# Ranking Environmental Stressors in Coastal and Marine Ecosystems: Developing a Framework for Prioritization

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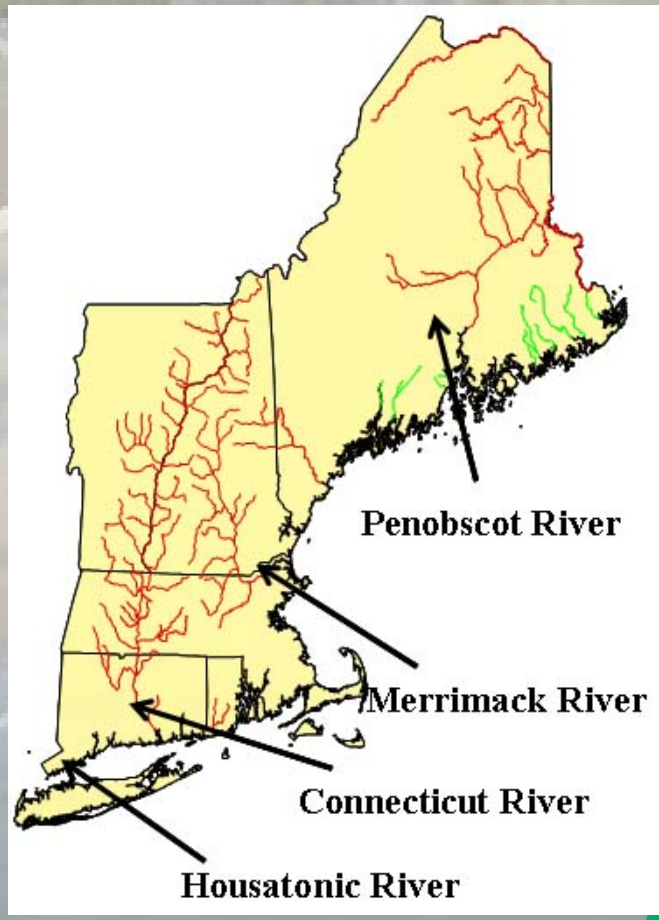
## BACKGROUND

**EDF's Northeast Coastal Ecosystem Resiliency Project**

- Elucidate the multitude of human uses and environmental drivers affecting fisheries, coastal and marine ecosystems, and coastal communities now and in the future

- Understand linkages between and interactions among these environmental stressors



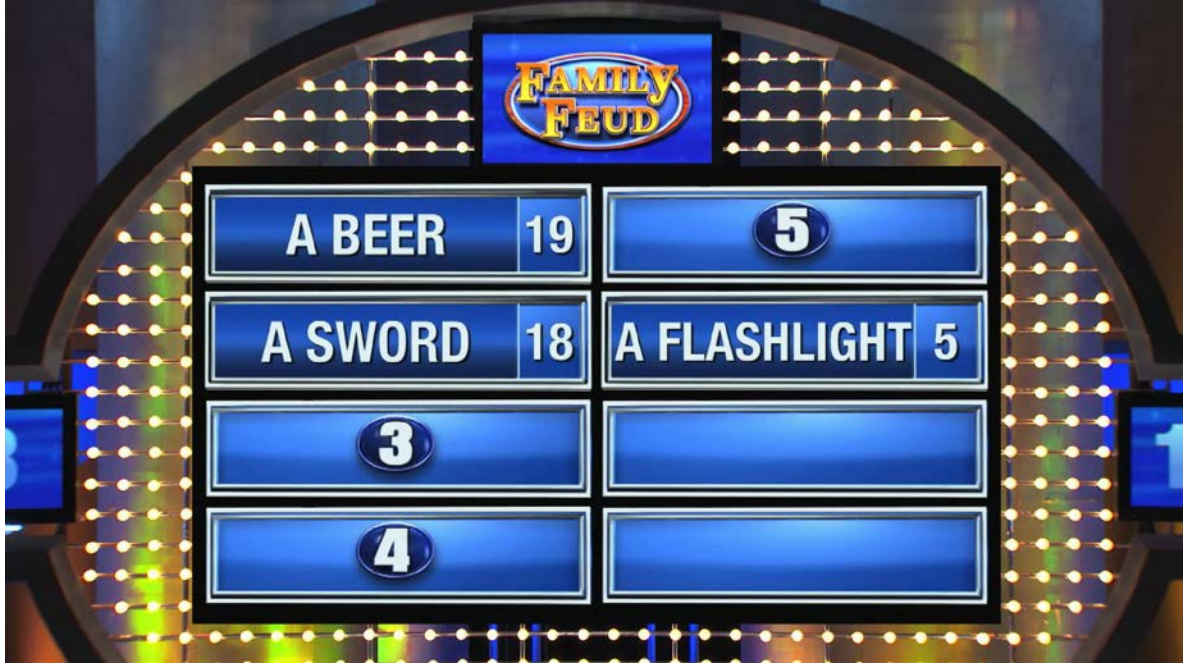

New England + Long Island

# OBJECTIVES

**To articulate and prioritize factors affecting ecosystem and human resiliency in the region.**

**To describe the relationships between habitats and stressors to increase understanding of the impacts and interactions of multiple stressors on coastal and marine systems.**

**To identify critical gaps in understanding, barriers to mitigation of stressors, and pressing and catalytic science and policy actions to better manage coastal stressors in a climate changing environment.**




## EXPERT SURVEY ON STRESSORS AND CLIMATE CHANGE

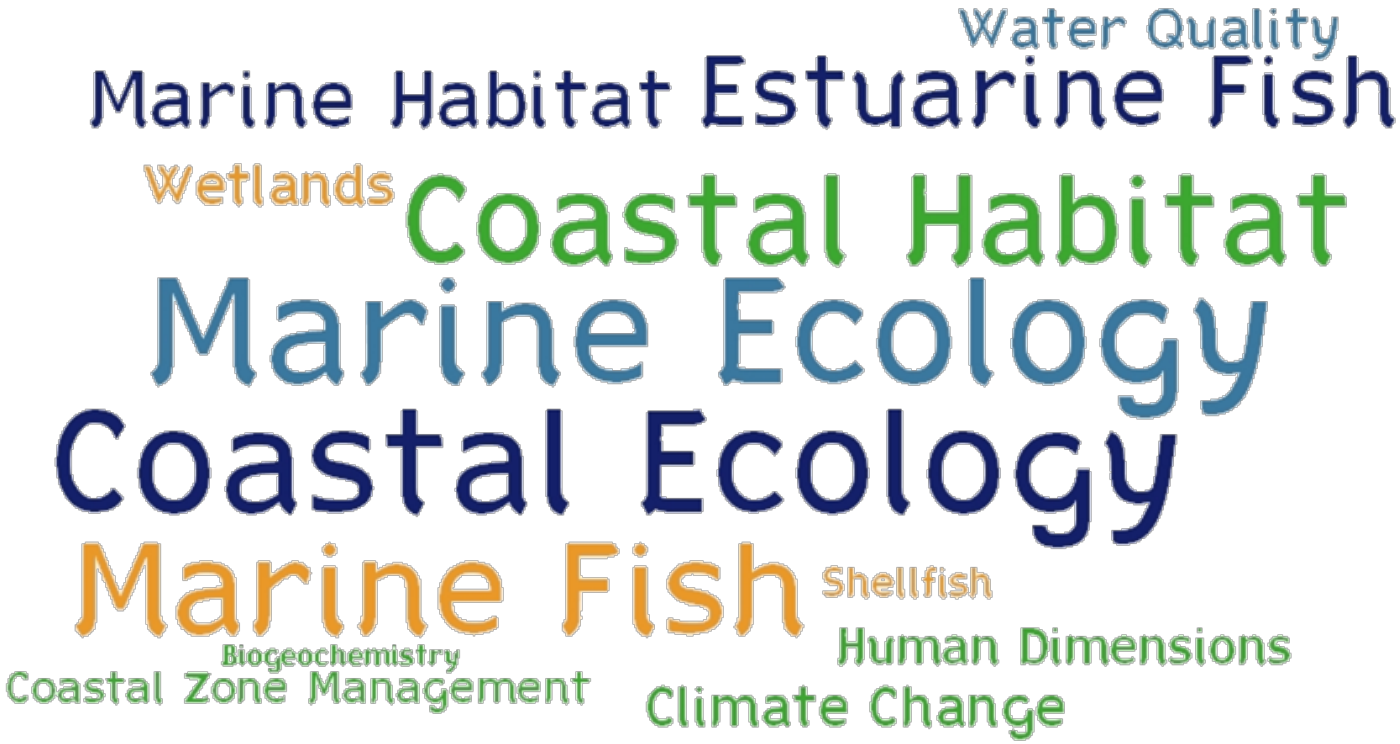
1. 1. Of the following environmental drivers, please rank the level of impact each is <u>currently</u> having on these elements of coastal and marine ecosystems: (n=80)

2. 2. How important is each of these environmental stressors likely to be <u>in 2050 under the following climate change scenario (modified IPCC A2 emissions scenario):</u> 4ºF increase in air temperature; 5ºF increase in sea surface temperature; 3 feet of additional sea level rise; 10% precipitation increase? (n=43)

**1 = No Impact / N/A** **2 = Minor / Moderate Impact** **3 = High Impact**
**4 = Very High Impact** **0 = Uncertain**

## ECOSYSTEM COMPONENTS

**STRESSORS…+15 MORE**

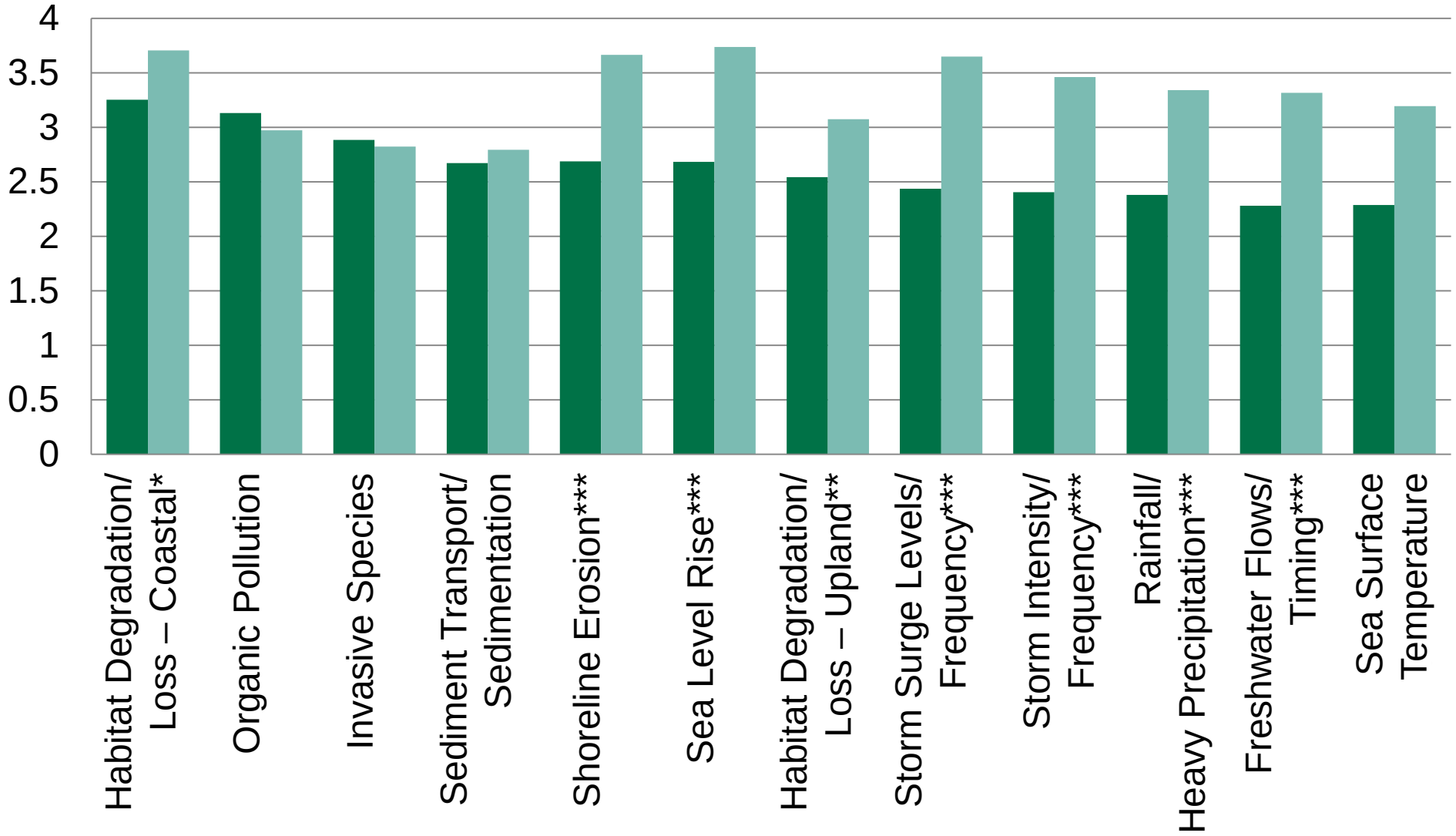



## WHO TOOK THE SURVEY

| | | |
|---|---|---|
| **Sector** | Academic | 59.6% |
| | State/Federal | 34.1% |
| | NGO | 14.9% |
| | Other | 10.7% |

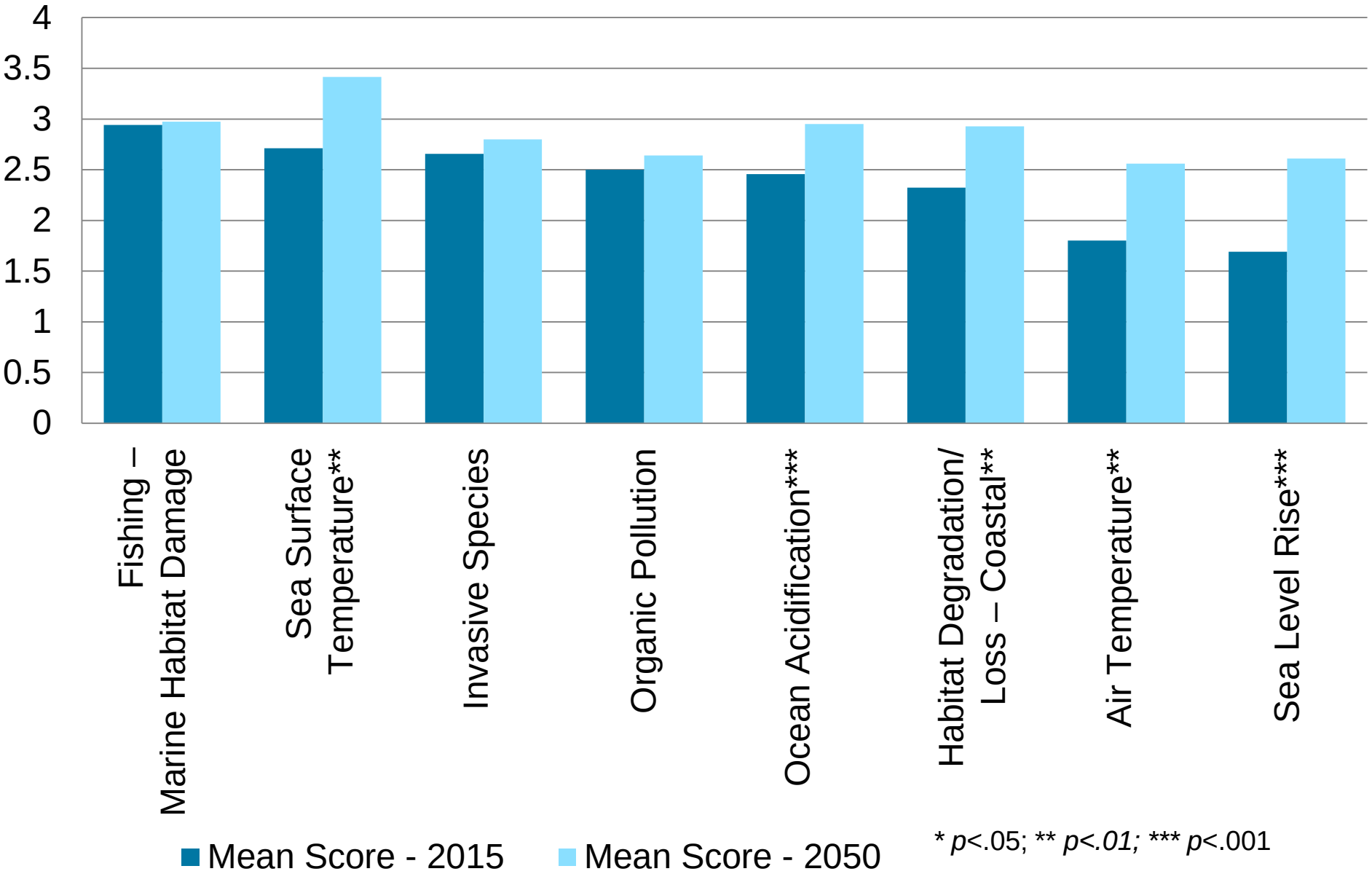
| | | |
|---|---|---|
| **Years Experience** | Less than 2 | 2.1% |
| | 2-5 | 0.0% |
| | 6-10 | 21.3% |
| | 11-20 | 25.5% |
| | 20+ | 51.1% |

# SURVEY RESULTS:
# MEAN IMPACT SCORES FOR WETLAND & ESTUARINE HABITATS




* *p*<.05; ** *p<.01;* *** *p*<.001

# SURVEY RESULTS:
# MEAN IMPACT SCORES FOR MARINE HABITATS

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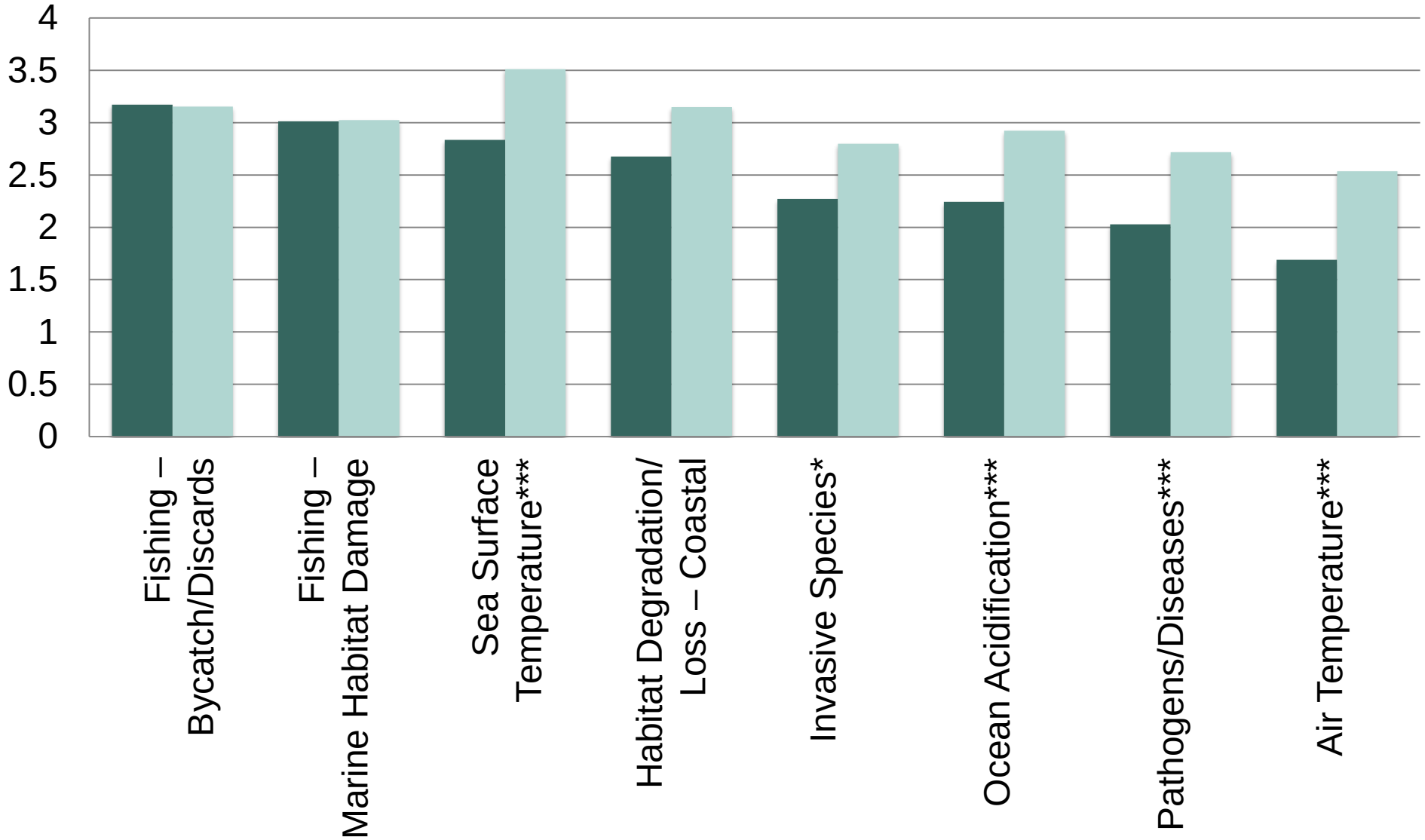
# SURVEY RESULTS:
# MEAN IMPACT SCORES FOR MARINE FISH POPULATIONS

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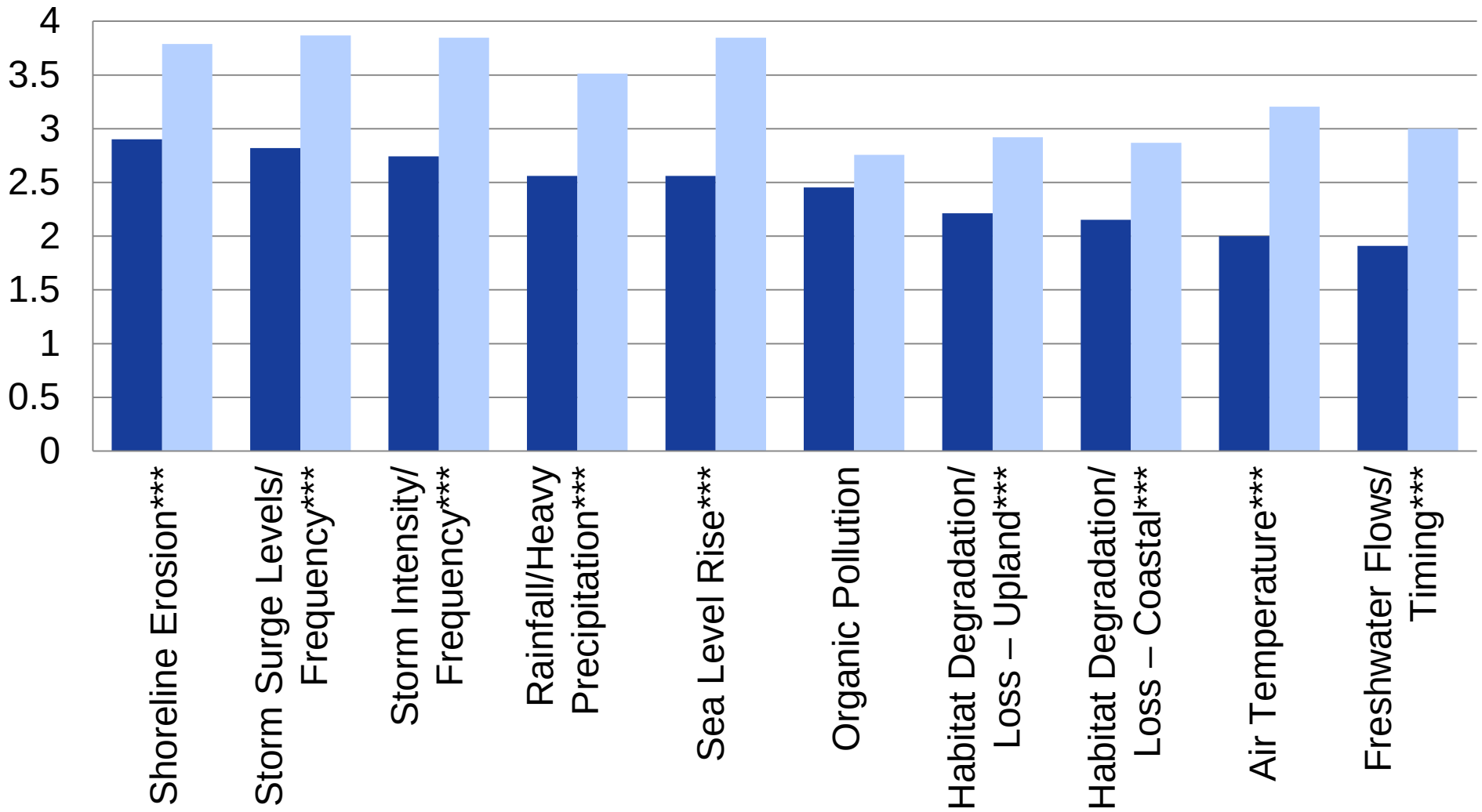
# SURVEY RESULTS:
# MEAN IMPACT SCORES FOR COASTAL CITIES AND TOWNS




■ Mean Score - 2015 ■ Mean Score - 2050

* *p*<.05; ** *p*<.01; *** *p*<.001

# SURVEY RESULTS:
# TOP STRESSORS ACROSS ALL RESOURCE COMPONENTS

| | Current Conditions | Future Conditions |
|---|---|---|
| **1** | Organic Pollution | Sea Surface Temperature |
| **2** | Habitat Degradation/Loss - Coastal | Habitat Degradation/Loss - Coastal |
| **3** | Invasive Species | Sea Level Rise |
| **4** | Sea Surface Temperature | Storm Surge Levels/Frequency |
| **5** | Fishing – Marine Habitat Damage | Shoreline Erosion |
| **6** | Trash (Plastics, etc.) | Increasing Storm Intensity/Frequency |
| **7** | Shoreline Erosion | Rainfall/Heavy Precipitation |
| **8** | Sea Level Rise | Air Temperature |
| **9** | Rainfall/Heavy Precipitation | Freshwater Flows/Timing |
| **10** | Fishing – Bycatch/Discards | Organic Pollution |

# SURVEY RESULTS: ANTICIPATING FUTURE IMPACTS

Stressors with the largest change in impact in the future:
(*All sig. at p<.01 for all habitats/ resources)*

- Sea Level Rise
- Increasing Storm Intensity/Frequency
- Increasing Storm Surge Levels
- Increasing Sea Surface Temperature
- Increasing Air Temperature
- Increasing Rainfall/ Heavy precipitation
- Changes in freshwater flow rates
- Ocean Acidification (except for cities/towns)
- Pathogens/ Diseases (except for cities/towns)

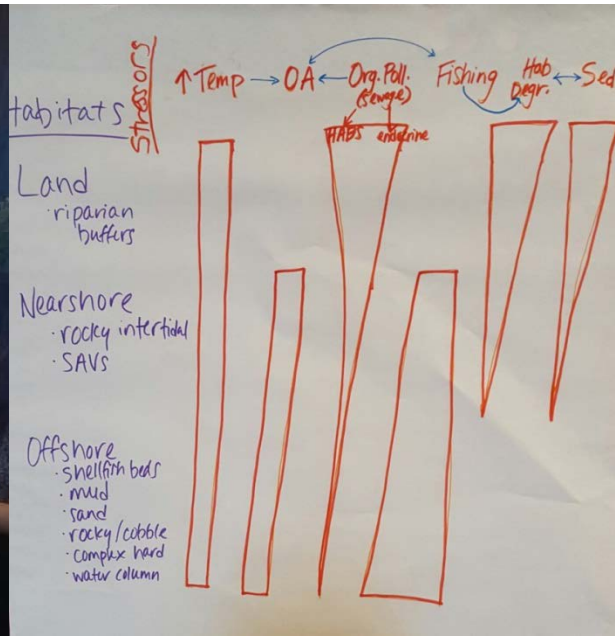
Stressors with no change/little change in impact in the future:

- Organic Pollution
- Trash
- Changes in Sediment Transport
- Dredging
- Fishing – Bycatch/Discards
- Fishing – Marine Habitat Damage
- Aquaculture

# EXPERT WORKSHOP

Two-day workshop (September 28-29, 2015):

- 37 external attendees
- Federal agencies (NOAA, EPA, USGS, USFWS)
- State agencies (MA, ME, FL)
- Academic institutions (Northeastern, Boston University, UMass Amherst, Marine Biological Laboratory, RI Sea Grant)
- NGOs/Partner institutions (Gulf of Maine Research Institute, Natural Capital Project, National Wildlife Federation)



# WORKSHOP DELIBERATIONS: TOP STRESSORS IN WETLAND & ESTUARINE HABITATS

| | Current Conditions | Future Conditions |
|---|---|---|
| **1** | Development* | Sea Level Rise |
| **2** | Organic Pollution | Development* |
| **3** | Sedimentation/Dredging | Storm Surge Level, Intensity and Frequency |
| **4** | Sea Level Rise | Freshwater Flows/Timing |
| **5** | Storm Surge Level, Intensity and Frequency | Ocean Acidification |
| **6** | Freshwater Flows/Timing | Sea Surface Temperature |
| **7** | Invasive Species | Air temperature |
| **8** | | Rainfall / Heavy precipitation |

*Development was a new stressor category that was developed at workshop and includes 6 sub-categories: (1) hydrologic barriers, (2) direct impact/fill, (3) watershed inputs, (4) hardened shorelines, (5) impervious areas, and (6) aquaculture

# WORKSHOP DELIBERATIONS: TOP STRESSORS FOR MARINE HABITATS

| | Current Conditions | Future Conditions |
|---|---|---|
| **1** | Fishing - Marine Habitat Damage | Habitat Degradation / Loss – Coastal and Upland |
| **2** | Sea Surface Temperature | Sea Surface Temperature |
| **3** | Organic Pollution | Organic Pollution |
| **4** | Habitat Degradation / Loss- Coastal and Upland | Ocean Acidification |
| **5** | Ocean Acidification | Fishing - Marine Habitat Damage |
| **6** | Invasive Species | Freshwater Flows/Timing |
| **7** | | Invasive Species |
| **8** | | Storm Surge Levels / Frequency |

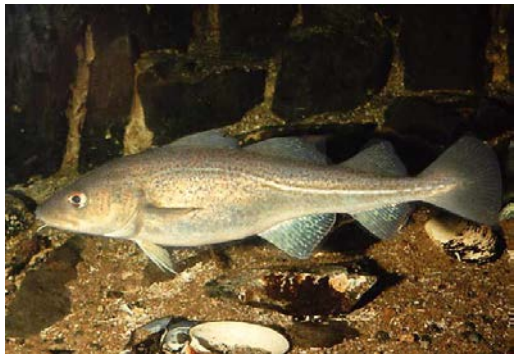
# WORKSHOP DELIBERATIONS: TOP STRESSORS FOR COASTAL CITIES AND TOWNS

| | Current Conditions | Future Conditions |
|---|---|---|
| **1** | Storm Surge Levels, Intensity and Frequency | Storm Surge Levels, Intensity and Frequency |
| **2** | Shoreline Erosion | Sea Level Rise |
| **3** | Rainfall / Heavy Precipitation | Shoreline Erosion |
| **4** | Organic Pollution | Rainfall / Heavy Precipitation |
| **5** | Habitat Degradation/Loss-Coastal | Air/Sea Surface Temperature |
| **6** | Sea Level Rise | Habitat Degradation/Loss-Coastal |
| **7** | Air Temperature | Organic Pollution |
| **8** | Freshwater Flows/Timing | Impacts of Hardening or Other Protection Structures (Development) |
| **9** | Trash | |

# WORKSHOP DELIBERATIONS: TOP STRESSORS FOR MARINE FISH POPULATIONS (2015)

**Sea-Run (ESA + state)**

**Coastal (ASMFC + state)**



**Marine (Magnuson)**

Importance of Stressor

**F**

**Dams**

Other Stressors

**F**

Habitat degradation
Increasing SST
Coast. Acidification
Freshwater Inputs

Other Stressors

**F**

Habitat degradation
Increasing SST
Ocean Acidification
Freshwater Inputs

Other Stressors

# WORKSHOP DELIBERATIONS: TOP STRESSORS FOR MARINE FISH POPULATIONS (2050)

## Optimistic → Extant species can survive

Importance of Stressor

| Sea-Run (ESA + state) | Coastal (ASMFC + state) | Marine (Magnuson) |
|---|---|---|
| Dams<br>**Increasing SST**<br>Habitat degradation<br>Terrestrial effects of climate change<br>Other Stressors | F*<br>Habitat degradation:<br>→**"Squeeze"**<br>**Increasing SST**<br>**Coast. Acidification**<br>Freshwater Inputs<br>**Disease**<br>**Pollutants (SLR)**<br>Other Stressors | F*<br>Habitat degradation<br>**Increasing SST**<br>**Ocean Acidification**<br>Freshwater Inputs<br>**Invasive species**<br>**Changed spp. interactions**<br>Other Stressors |

# Summary Across All Resources

# SURVEY RESULTS: AVERAGE SCORE OF TOP 10 STRESSORS FOR CURRENT CONDITIONS (2015)

| Current Conditions | Average score | Wetlands / Estuarine Habitats | Coastal Cities and Towns | Marine Habitats | Marine Fish Populations |
|---|---|---|---|---|---|
| Organic Pollution | 2.61 | 3.13 | 2.45 | 2.5 | 2.37 |
| Habitat Degradation / Loss - Coastal | 2.60 | 3.25 | 2.15 | 2.32 | 2.68 |
| Invasive Species | 2.43 | 2.89 | 1.92 | 2.66 | 2.27 |
| Sea Surface Temperature | 2.40 | 2.29 | 1.77 | 2.71 | 2.84 |
| Fishing - Marine Habitat Damage | 2.34 | 1.81 | 1.6 | 2.94 | 3.01 |
| Trash | 2.29 | 2.29 | 2.29 | 2.37 | 2.22 |
| Shoreline Erosion | 2.19 | 2.69 | 2.9 | 1.77 | 1.41 |
| Sea Level Rise | 2.14 | 2.69 | 2.56 | 1.69 | 1.64 |
| Rainfall / Heavy Precipitation | 2.14 | 2.38 | 2.56 | 1.83 | 1.77 |
| Fishing - Bycatch / Discards | 2.13 | 1.64 | 1.49 | 2.2 | 3.17 |

Notes a priority stressor across all resources from the expert workshop

Notes a stressor of research importance across all resources with less consensus on level of impact

# SURVEY RESULTS: AVERAGE SCORE OF TOP 10 STRESSORS FUTURE CONDITIONS (2050)

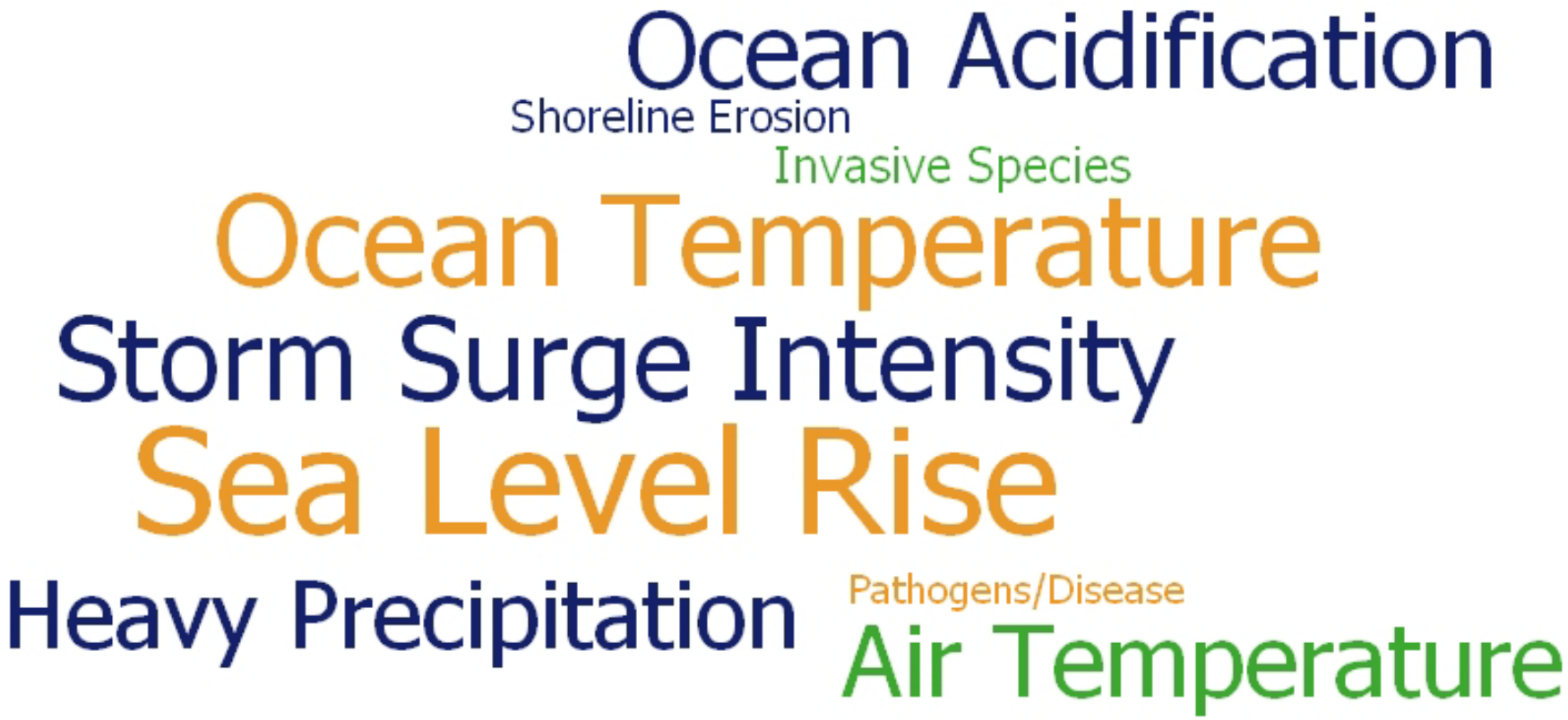
| Future Conditions | Average Score | Wetland/ Estuarine Habitats | Coastal Cities and Towns | Marine Habitats | Marine Fish |
|---|---|---|---|---|---|
| Sea Surface Temperature | 3.24 | 3.2 | 2.82 | 3.41 | 3.51 |
| Habitat Degradation / Loss - Coastal | 3.16 | 3.71 | 2.87 | 2.93 | 3.15 |
| Sea Level Rise | 3.15 | 3.74 | 3.85 | 2.61 | 2.39 |
| Storm Surge Levels / Frequency | 3.03 | 3.65 | 3.87 | 2.5 | 2.1 |
| Shoreline Erosion | 3 | 3.67 | 3.79 | 2.4 | 2.13 |
| Storm Intensity / Frequency | 2.97 | 3.46 | 3.85 | 2.41 | 2.17 |
| Rainfall / Heavy Precipitation | 2.89 | 3.34 | 3.51 | 2.45 | 2.25 |
| Air Temperature | 2.85 | 3.1 | 3.21 | 2.56 | 2.54 |
| Freshwater Flows/Timing | 2.79 | 3.32 | 3 | 2.49 | 2.34 |
| Organic Pollution | 2.7 | 2.97 | 2.76 | 2.64 | 2.41 |

Notes a priority stressor across all resources from the expert workshop

Notes a stressor of research importance across all resources with less consensus on level of impact

# EASIEST STRESSORS TO ADDRESS

# MOST DIFFICULT STRESSORS TO ADDRESS



# FROM EVALUATION TO ACTION: CONSIDERATIONS FOR DEVELOPING MANAGEMENT STRATEGIES

- Healthy habitats are important for resiliency
  - Coastal and upland restoration
  - Protecting and creating coastal buffers
- Scale is an important consideration:
  - Need for feedback loops between federal, state, and local levels
  - Need to be able to scale up actions at the local level
  - Develop support for solutions at the local scale
  - Nested scales of management (watershed and other)
- Need for actions that can address multiple stressors
- Adaptive management to address uncertainty
- Importance of partnerships to achieve broad goals
- Transfer risk from the public to the private sector

# CONCLUSIONS AND LESSONS

- Useful method for identifying priority stressors now and in the future
- Enable normalized scores comparing relatively likely impacts across stressors
- Useful in making decisions about prioritizing action, or allocating funding or resources
- Priorities may differ at the local level
- Need for better understanding of interactions between stressors
- Some issues may improve in the future (organic pollution, invasive species, impacts from fishing) → some reasons for optimism

# QUESTIONS?

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