Research Questions/Activities for Oysters

- Understanding difference in productivity of sanctuaries versus "open for harvest" areas.

- Continue to test and monitor best methods for restoration of oyster reefs (e.g., vertical profile, spat on shell, etc.).

- Based on recruitment studies, investigate mechanisms that have the greatest impacts on key recruitment bottlenecks.

- Can we use hatchery-raised oysters to address disease-related bottlenecks?

- How can seagrass and oyster restoration projects work together to test for synergies?

- Lit review and follow up: what is the impact of toxic contaminants (including microplastics) on oysters? (Use GulfWatch to understand what concentrations might be.)

Research Questions/Activities for Clams

- Beginning with modeling perhaps, consider experimenting with additional harvesting regulations and/or predator-exclusion/aquaculture a la Brian Beal.

- Review Brian Beal recruitment studies. Do we need to investigate mechanisms that have the greatest impacts on key recruitment bottlenecks, for our estuary compared with his work in Southern Maine?

- What is the age structure of the clams at H-S estuary?

- Experiment with different incentives/methods for removing green crabs. (talk to Gabby Bradt & Manomet Center in Massachusetts)

- Lit review and follow up: what is the impact of toxic contaminants on clams?

Research Questions/Activities for Eelgrass

- How can we include feedback mechanisms (e.g., loss of eelgrass increases sediment resuspension; biogeochemical) in our model and assessments?

- How do we include feedbacks from other bio resources (e.g., more oysters leads to less chl-a and less TSS; more fish leads to more grazing of epiphytes; more carbon from eelgrass feeds fish drivers, etc.)

- Conduct/build a bio-optical model to better understand light dynamics in Great Bay Estuary.

- Do we have the data we need to understand whether sediment and water column nutrient levels are impacted by regeneration of nutrients from previous years? If so, what is our assessment of the contribution from regeneration? (This will be different for each of the five zones.)

- What is the relationship between tributary inputs of nutrients, organic matter and TSS and estuarine biological response (phytoplankton, seaweed and eelgrass)?

- Do eelgrass shoots (in 5 different zones) show signs of sulphur intrusion? (Note Fraser and Kendrick 2017, showing relationship between cadmium and Sulphur metabolism.)

- What is the relationship between nutrient loading, circulation and the amount of eelgrass leaf tissue nitrogen?

- How do carbon reserves in belowground biomass relate to other variables (carbon reserves being an indicator of stress)?

- Can we use genetic markers for resilience—and perhaps link this to the hydrodynamic model—to better understand distribution patterns and add insight into restoration priorities?

- What do we know about green crabs, invertebrate grazers and fish for these different zones, especially with regard to predation on eelgrass seeds.

- How do wind and precipitation relate to TSS and other light attenuators?

- How does hardened shoreline patterns and wind combine to impact waves and resuspension?

- How important is it to keep track of silica, because it drives diatoms and also because it can be taken up as a defense mechanism to heavy metal toxicity?

- How does the location and magnitude of fresh and cold groundwater intrusion into the estuarine zone relate to other variables, such as: eelgrass distribution, health, nutrients, eelgrass health?

- How do changing patterns in Ruppia distribution relate to changes in temperature, wind, etc.?

    - What are the feedback consequences (e.g., sediments, sediment resuspension, etc.) of greater amounts of Ruppia?

Research Questions/Activities for Salt Marsh

- What do we know about the impact of green crabs and other predators (some moving northward, such as: fiddler and purple marsh crabs) on salt marshes?

- Develop a nutrient budget specific to salt marshes.

- Develop a sediment budget specific to salt marshes.

- What is the ongoing/future impact and/or effectiveness of past management techniques, e.g., ditching, etc.?

Research Questions/Activities for Fish

- Important to track whether regional and marine dynamics are accounting for some of the year to year variability in fish abundance and condition.

- Based on recruitment studies, investigate mechanisms that have the greatest impacts on key recruitment bottlenecks for key species: herring, smelt, sturgeon, American eel, sturgeon, trout, sea lamprey.

- What is the best way to develop an index of biotic integrity specific to our estuaries?

Research Questions/Activities re: Humans

- What concentrations of microplastics are necessary to pose a threat to human health?

- Which biotoxins (e.g., DSP, PSP, ASP, cyanotoxins) are posing the greatest threat to human health? Which should be monitored most closely? How can we better manage and contain risks associated with these biotoxins?

- What's the evidence for BMAA being aerosolized around the Great Bay Estuary? How about Hampton-Seabrook Estuary?

- What do we know and need to know about synergistic effects between BMAA and mercury, and how should that influence management actions? Are there synergistic effects between other biotoxins and other toxic contaminants, either legacy or emerging?

- Do we understand the relationship between ph and toxicity of heavy metals, such as cadmium? How will coastal acidification impact heavy metal toxicity?

- What is the impact of changing storm frequency/magnitude on bacterial concentrations in the water column and in shellfish?

LIST OF CROSS CUTTING QUESTIONS

Applicable to All Five Focus Areas

1. How much TSS involves resuspended sediments versus new sediments from riverine or ocean or salt marsh erosion or wastewater sources?
2. How do we include feedbacks for each resource (e.g., more oysters leads to more oysters) as well as feedbacks from other resources (e.g., more oysters leads to less chl-a and less TSS, which can benefit eelgrass, which can benefit fish, etc.)?

Applicable to Four of the Five Focus Areas in this Draft Plan

3. What do we know about the impact of green crabs (and other predators) on the four resources?
4. We know that green crabs are having mostly a negative impact on all four resources. What can we do to decrease their abundance?
5. Is there an amount of recovery that creates a tipping point (for each of the four non-human focus areas) so that the recovery becomes self-reinforcing?
6. Are the types and sizes of phytoplankton changing or remaining stable? For example, could use "size fraction" as a metric here. *(note the importance of the temporal/spatial component here)*
7. What is the relationship between tributary inputs of nutrients, organic matter and TSS and estuarine biological response (phytoplankton, seaweed and eelgrass)?