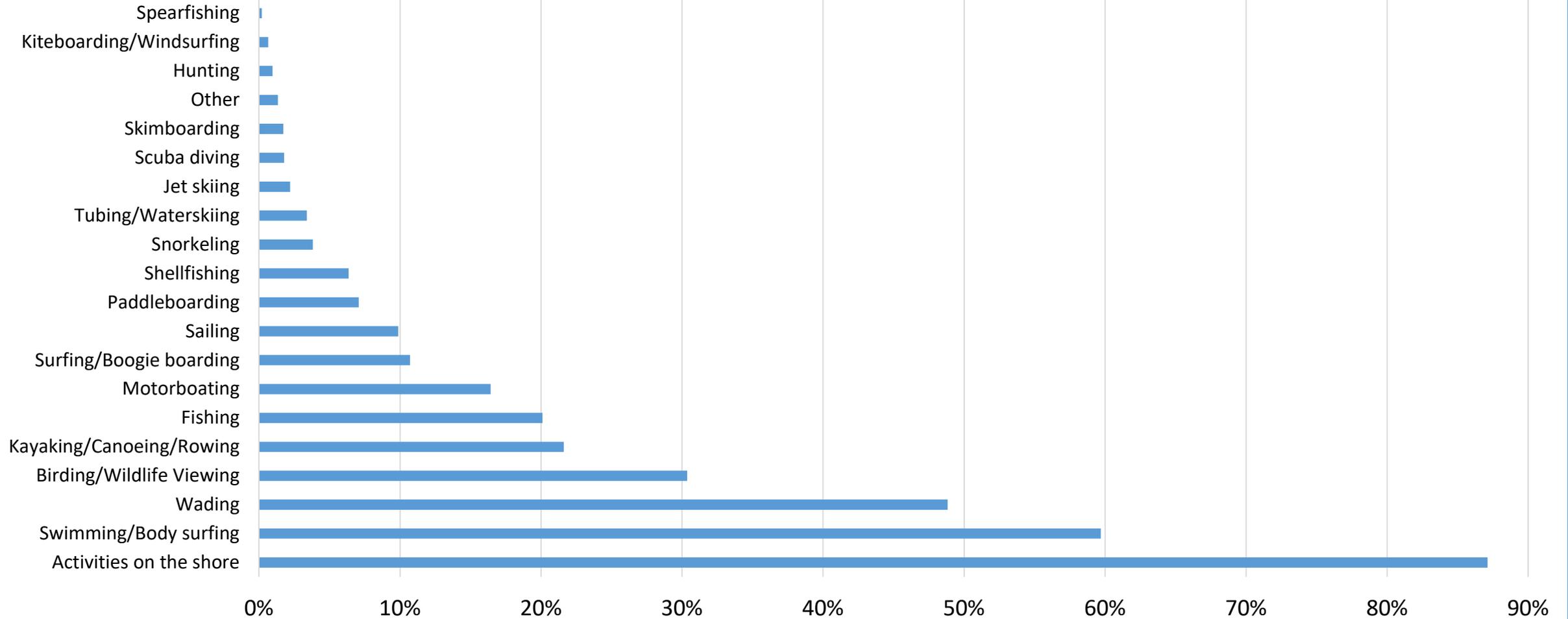
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Results extrapolated to population of sampled area using demographic and sampling weights

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# Summary Stats

Saltwater activities last 12 months- participants only



# Summary Stats

| Effort Summary - days per season and per year |      |                        |
|---|------|------------------------|
| Season  | Mean | Total from Sample Area |
| Spring  | 9.0  | 15.9M                  |
| Summer  | 18.8 | 41.9M                  |
| Fall  | 10.2 | 18.8M                  |
| Winter  | 3.3  | 5.1M                   |
| Total Year                                    | 36.8 | 83.6M                  |
| Notes:  |      |                        |
| • Truncated > 95 <sup>th</sup> percentile     |      |                        |

# Trip Geolocation

Where did you go in **New England**? Please place a PIN on the map to mark where you went. You can navigate using the map, or use the search function and/or dropdown menus.

## Select State

## Select Town

## Search for a Place

Examples: beach name, street name, marina, or park name.

I can't find the place on the map/I don't remember the name.

## Confirm Location

Is this the correct place?

E Beach Rd, Charlestown, RI  
02813, USA



Use the + and - buttons at the bottom-right of the window to zoom in and out. Click and drag to move the map. Click to place a PIN on the map

# Trip Geolocation

- Web responses



Where did you go in **New England?**  
Please place a PIN on the map to mark where you went. You can navigate using the map, or use the search function and/or dropdown menus.

**Select State**  
Rhode Island

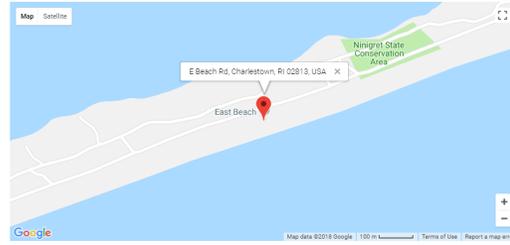
**Select Town**  
Charlestown

**Search for a Place**  
east beach  
Examples: beach name, street name, marina, or park name.

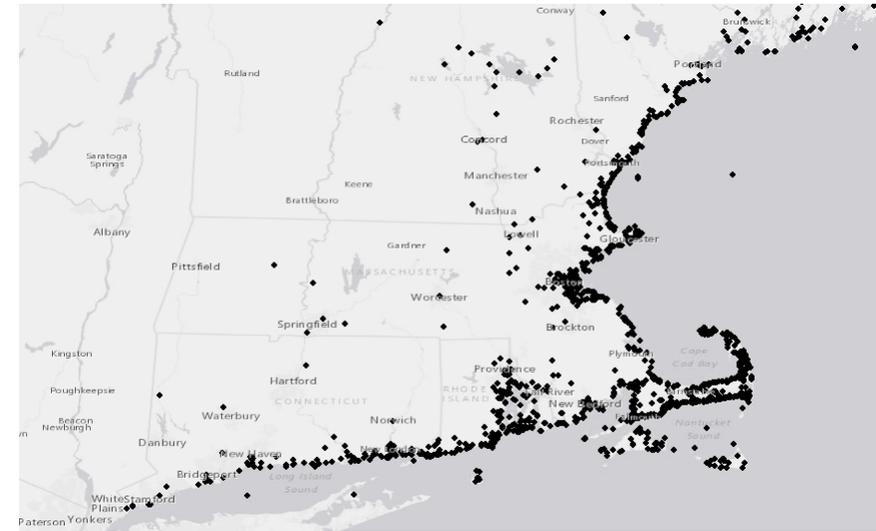
Search

I can't find the place on the map/I don't remember the name. **Reset**

**Confirm Location**  
Is this the correct place?  
E Beach Rd, Charlestown, RI 02813, USA  
**Confirm Location/Next**



Use the + and - buttons at the bottom-right of the window to zoom in and out. Click and drag to move the map. Click to place a PIN on the map



- Paper responses

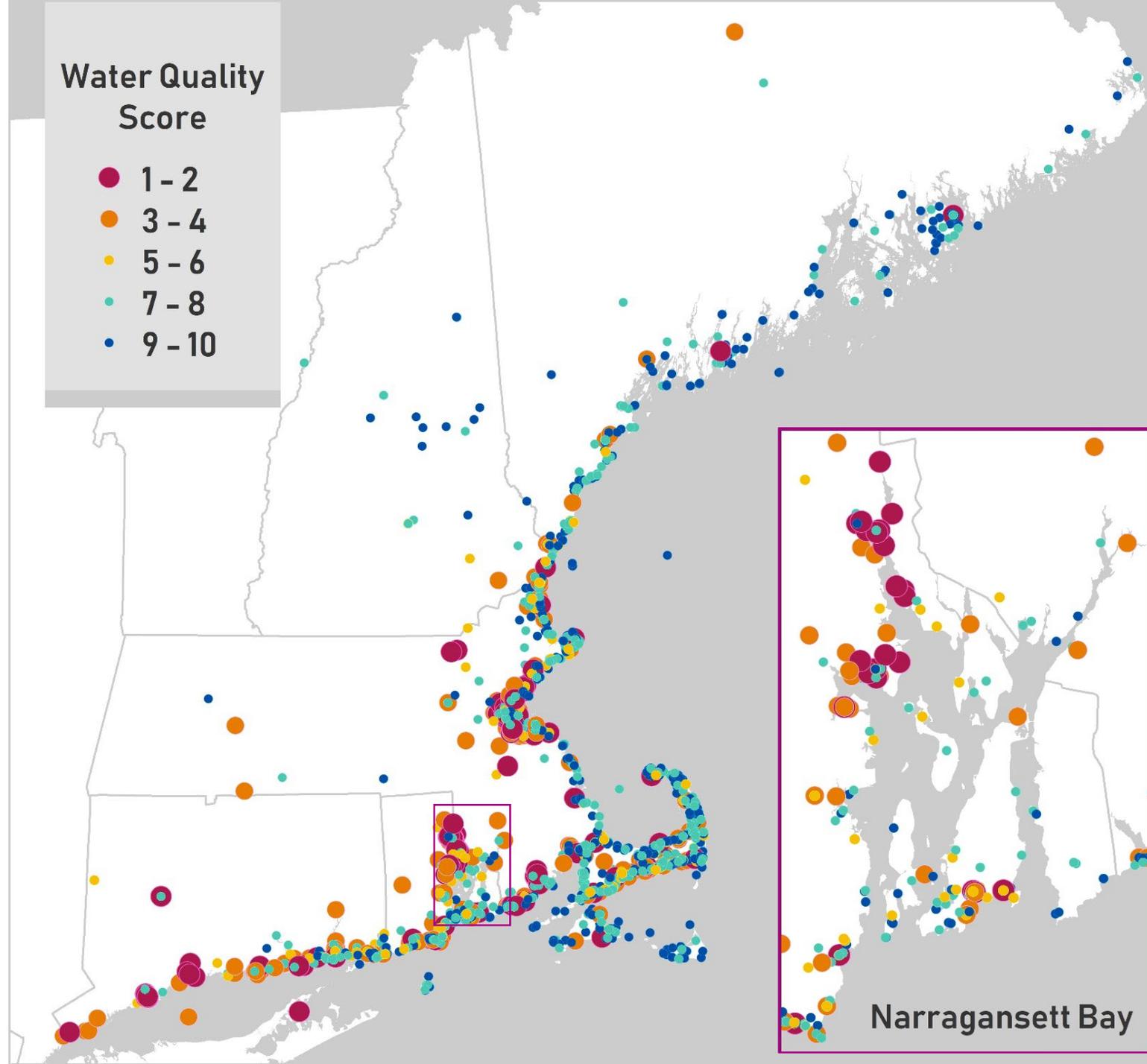


Google Maps Platform



- State
- Town
- Place

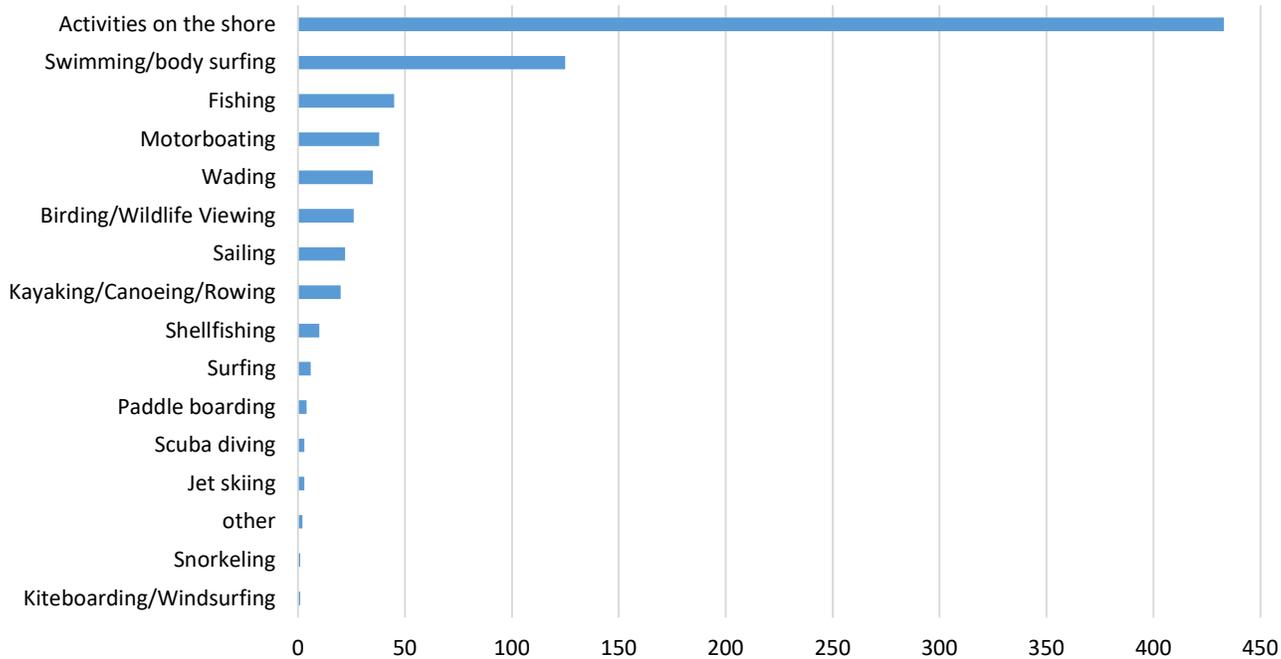
- Trip Profiles
  - 838 single day trips
  - 290 overnight
- Best/Worst WQ
  - 881 best
  - 801 worst



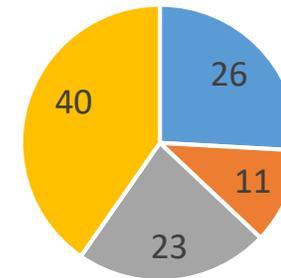
# Last Trip

- 40% went to beaches
- Average 28 miles one way, 46 minutes
- 4 hours average reported on site time

Day Trip Most Important Activity



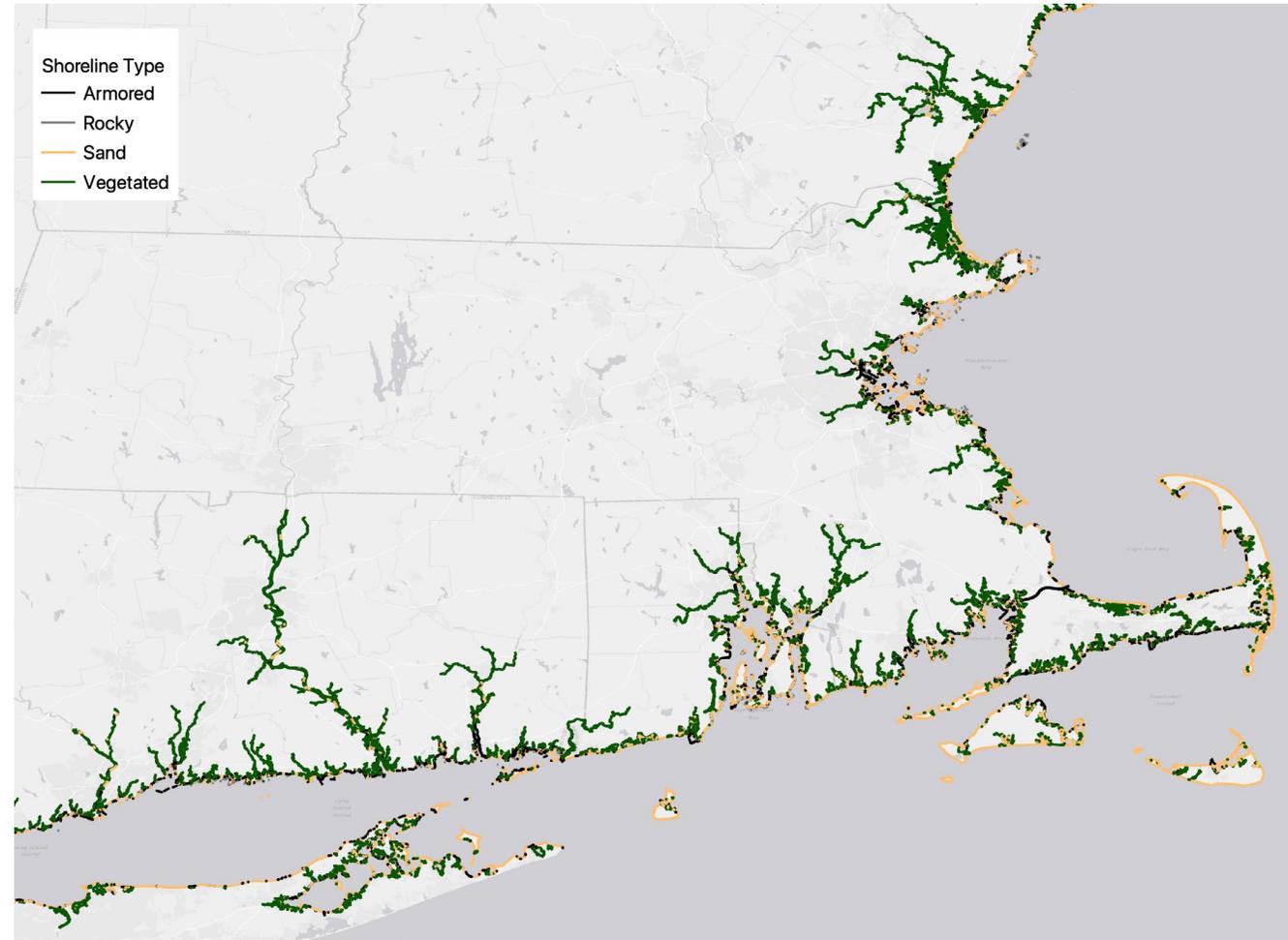
Day Trip Water Contact (% of responses)



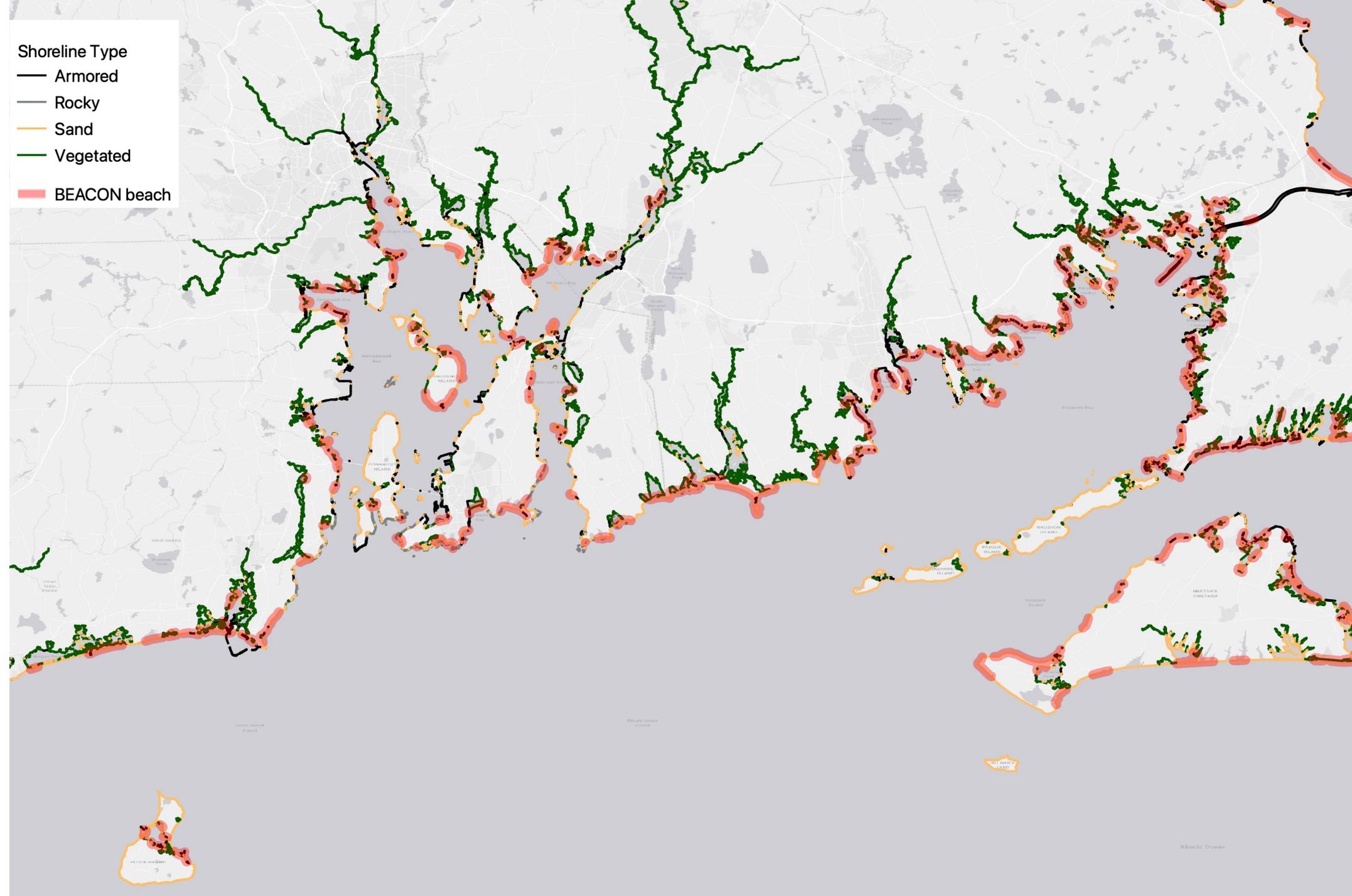
- did not get wet at all
- Got sprayed
- Waded
- got most or all of my body wet

# Travel Cost Model

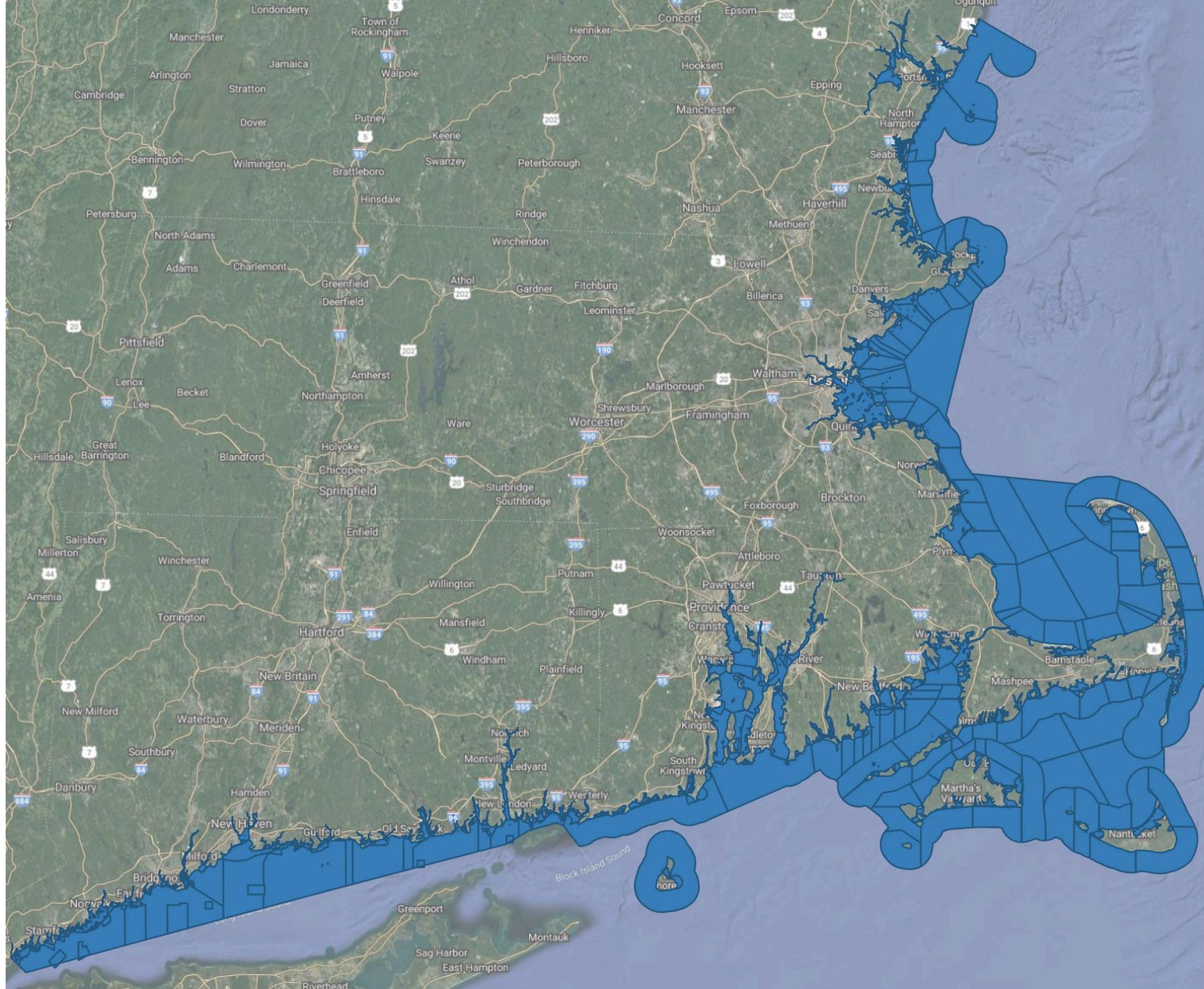
- Choice set (CT-NH)
  - Based on NOAA's ESI lines
  - 15k+ segments
  - Connected with BEACON beach lines and data
- Matched reported trip locations to closest shoreline segment
- Water Quality
  - Summarized to the shoreline segments and water polygons (303d water segments)



- Shoreline Type**
- Armored
  - Rocky
  - Sand
  - Vegetated
  - BEACON beach



- **Water Quality Data**
  - Summarized by 303d coastal water units
  - Thin coverage!
  - Beach closure and bacteria sampling
- **Remote Sensing**
  - Clarity (Secchi)
  - Maximum Chlorophyll Index
- **Other Attributes**
  - ESI shoreline type
  - Impervious surface
  - Developed land use
  - Sheltered/exposed
  - Has rock or docks

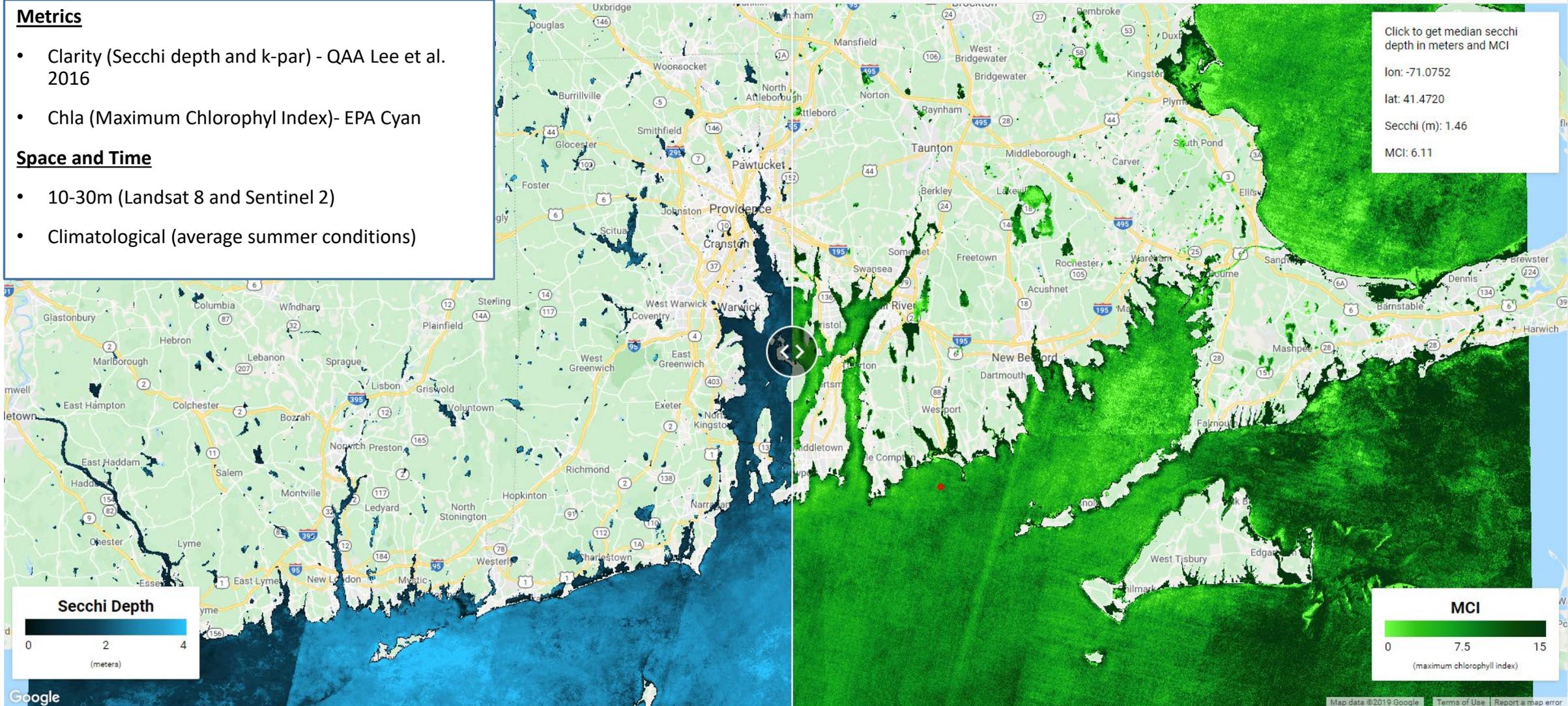


### Metrics

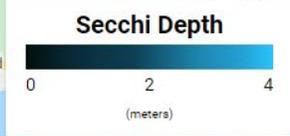
- Clarity (Secchi depth and k-par) - QAA Lee et al. 2016
- Chla (Maximum Chlorophyll Index)- EPA Cyan

### Space and Time

- 10-30m (Landsat 8 and Sentinel 2)
- Climatological (average summer conditions)

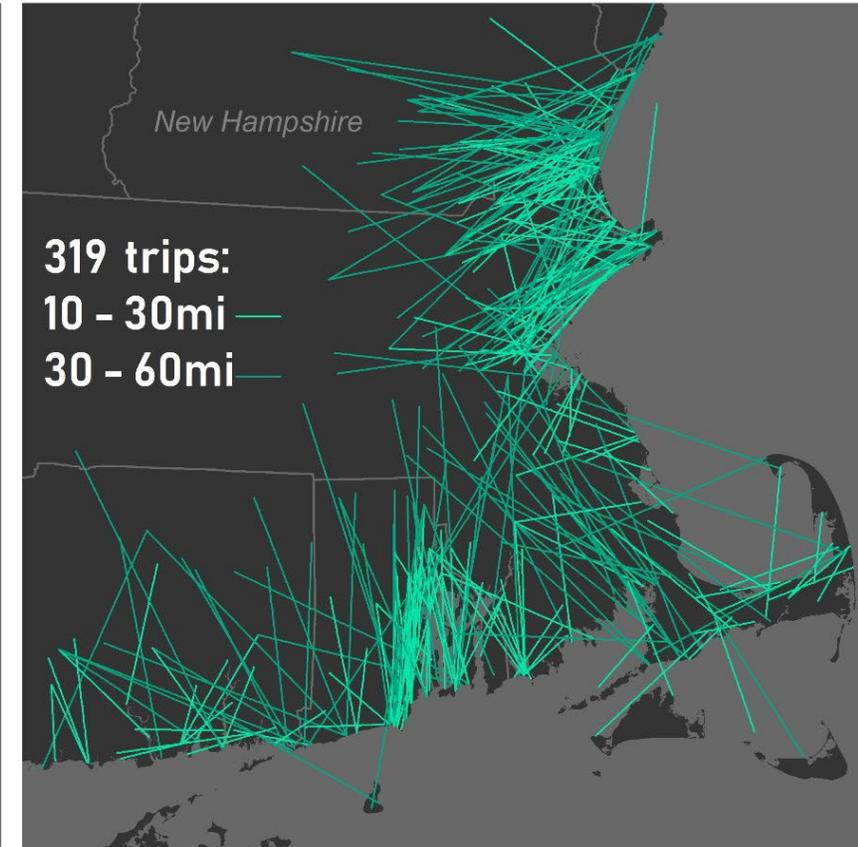
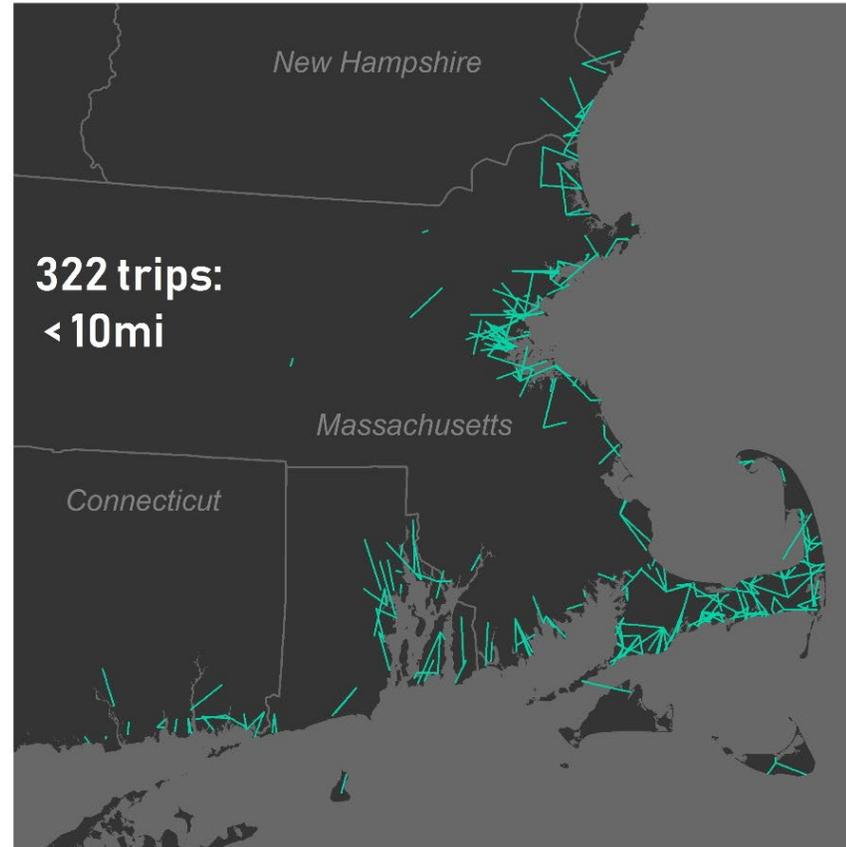


Click to get median secchi depth in meters and MCI  
lon: -71.0752  
lat: 41.4720  
Secchi (m): 1.46  
MCI: 6.11



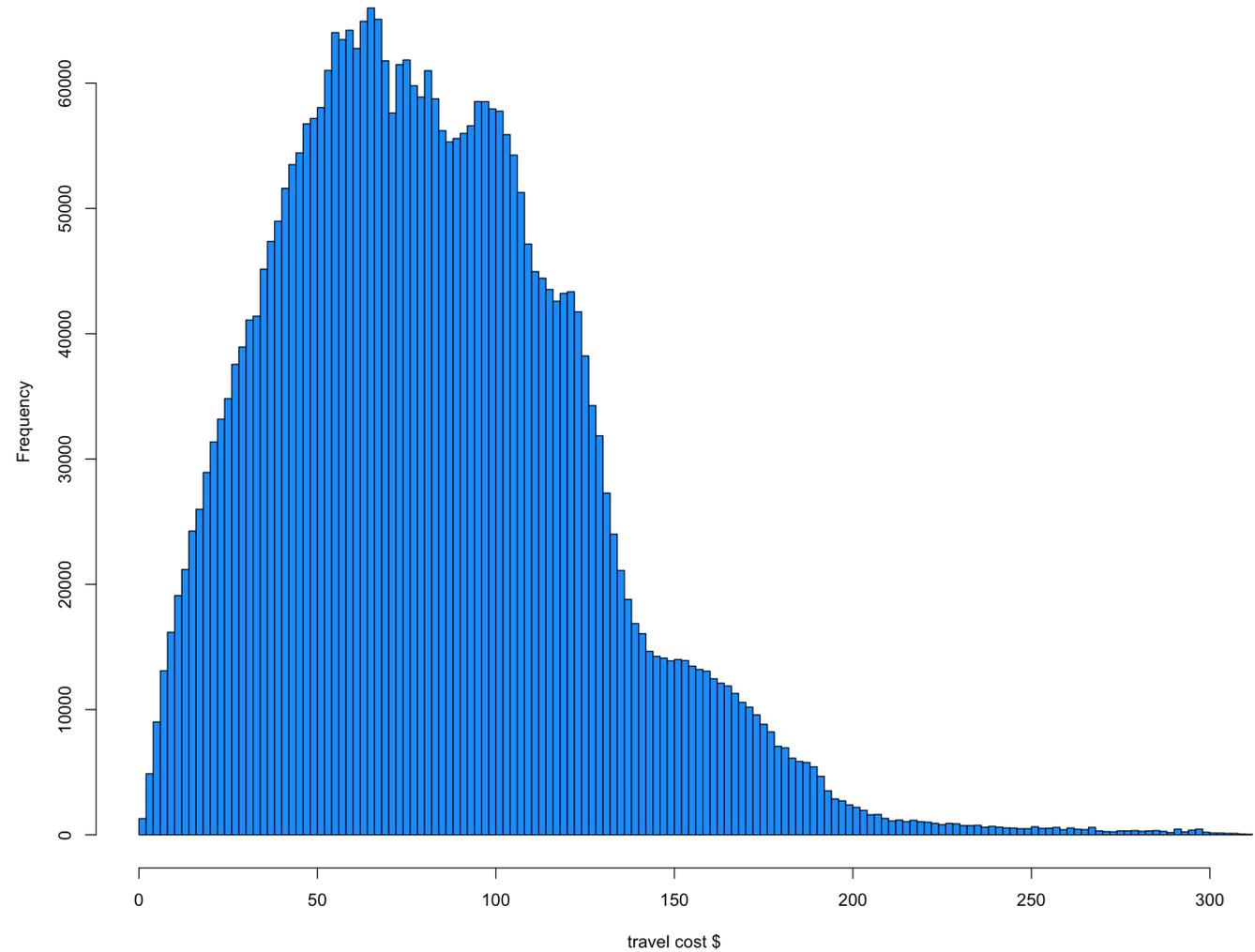
# Origin/Destination Routing

- Travel time and distance through travel networks
- 1.4k responses x 15k shoreline segments = 20M+ routes



# Travel Costs

- Gas and wear and tear:  
 $2 \times (.55\text{¢} \times \text{miles})$
- Time:  
 $2 \times (1/3 \times (\text{income}/2080) \times \text{hours})$
- Travel cost/number of adults on the trip



# Random Utility Model

- Pick shoreline segment that maximizes utility

$$u_i = \max (v_{i1}, v_{i2}, \dots, v_{is})$$

- “observable” part of utility can be estimated

$$v_{ij} = \beta_{tc} t c_{ij} + \beta_q q_i + e_{ij}$$

- We observe the choice

$$y_{ij} = \begin{cases} 1 & v_{ij} > v_{ik} \\ 0 & \text{otherwise} \end{cases}$$

- Logit model

$$p_{ij} = P(y_{ij} = 1)$$

$$\text{logit}(p_{ij}) = \log\left(\frac{p_{ij}}{1 - p_{ij}}\right) = \beta_{tc} t c_{ij} + \beta_q q_j + e_{ij}$$

# Logit Model

$$\text{logit}(p_{ij}) = \beta_{tc}tc_{ij} + \beta_qq_j + \beta_d(q_j \times d_i) + e_{ij}$$

- Site attributes-  $q_j$  :
  - BEACON Beach
  - Shoreline types
  - Has docks, rocks
  - Sheltered/exposed
  - % Impervious surface
  - Clarity (Secchi Depth, m)
  - Maximum Chlorophyll Index (MCI)
  - Closure history (average per season in last 5 years)
- Individual attributes-  $d_i$  :
  - Level of water contact x clarity

# Preliminary Results

$$\text{logit}(p_{ij}) = \beta_{tc}tc_{ij} + \beta_q q_j + e_{ij}$$

- Value per-trip per-person ( $1/-\beta_{tc}$ ):
  - \$27
- Marginal effects ( $\beta_q / -\beta_{tc}$ ):
  - Beach: +\$35.5
  - 1 meter clarity: +\$6.1

|                  |          |
|------------------|----------|
| Travel Cost (\$) | -0.04*** |
| Beacon Beach     | 1.30***  |
| Docks            | 0.26**   |
| Rocks            | -0.05    |
| Sheltered        | 0.50**   |
| Impervious (%)   | -0.07*** |
| Armored (%)      | -7.74*** |
| Rocky (%)        | -6.54*** |
| Sand (%)         | -6.92*** |
| Vegetated (%)    | -7.11*** |
| Clarity (m)      | 0.22**   |
| MCI              | 0.002    |
| Beach Closures   | -0.007   |

N 692

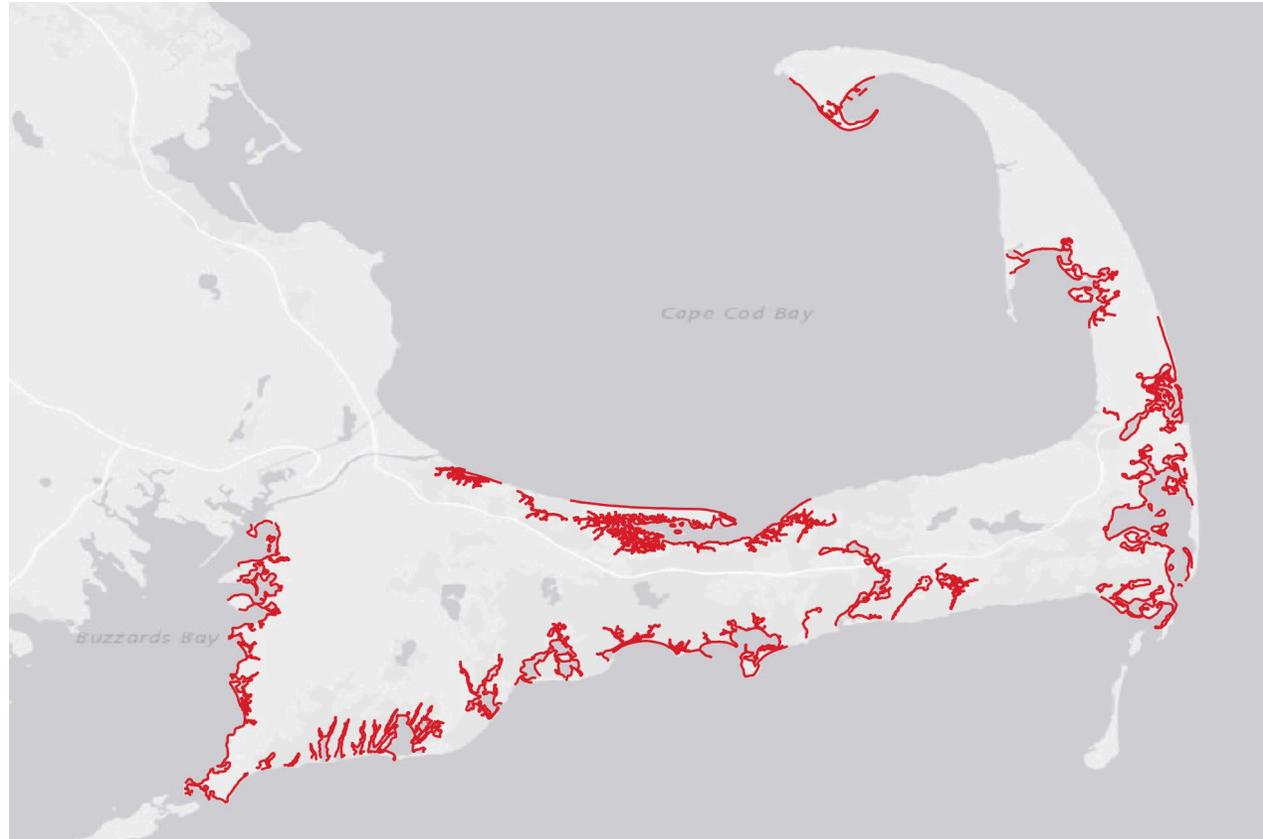
Significance: \*\*\* = p < 0.001

\*\* = p < 0.01

\* = p < 0.05

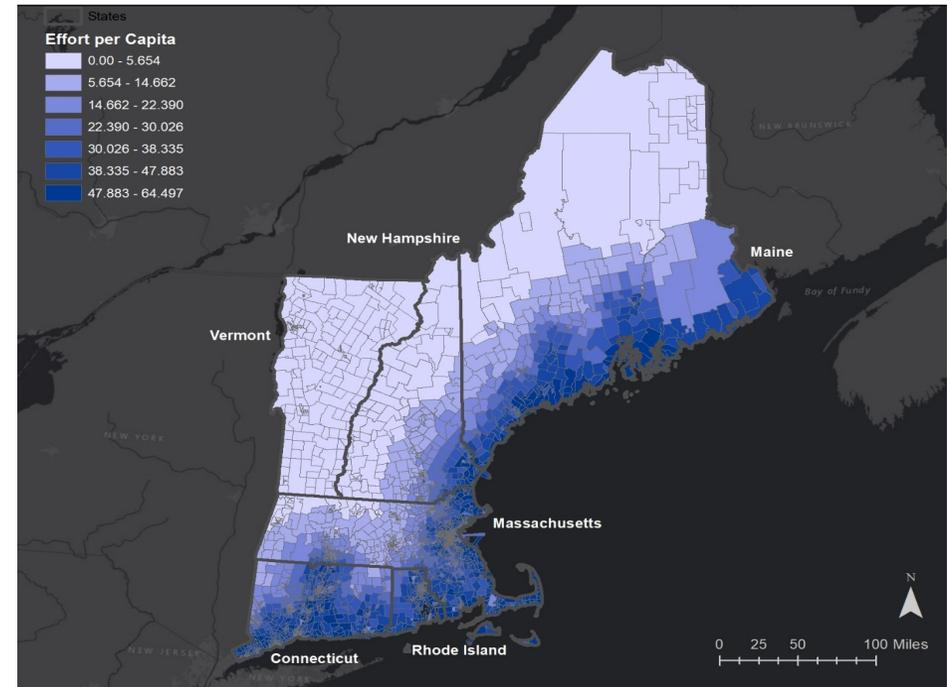
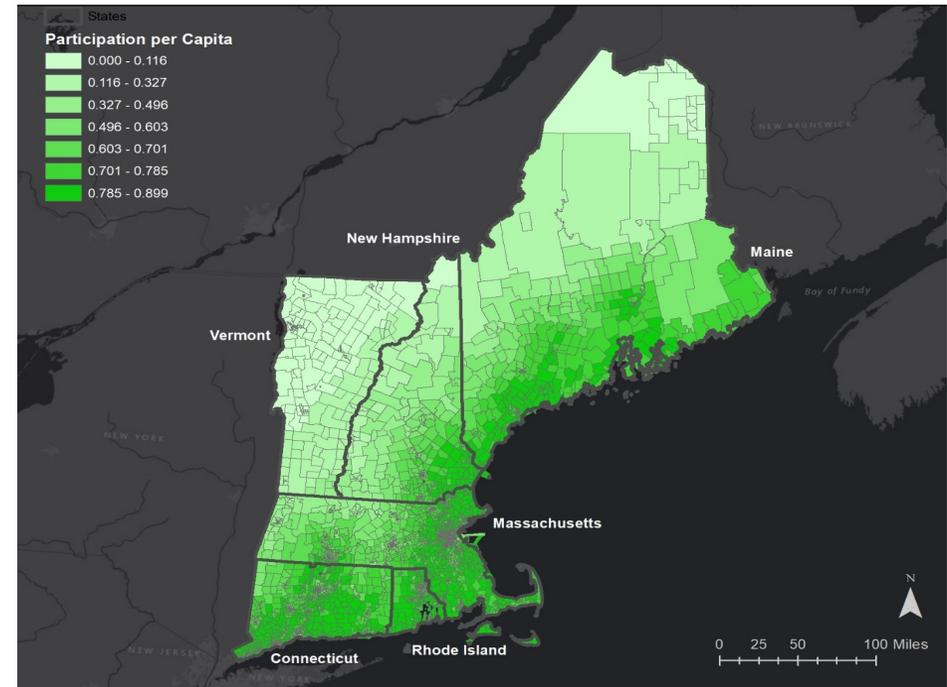
# Example Welfare Changes

- Cape Cod Estuary TMDLs
  - Nutrient targets to improve conditions for eelgrass
- Assume 1 meter change in clarity for associated shoreline segments
- Assume total trips in population stays the same (14.1 million summer trips)
- \$13.2M increase in consumer surplus per summer season (using logsum approach)
  - About \$.9 per trip



# Next

- Nested and mixed logit
  - Beach vs other shoreline
  - Activity then location
- Seasonal demand models
  - Linked, repeated RUM
- Water quality variables
  - Bacteria samples
- Overnight trips
- Connection to visitation quantification work





<https://www.epa.gov/water-research/human-dimensions-water-quality-research>

Contact: [Merrill.Nathaniel@epa.gov](mailto:Merrill.Nathaniel@epa.gov)

Great Salt Marsh, Barnstable, MA