Jennifer Plunket
North Inlet-Winyah Bay Reserve

Robin Weber
Narragansett Bay Reserve

Call-in number: 1-888-240-2560
Passcode: 7347630061#

National Estuarine Research Reserve System Science Collaborative

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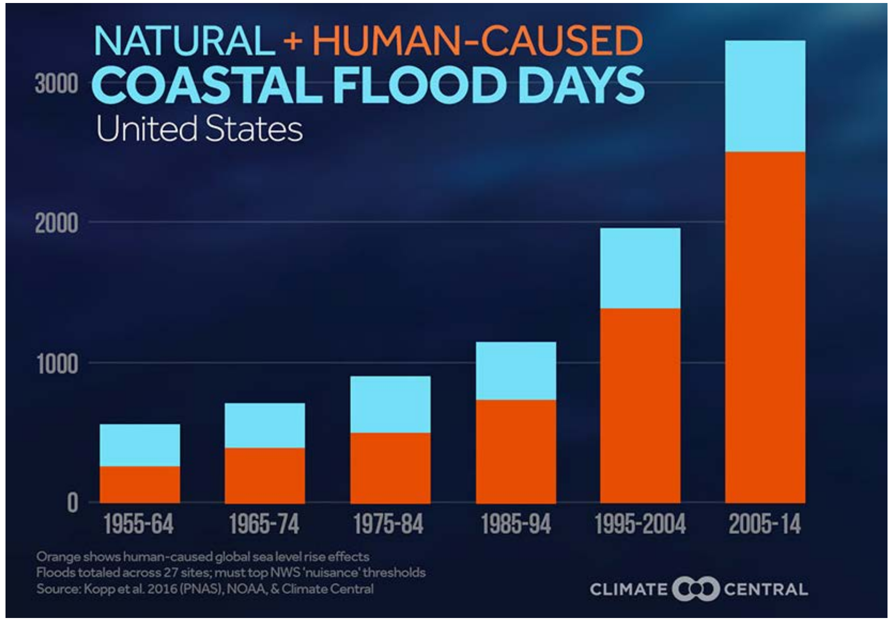
Evaluating Coastal Habitat Vulnerability to Climate Change

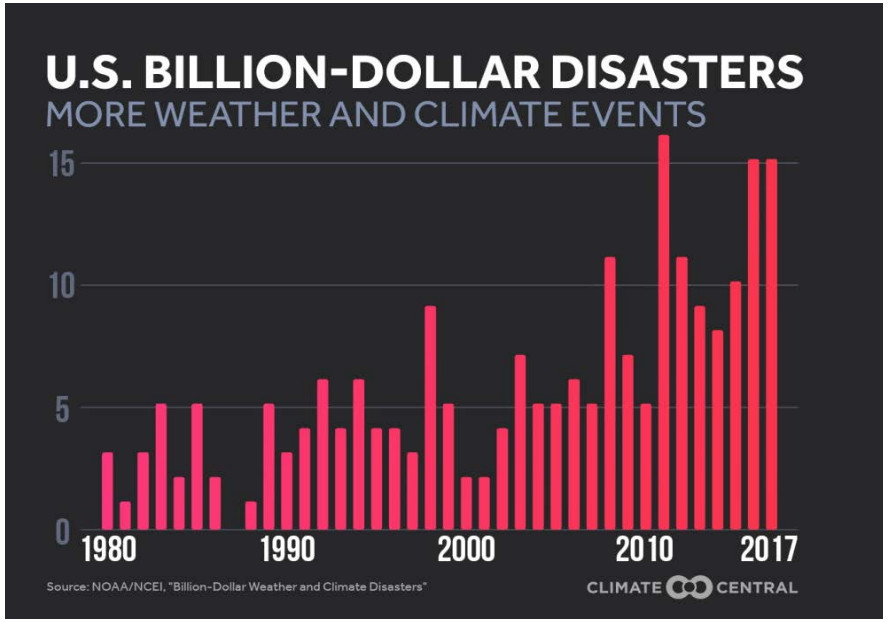
Summary Points:

Jennifer Plunket is the Stewardship Coordinator at the North Inlet-Winyah Bay National Estuarine Research Reserve in South Carolina. Jennifer oversees a variety of restoration and land management activities that support the long-term conservation of the North Inlet and Winyah Bay estuaries. She has a PhD in Oceanography and Coastal Science from Louisiana State University.

Robin is the Stewardship Coordinator for the Narragansett Bay National Estuarine Research Reserve in Rhode Island. Robin works on the management and restoration of different habitats on Reserve properties and works with partners to enhance stewardship of managed lands more broadly within the State of Rhode Island. She has a MS in Remote Sensing and GIS from Colorado State University.

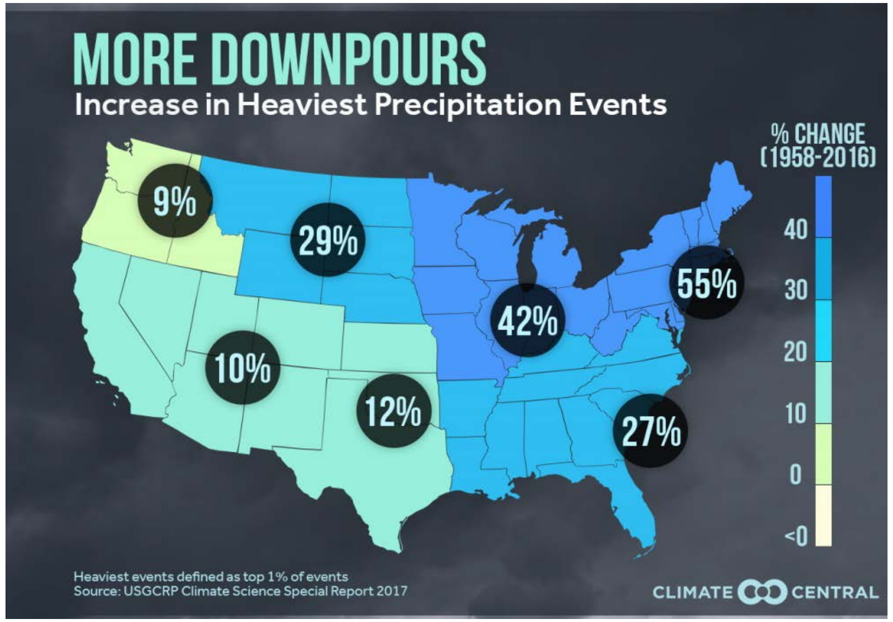
For the past seven years, Jennifer and Robin have been working to envision, develop, pilot test, and implement a climate vulnerability assessment tool. They led or co-led several grants that formed the basis of the assessment tool, including two recent Science Transfer grants that are helping others learn from their experience and apply their tool more broadly.

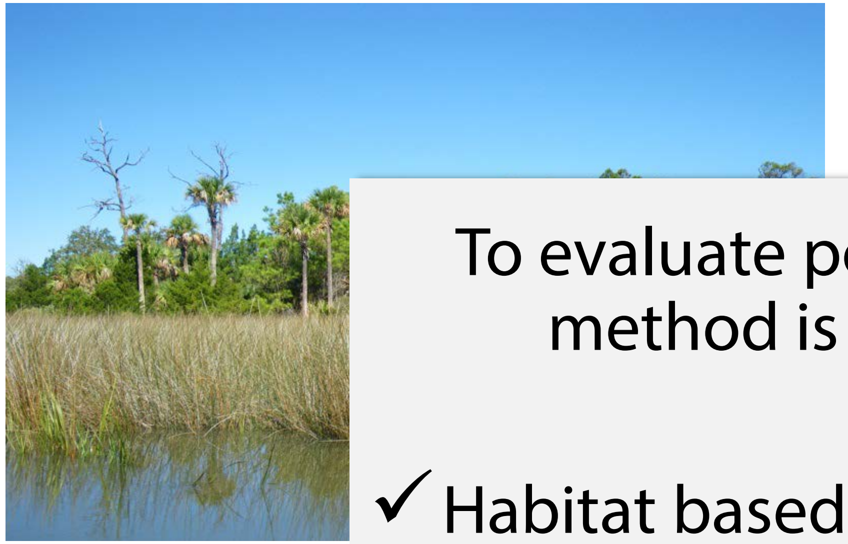




Summary Points:

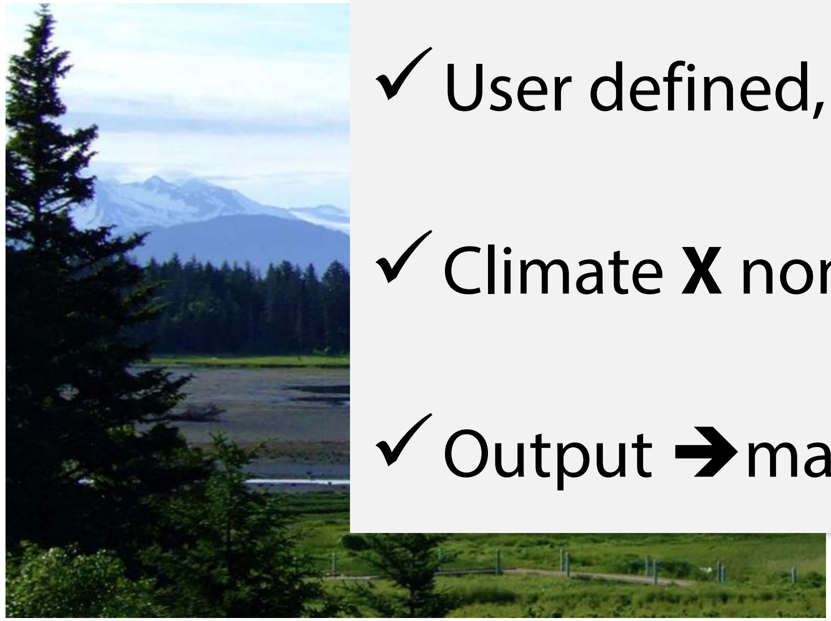
There is an increasing need to understand how rising sea levels and changes in climate patterns (eg. more frequent extreme weather events, more frequent downpours) may impact coastal habitats and the benefits they provide.

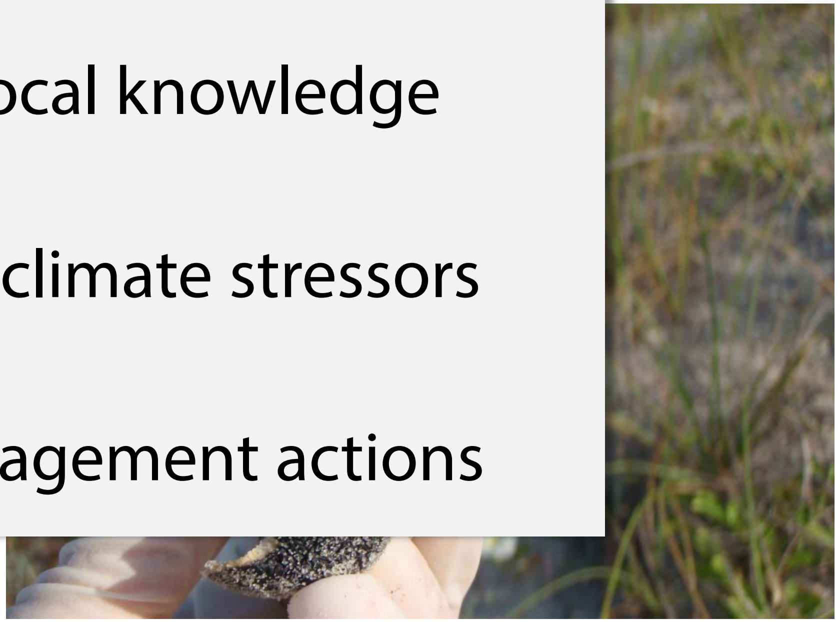




To evaluate potential impacts, a method is needed that is:

- ✓ Habitat based and site-specific
- ✓ User defined, local knowledge
- ✓ Climate **X** non-climate stressors
- ✓ Output ➔ management actions

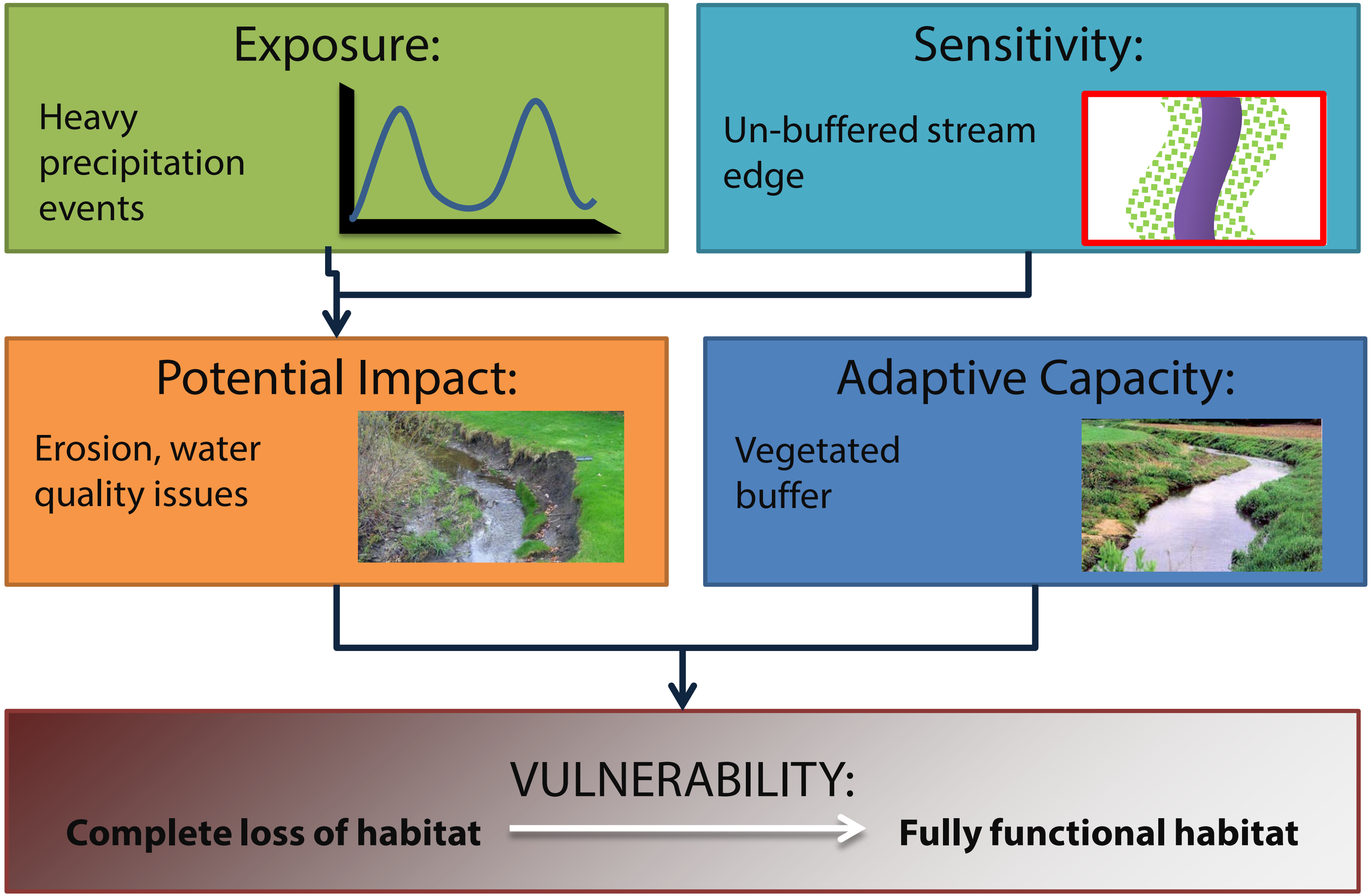




Summary Points:

The National Estuarine Research Reserve System developed a new tool, the Climate Change Vulnerability Assessment Tool for Coastal Habitats, or “CCVATCH”, to help communities evaluate the potential impacts of climate change and sea level rise on their local habitats.

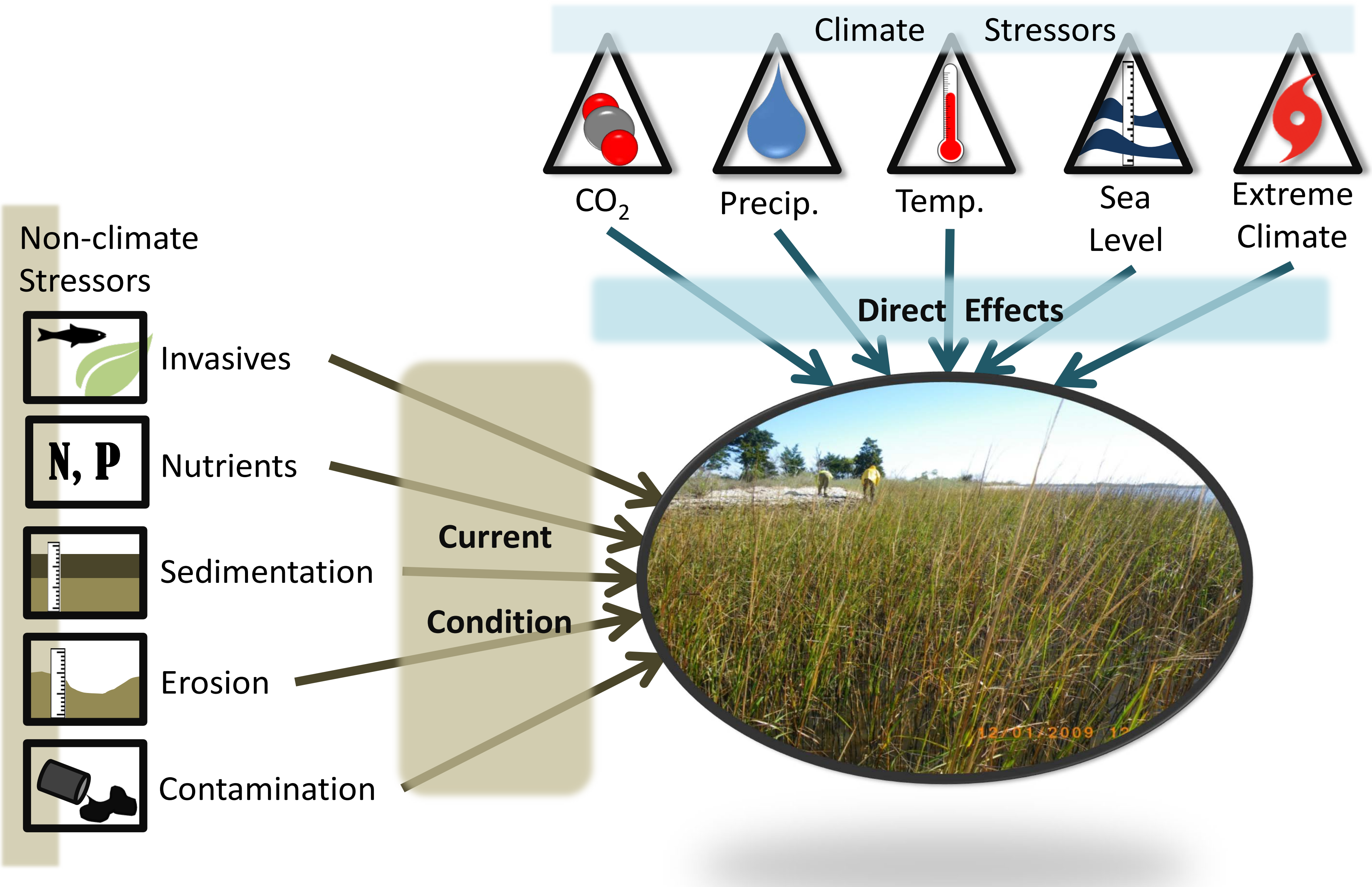
Vulnerability Assessment Framework



Summary Points:

CCVATCH is habitat-based and site specific, and can be applied at a variety of geographic scales. For example, the tool could assess climate impacts on a 100-acre parcel of cyprus swamp within a National Wildlife Refuge or it could be used to evaluate a set of individual salt marshes across a state to inform management and restoration activities. However, it is not meant to assess the overall vulnerability of a broader habitat, or to assess vulnerabilities across multiple sites, as it is site-specific.

Exposure and Sensitivity



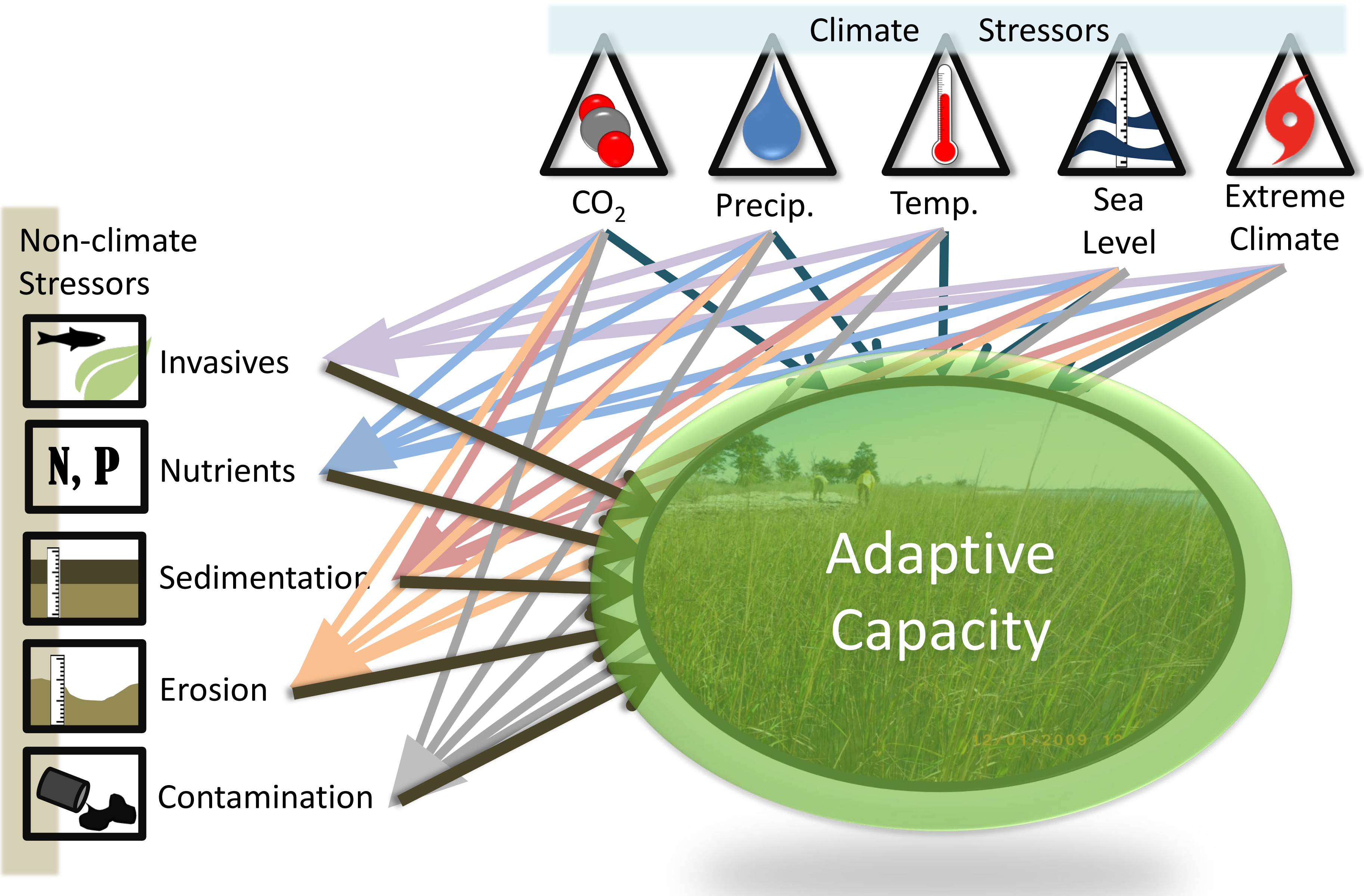
Summary Points:

The tool considers the direct effects of climate stressors on a habitat, (e.g. changes in precipitation, air temperature, carbon dioxide levels, sea level, and frequency of extreme climate events) and the effect of non-climate environmental stressors on a habitat.

The five non-climate stressors were selected after a literature review, and sensitivity analysis across reserves revealed invasives, nutrients, sedimentation, erosion, and contamination to be the most common non-climate stressors to reserves and other managed lands.

One key point to note is that the tool focuses primarily on the interactions between climate and non-climate stressors and how these interactions affect coastal habitats, rather than looking at the direct impacts of each stressor on the environment.

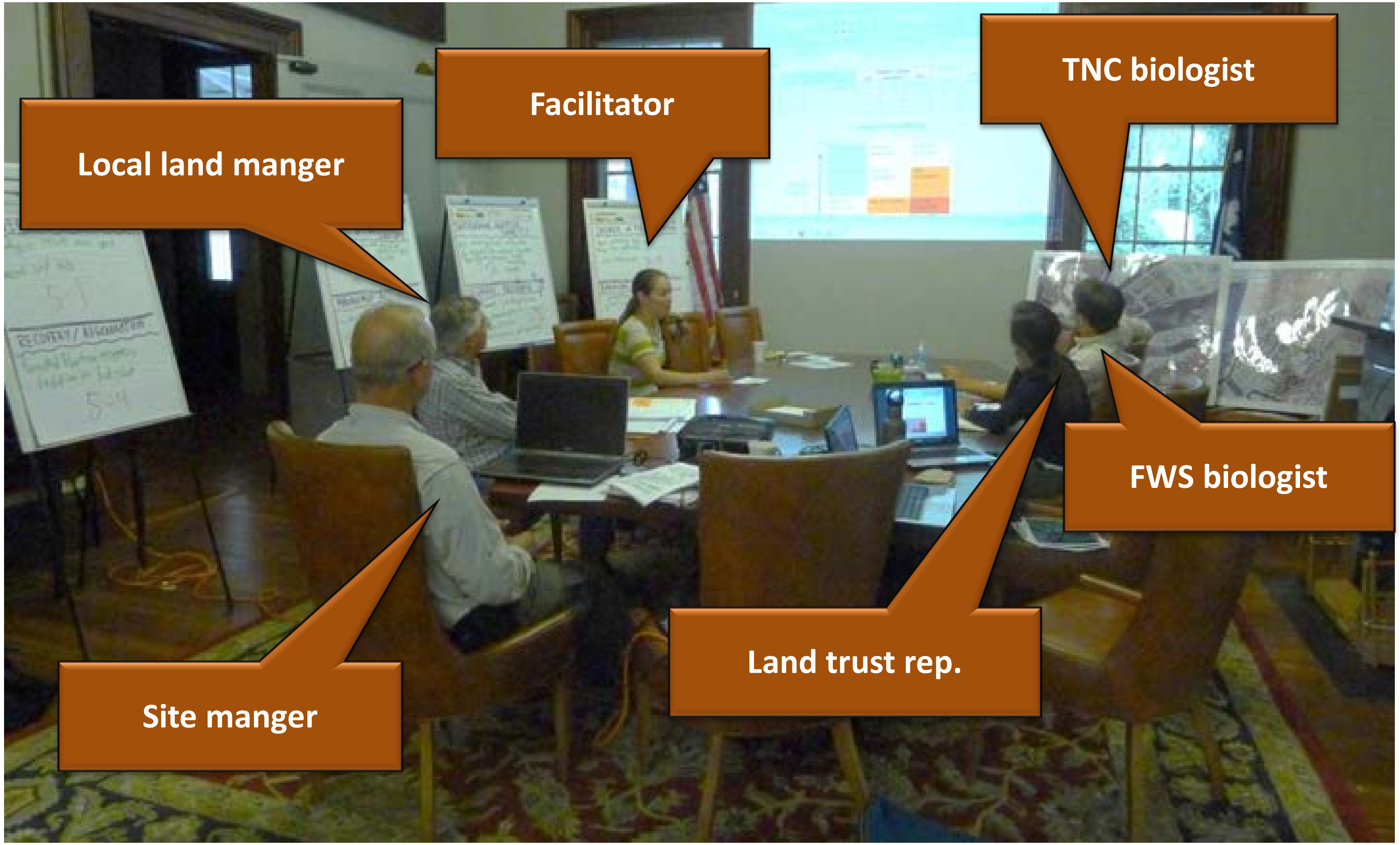
Exposure and Sensitivity Interact



Summary Points:

The tool also considers the adaptive capacity of the habitat, which can be defined as the natural traits of the system or potential management actions that can lessen the impacts of climate change.

CCVATCH process: Expert Elicitation (People who know the place and research)

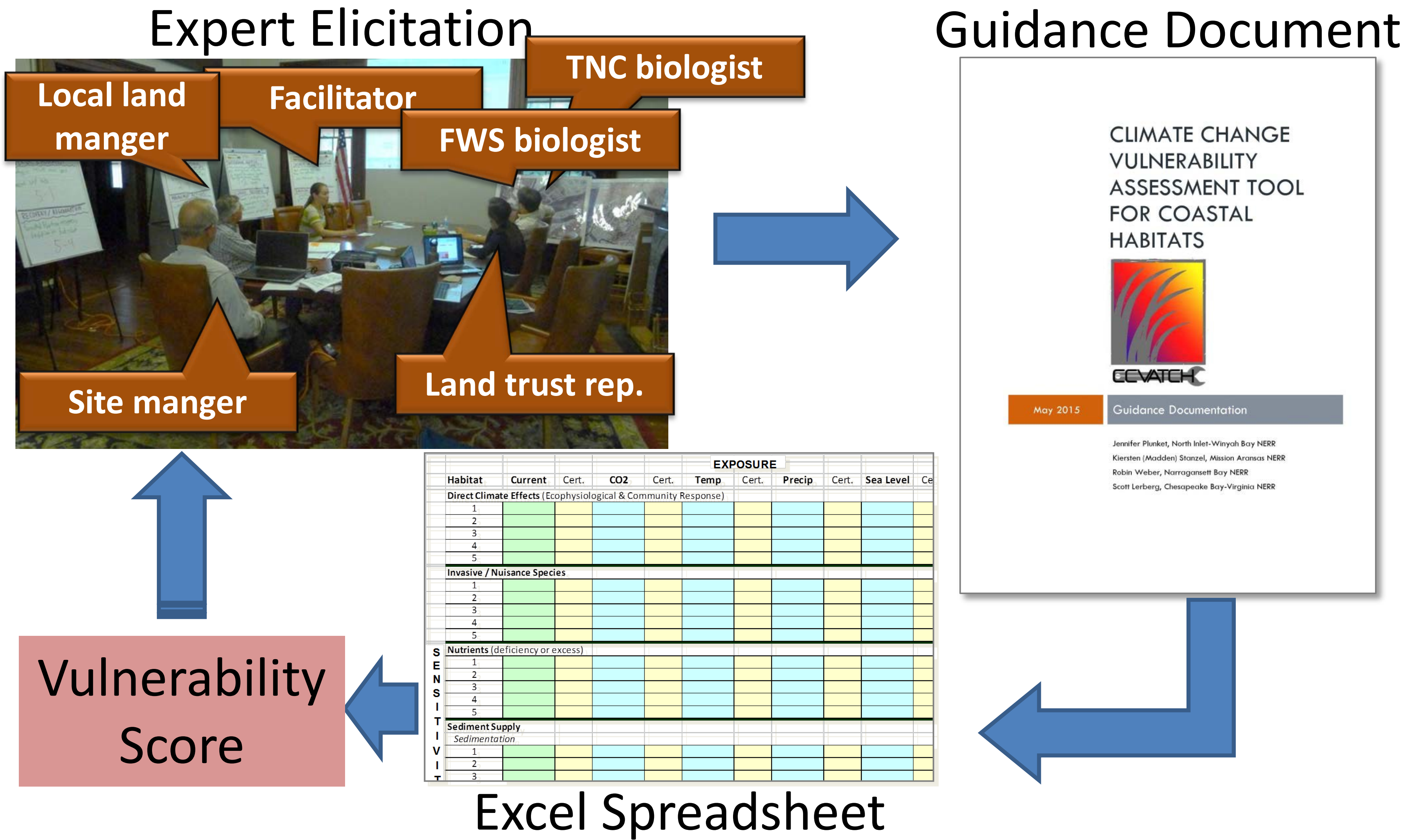


Summary Points:

CCVATCH is an expert elicitation process which is designed to bring together those who best know the habitat and relevant scientific research (scientists and decisionmakers) to create a shared understanding of how changes in climate and management practices will make the habitat more or less vulnerable in the future. The goal is to ensure assembly of a team of people who can answer a broad range of questions about the habitat in question.

For example, the expert team for one of Jennifer's pilot studies included biologists from The Nature Conservancy and the U.S. Fish and Wildlife Service, a local land manager, a land trust representative, the habitat's site manager, and a facilitator.

CCVATCH process: Expert Elicitation (People who know the place and research)



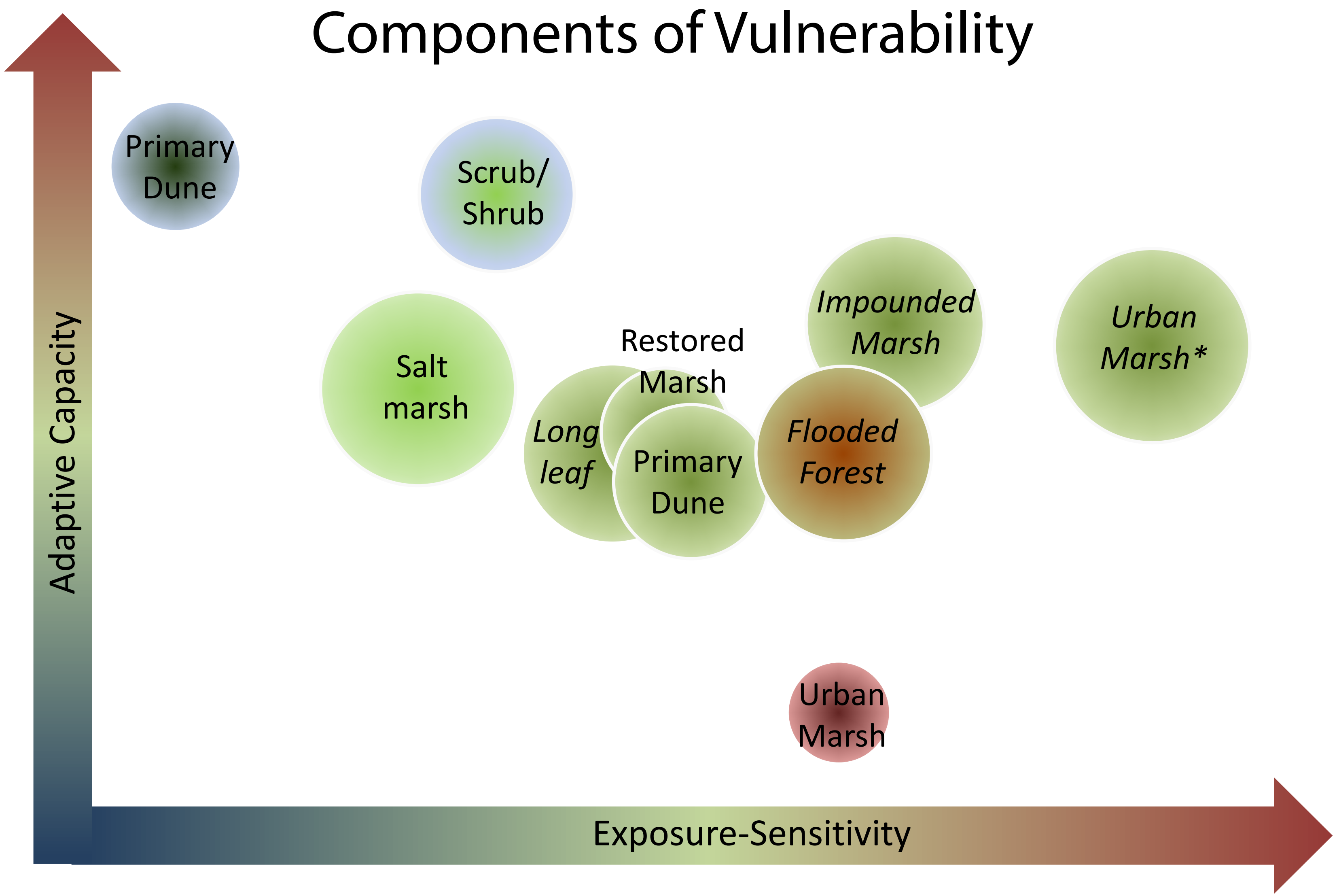
Summary Points:

The facilitator leads the expert team in working through the CCVATCH Guidance Document. This document guides users through a series of questions to assess the potential interactions of climate change exposure with non-climate stressors to affect the habitat's ability to persist.

The document also asks teams to consider the direct effects of climate stressors on the habitat, the current condition of the habitat, and the natural and anthropogenic conditions that affect adaptive capacity.

Answers to the questions are entered into a spreadsheet, which then calculates a vulnerability score for the habitat. Scores range from -2 to 10, where -2 means the habitat is benefitting from climate change and 10 is worst case scenario.

2015 Pilot Project Outcomes



South Carolina sites are in italics

*Refers to a salt marsh surrounded by urban development

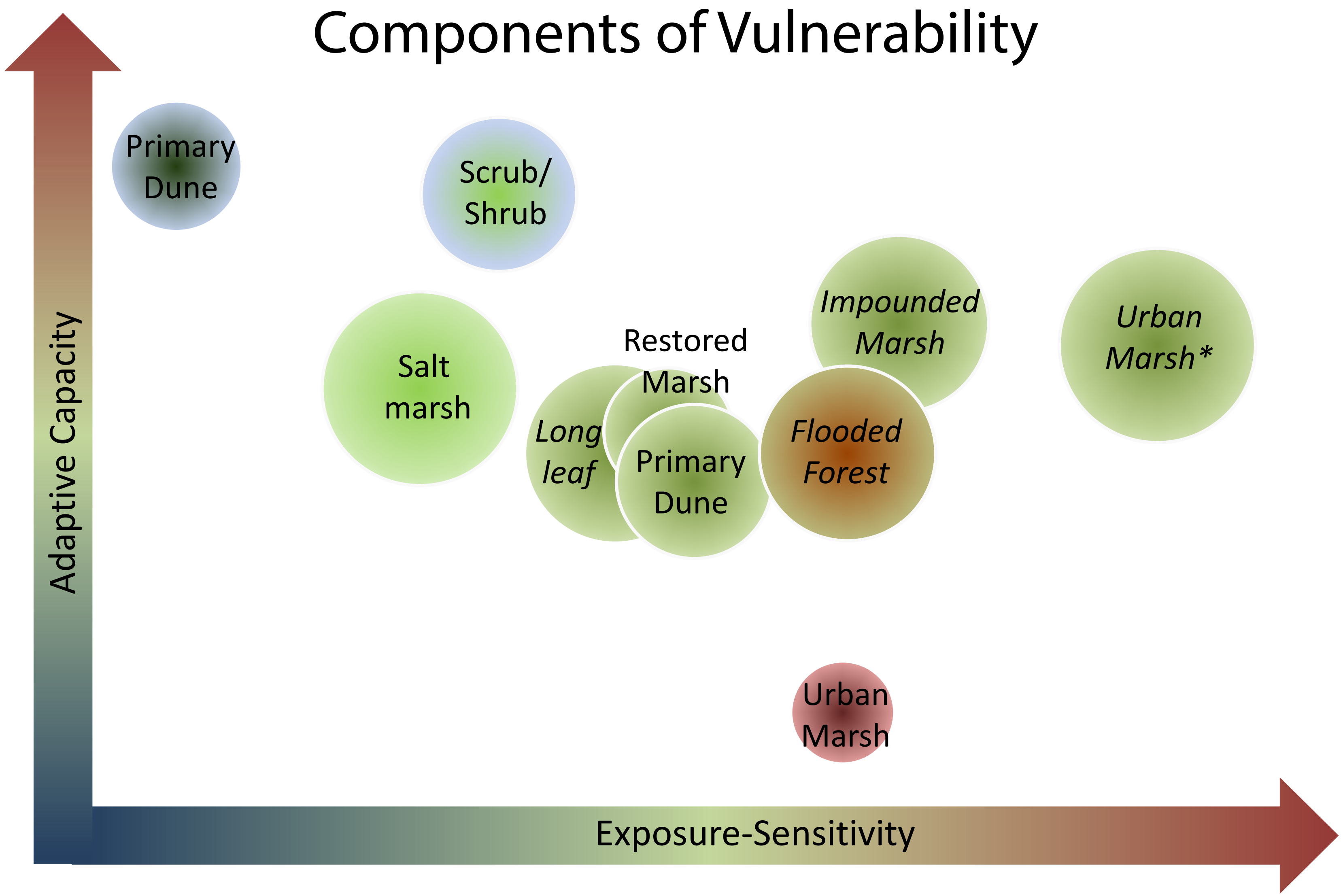
Summary Points:

The graph depicts some of the scoring results from a pilot project Jennifer's team conducted in 2015, plotting calculated exposure-sensitivity scores (direct effects of climate change and anticipated interactions of climate and non-climate stressors) with adaptive capacity scores. This project showed that, although a habitat may be at a high risk for a particular stressor, it might have adaptive capacity elements that make it less vulnerable.

For instance, a salt marsh with a buffer of protected land around it that allows it to migrate with sea level rise will be less vulnerable than a salt marsh surrounded by urban development.

CCVATCH also asks users to assign certainty scores for the basis and level of agreement between assessors for the current condition, exposure-sensitivity, and adaptive capacity scores. The smaller the circle, the higher the certainty.

2015 Pilot Project Outcomes



South Carolina sites are in italics

*Refers to a salt marsh surrounded by urban development

Questions:

Can you clarify how adaptive capacity was calculated for sea level rise?
Adaptive capacity did not focus specifically on sea level rise. It generally looked at how the following factors might affect the ability of a habitat to adjust to a changing climate (including rising sea level): degree of fragmentation; barriers to migration; recovery/regeneration; diversity of functional groups; management actions; and institutional/human response.

How long does the expert elicitation process take?
In Jennifer's project in the Southeast, it took two days.

Have you seen CCVATCH used to analyze vulnerability across multiple sites? Do you have recommendations for how to do that type of work?
We tried to analyze vulnerability for all salt marshes in South Carolina, but it did not work well because there are too many site-specific differences between marshes. However, Robin will discuss how she used CCVATCH across many sites in New England and will share her insights into how that process works.

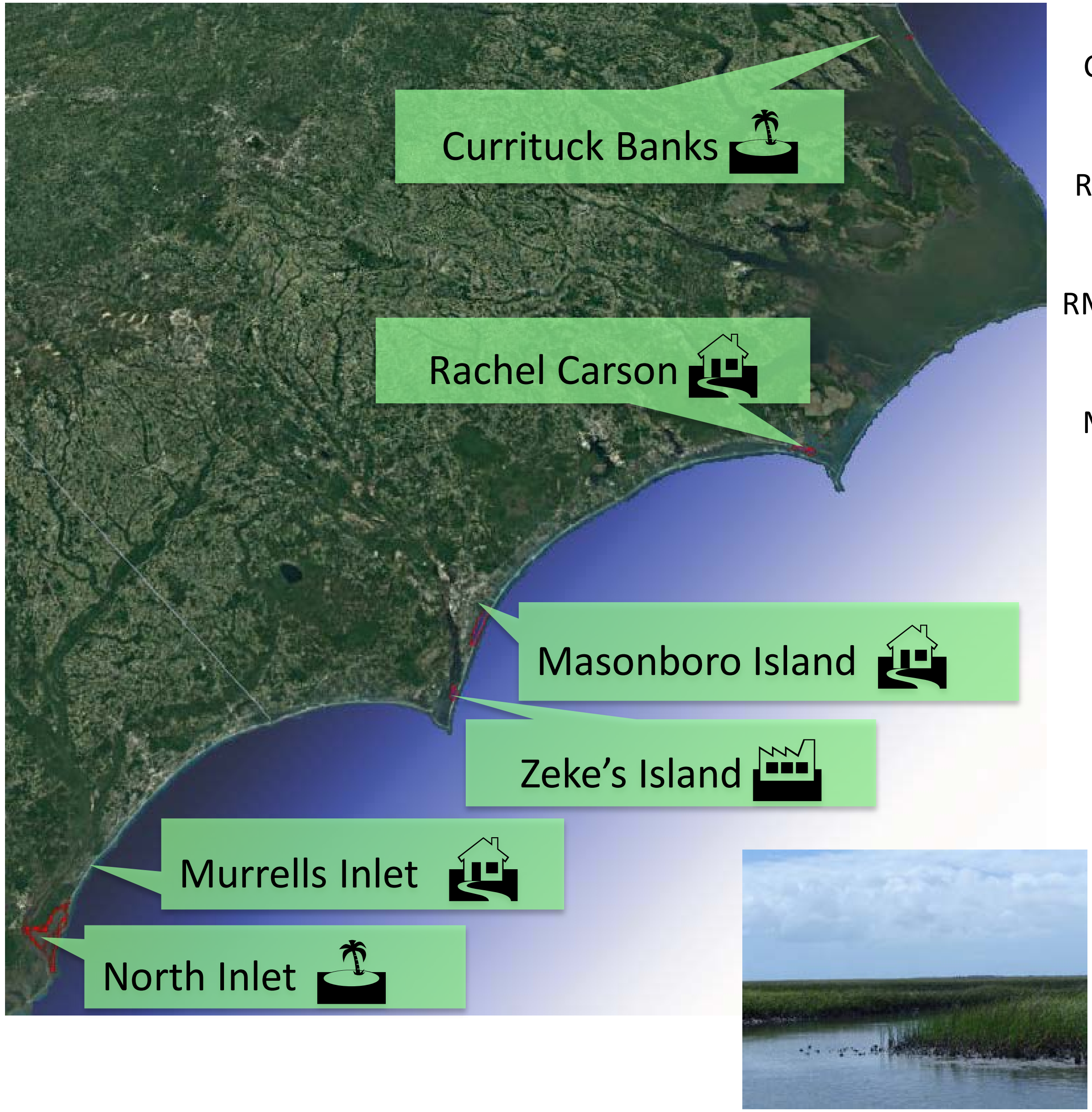
Summary Points:

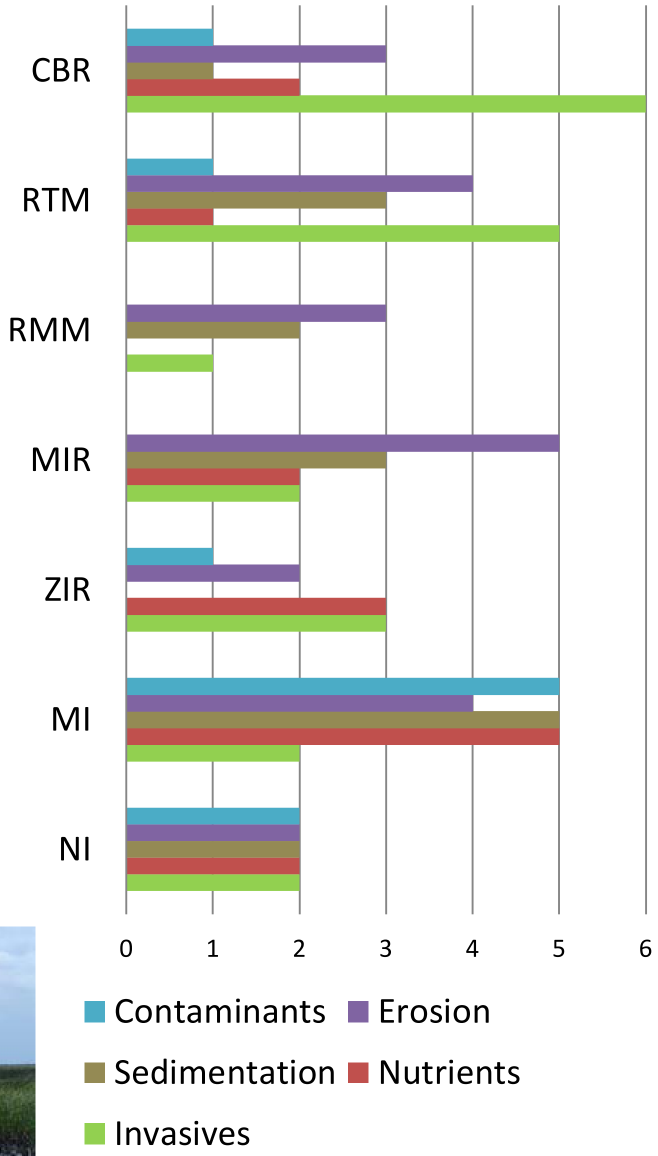
Jennifer and Robin applied CCVATCH at sites in the Southeast (Jennifer) and Northeast (Robin). Their projects demonstrate the adaptibility of the tool, as they applied it and interpreted data differently.

Applications of CCVATCH in the Southeast and New England

Goal: To inform mitigation/adaptation decisions through a better understanding of vulnerabilities

Southeastern Emergent Marsh Assessment





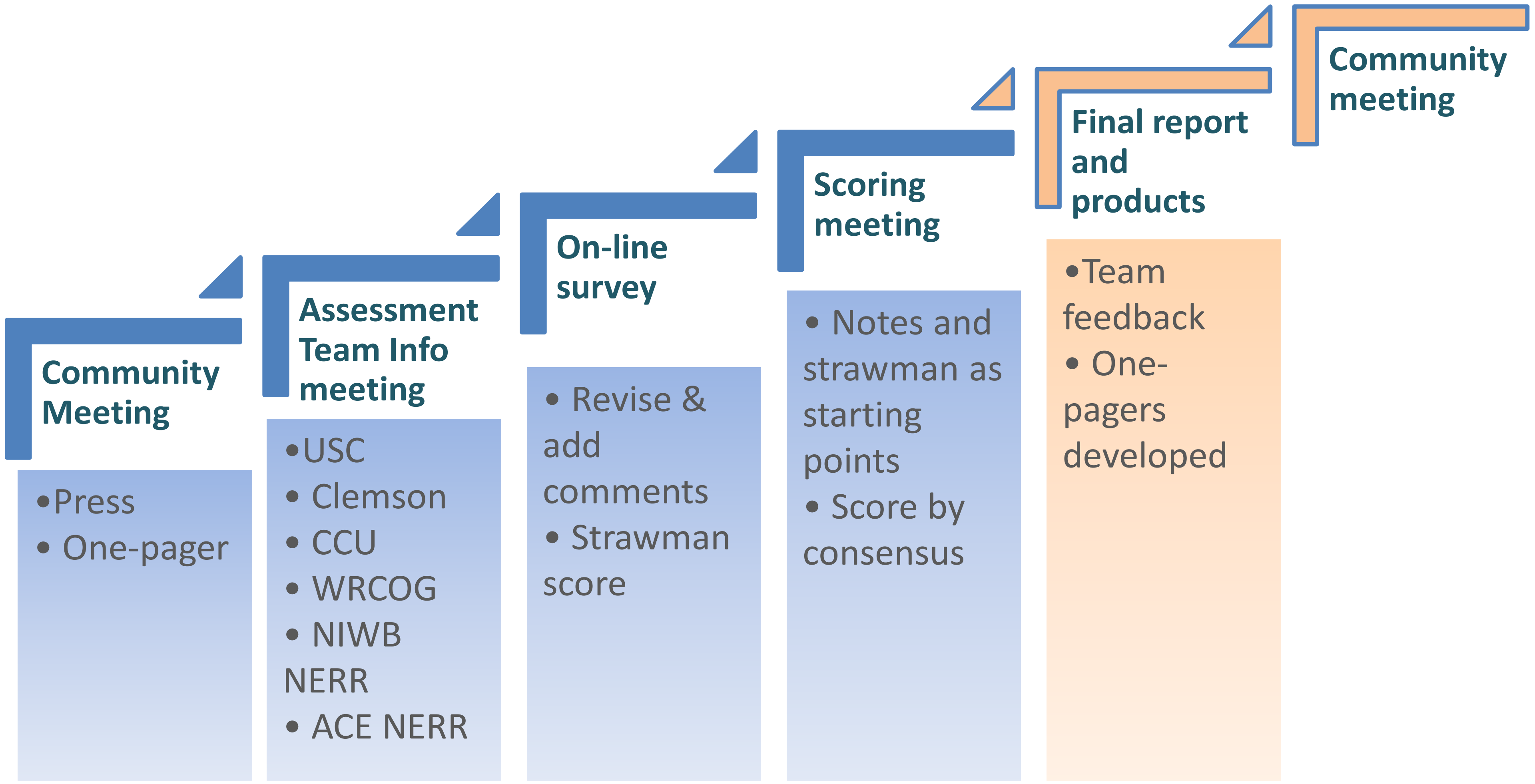
Summary Points:

In the Southeast, Jennifer's team looked at emergent marsh sites across South Carolina and North Carolina. Although some experience more climate impacts than others, each site is facing the same predicted climate impacts and similar predicted sea level rise.

All sites were within Reserve systems, with the exception of Murrell's Inlet.

The figure shows exposure-sensitivity scores for non-climate stressors at each listed site, which help elucidate whether particular stressors are more likely to have a higher impact on a site's vulnerability.

North Inlet/Murrells Inlet Assessment



Summary Points:

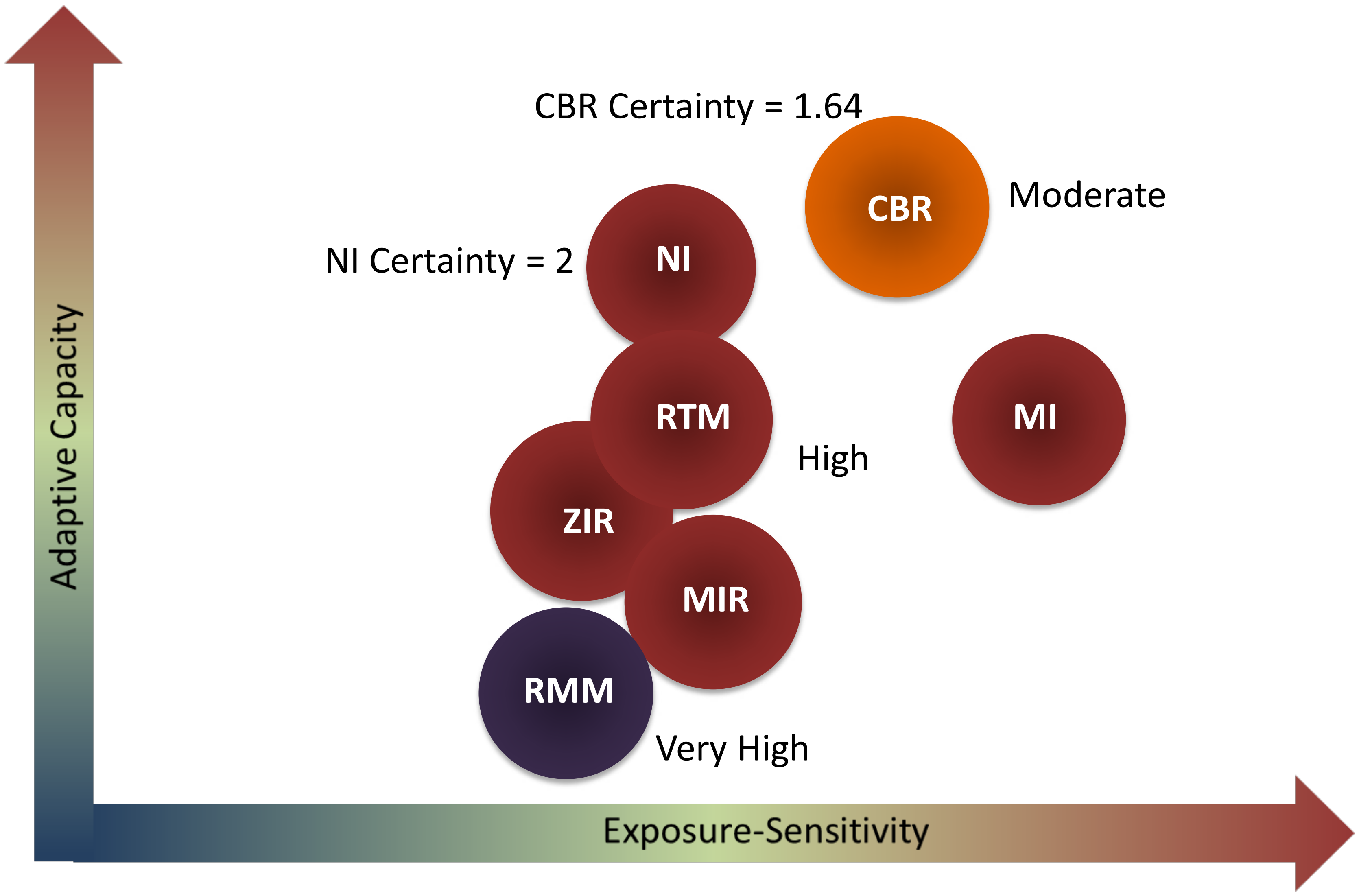
*North Carolina team used a slightly different process than shown below:

- The team held a community meeting, inviting anyone interested or concerned about the estuary.
- They then assembled an assessment team, mostly consisting of university-related personnel (Clemson, Coastal Carolina, University of South Carolina), but also representatives from reserves and local and/or regional government.
- The assesment team conducted a dry run through questions in the tool to determine knowns, unknowns, and what personnel would be needed to obtain the information required to assess a climate vulnerability score.
- The team then received compiled information in an online survey, giving them the opportunity to add information and/or make comments as part of a data-gathering process.
- The team then came back together for a full day meeting where they went through the scoring process. Scoring was done by consensus (six people in the room).

The team is has produced a number of resources using CCVATCH.

Ultimately, the team's goal is to bring their findings back to the community, tell them what vulnerabilities exist for North Inlet/Murrells Inlet, and give some suggestions to address them.

Southeast Site Overall Vulnerability

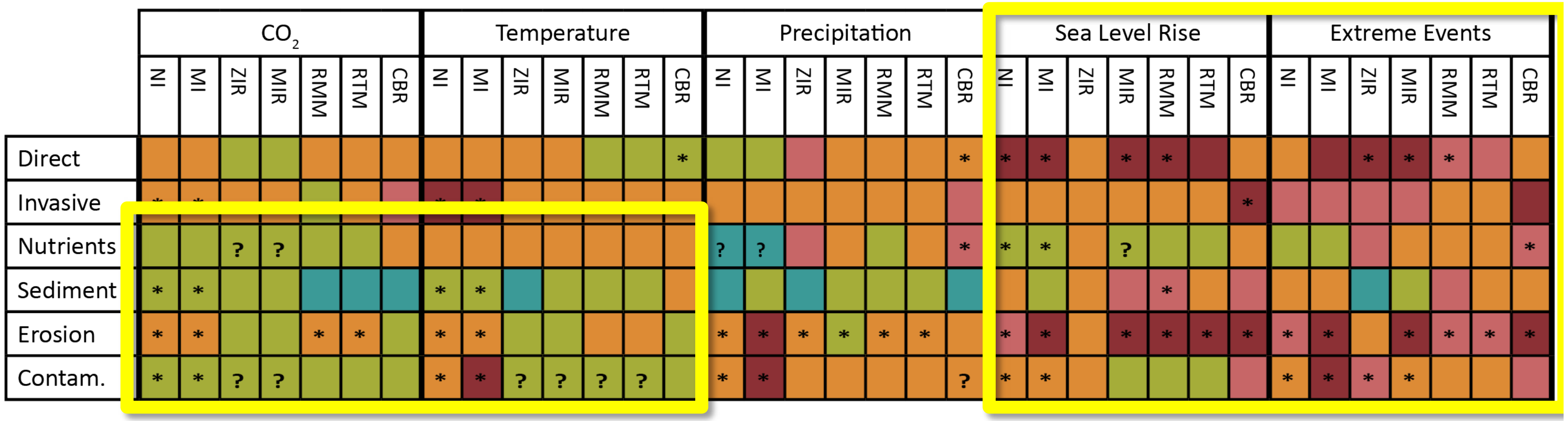


Summary Points:

Overall vulnerability of southeast sites ranged from moderate to very high.

The overall certainty scores were similar across sites, averaging approximately 1.8 on a scale of 0-4, where 4 is highest. All of the expert groups assessing each site were somewhat, but not very, certain.

Sensitivity-Exposure Scores



>5	**Habitat persistence, extent or functionality will be severely impacted**
3 to 4	**Habitat persistence, extent or functionality will be moderately limited**
1 to 2	**Habitat will be negatively impacted with some potential loss of functionality**
0	**No anticipated change in habitat extent or function**
< 0	**Habitat my benefit by alleviation of a non-climate stressor**

Certainty Scores

* High	Moderate evidence (several sources, some consistency, methods vary and/or documentation limited, etc.), medium consensus, general information can be applied to local habitats
? None	No direct or anecdotal evidence is available to support the score, topic needs further investigation

Summary Points:

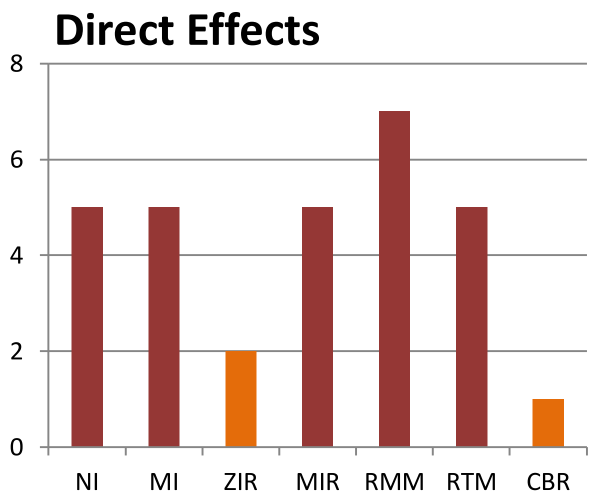
The figure shows the results (individual direct impacts from climate change across the top, non climate stressors on the left side) for each site. Below are guidelines for interpreting the results:

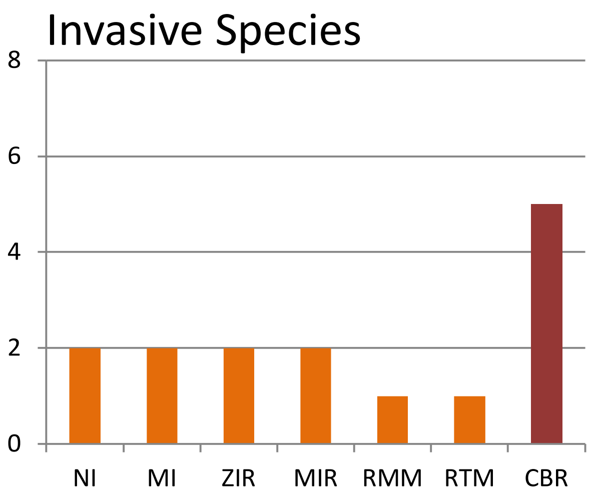
- The boxes in red indicate the highest vulnerability scores (>5), in which habitat function would be severely impacted by that climate change-stressor interaction.
- An asterisk (*) indicates certainty was very high (3 or more).
- A question mark (?) indicates interactions where there was a certainty score of 0.
- The green boxes indicate no anticipated change in habitat. Most of the low-certainty scores fell within green boxes. Record-keeping for certainty is important as it prevents oversimplification of sensitivity scores that might lead stakeholders to conclude that a given stressor poses no risk.
- The first row indicates how sensitive a given site is to the direct climate change effect listed; i.e., the top-leftmost square indicates the assigned exposure-sensitivity score -- and certainty in this measurement -- for North Inlet's exposure to an increase in carbon dioxide.

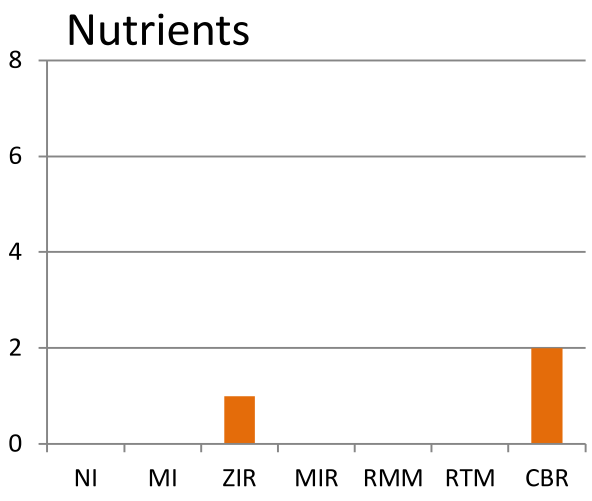
Unsurprisingly, the highest impact scores were in sea level rise and extreme events (tropical storms). These are coastal sites, so it is expected that these locations are where most of the impacts will occur and where most of the highest certainties are.

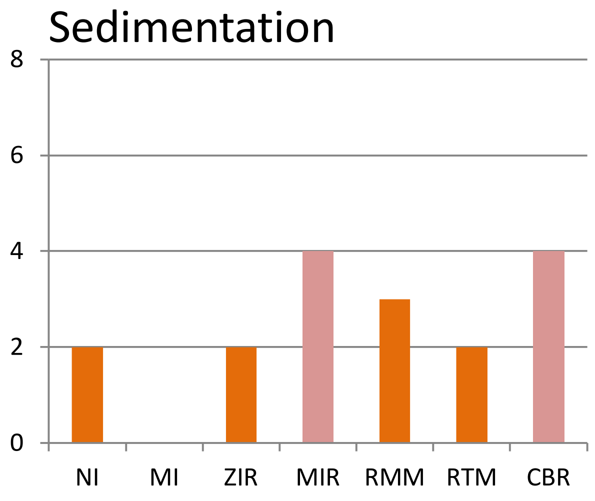
Note: Sensitivity-exposure scores account for different variables than adaptive capacity scores (see response to question 1 on page 10 above).

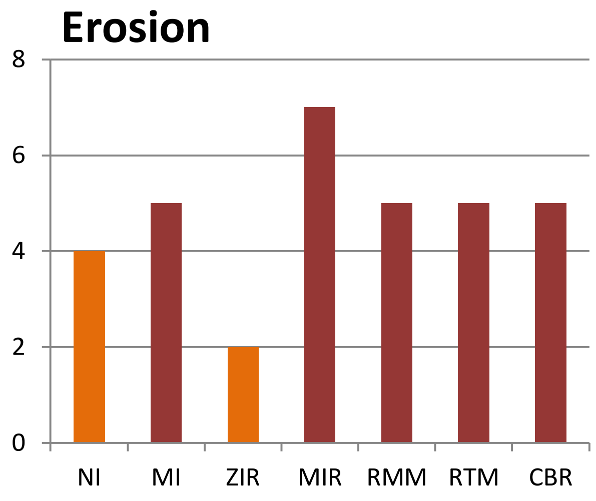
Sea Level Rise and Sensitivity

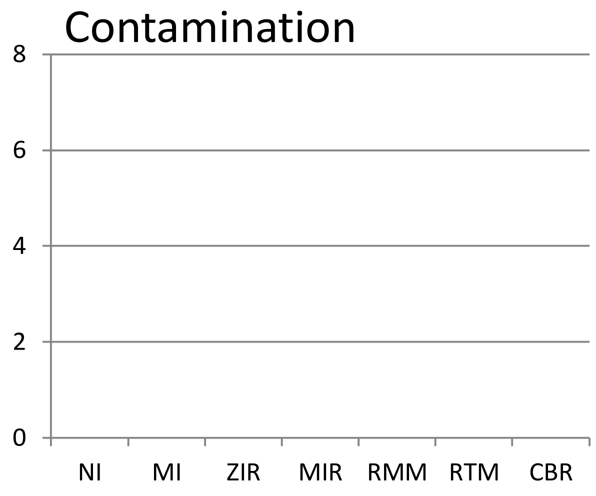










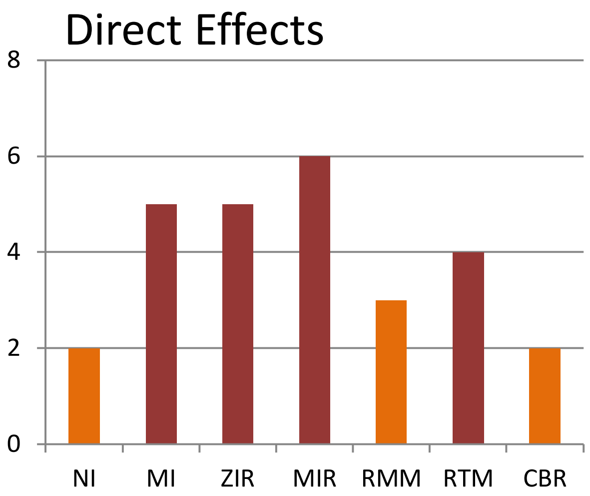


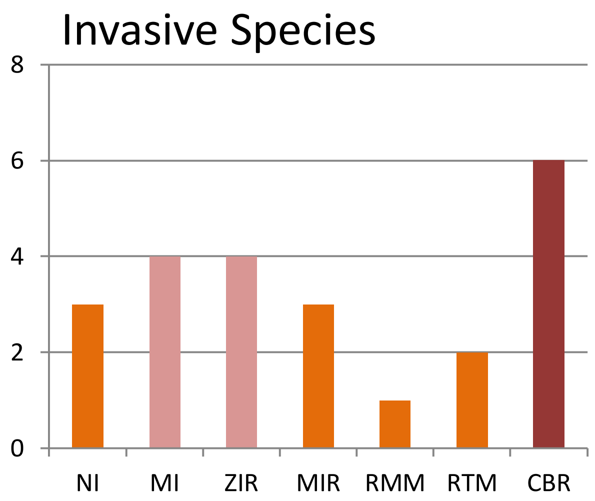
Summary Points:

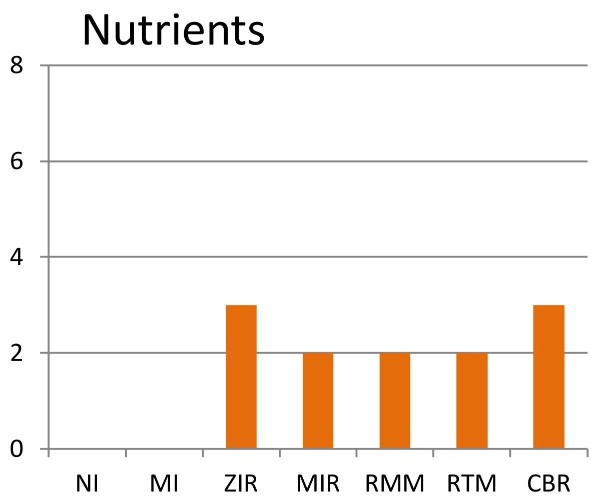
CCVATCH facilitates more detailed understanding of how predicted climate changes will impact habitats through each existing stressor; for example, sea level rise will affect marshes directly, but it will also interact with other factors.

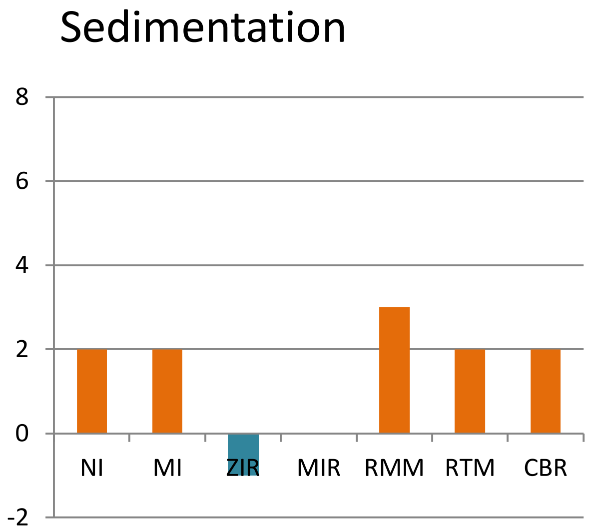
One unexpected result across all sites was the interaction of sea level rise and erosion. For example, Zekes Island Reserve and Masonboro Island Reserve are geographically close and have similar habitats; however, those groups felt that potential for erosion at Masonboro Island was much greater. Their concern was that, with increased sea level rise, there would be higher rates of tidal flow which would interact with the current problem of marsh die-off and intensify the erosion problem.

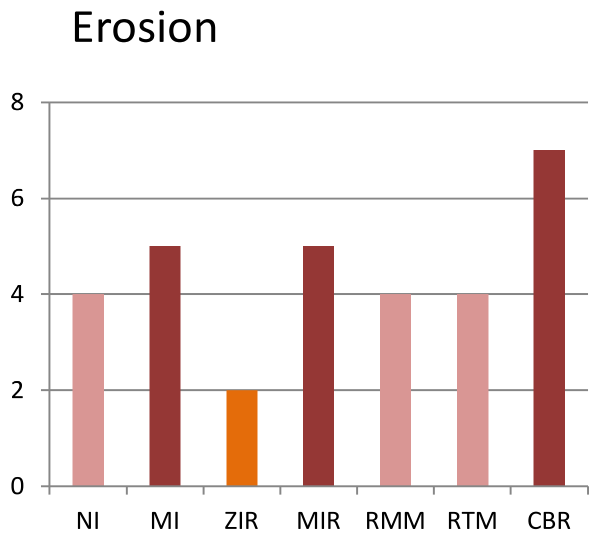
Extreme Events and Sensitivity

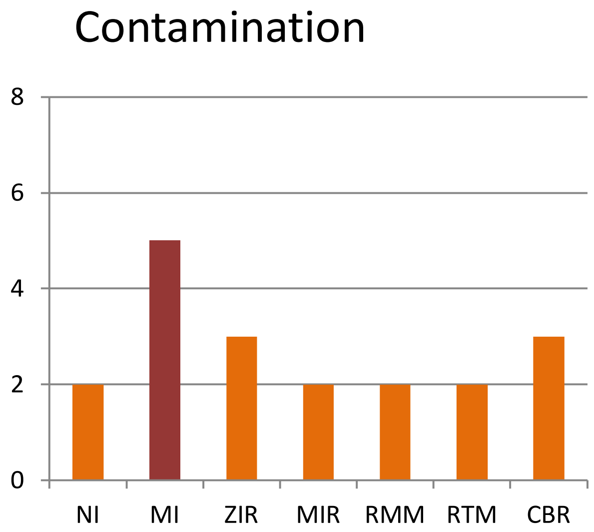










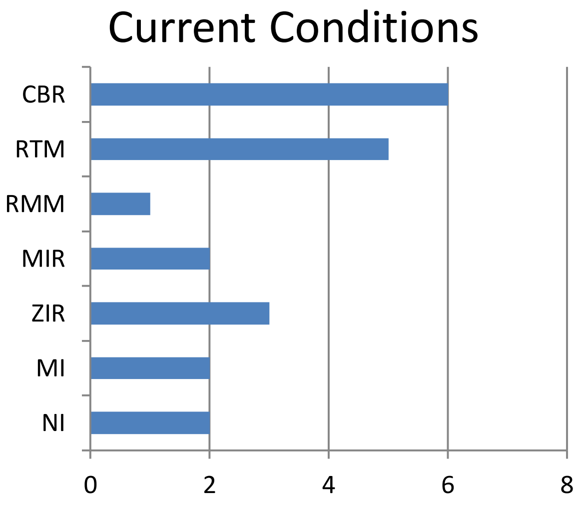


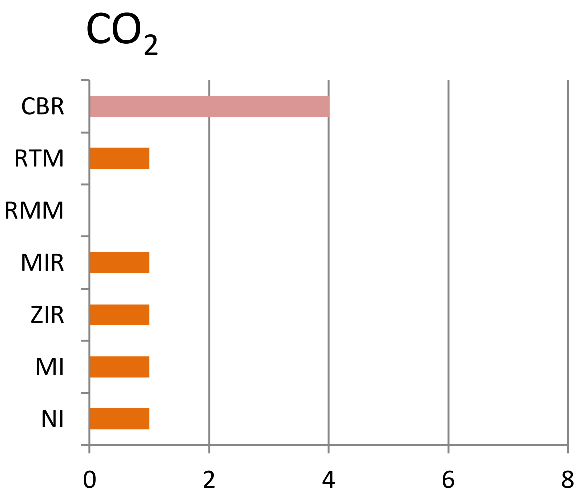
Summary Points:

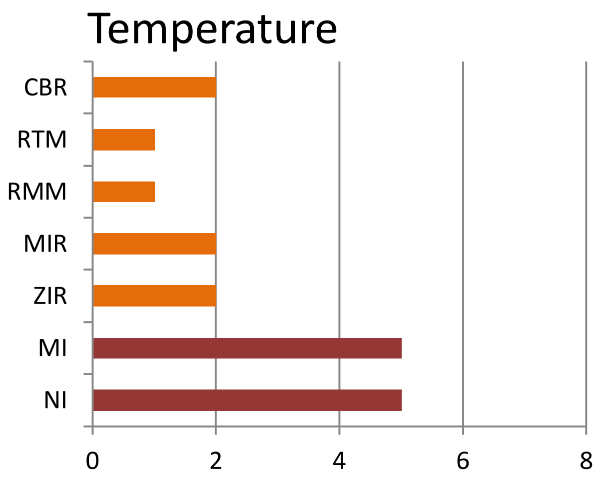
With sea level rise, erosion stood out across sites; conversely, for extreme events, the interaction with non-climate stressors is higher across the board.

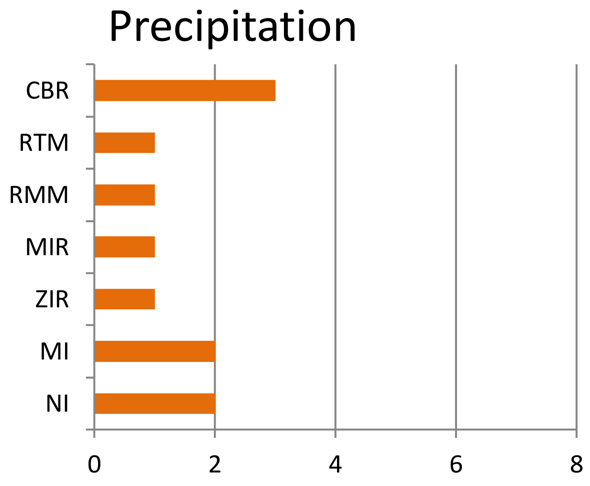
Overall, extreme events are going to have high potential interactions with non-climate stressors.

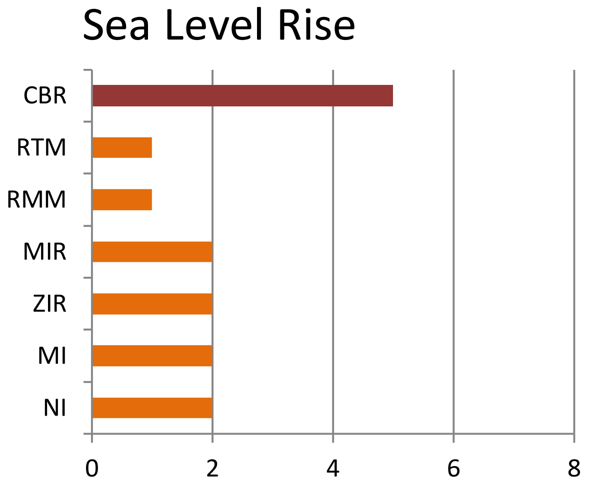
Invasive Species and Exposure

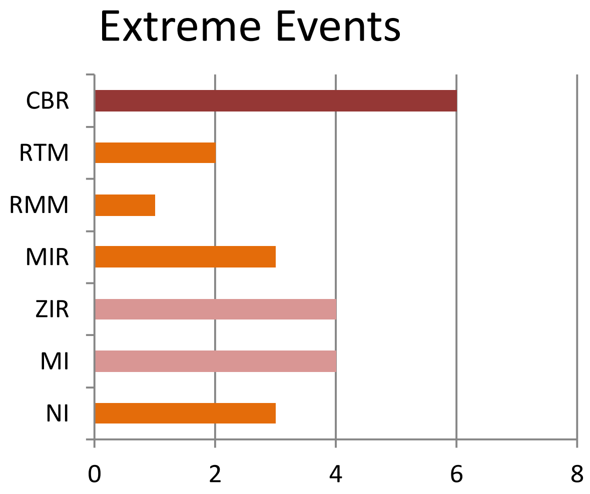












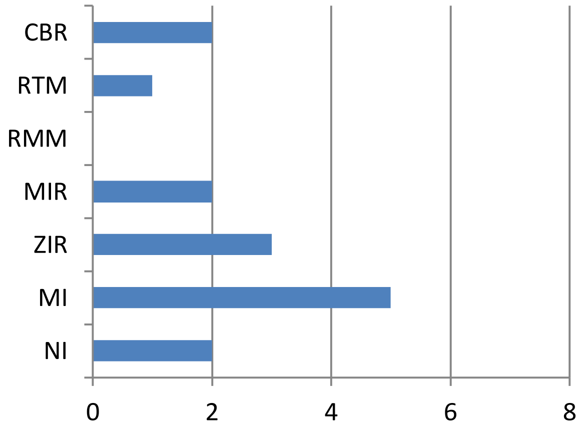
Summary Points:

Data can also be examined by each non-climate stressor.

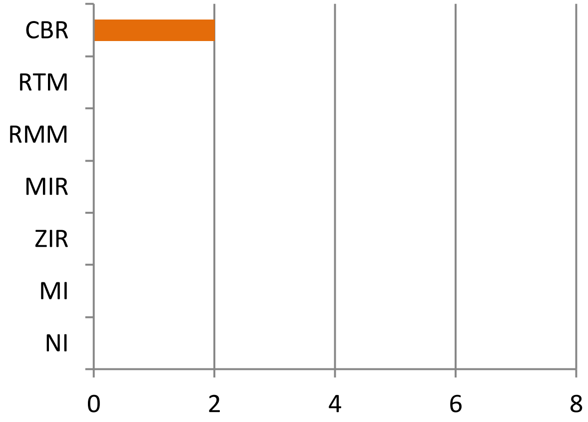
Invasive species showed high sensitivity-exposure scores across sites and stressor interactions. Despite some variability in sites, temperature and extreme events showed overall high potential for interacting with invasive species in a way that negatively impacts habitats, such as moving propagules or creating gaps for invasive species to enter.

Nutrients and Exposure

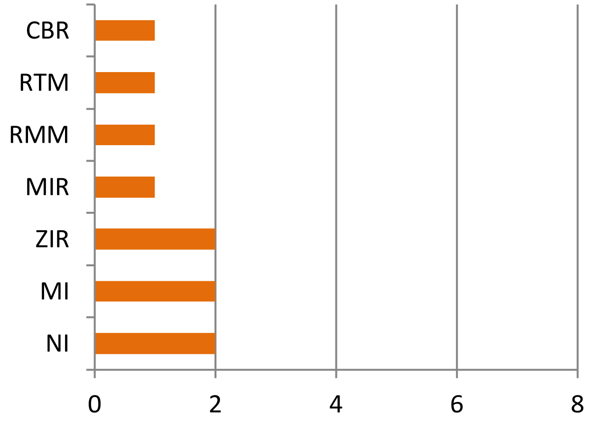
Current Conditions



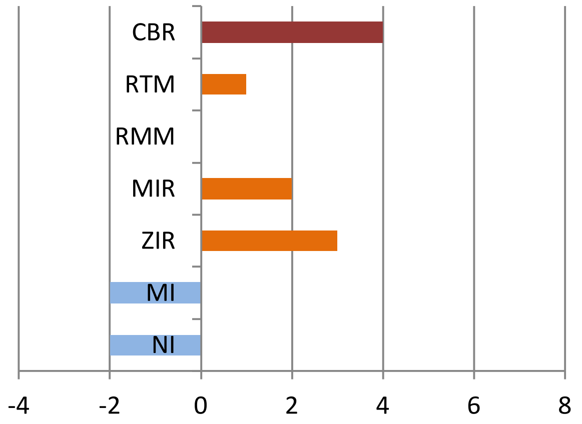
CO_2



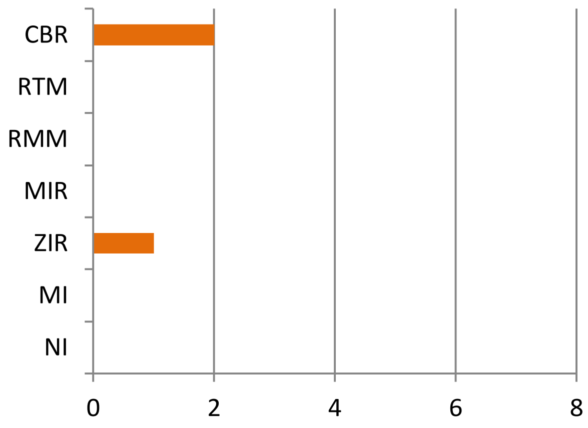
Temperature



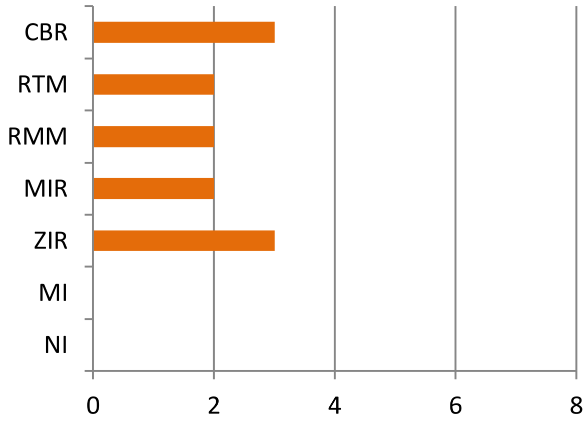
Precipitation



Sea Level Rise



Extreme Events

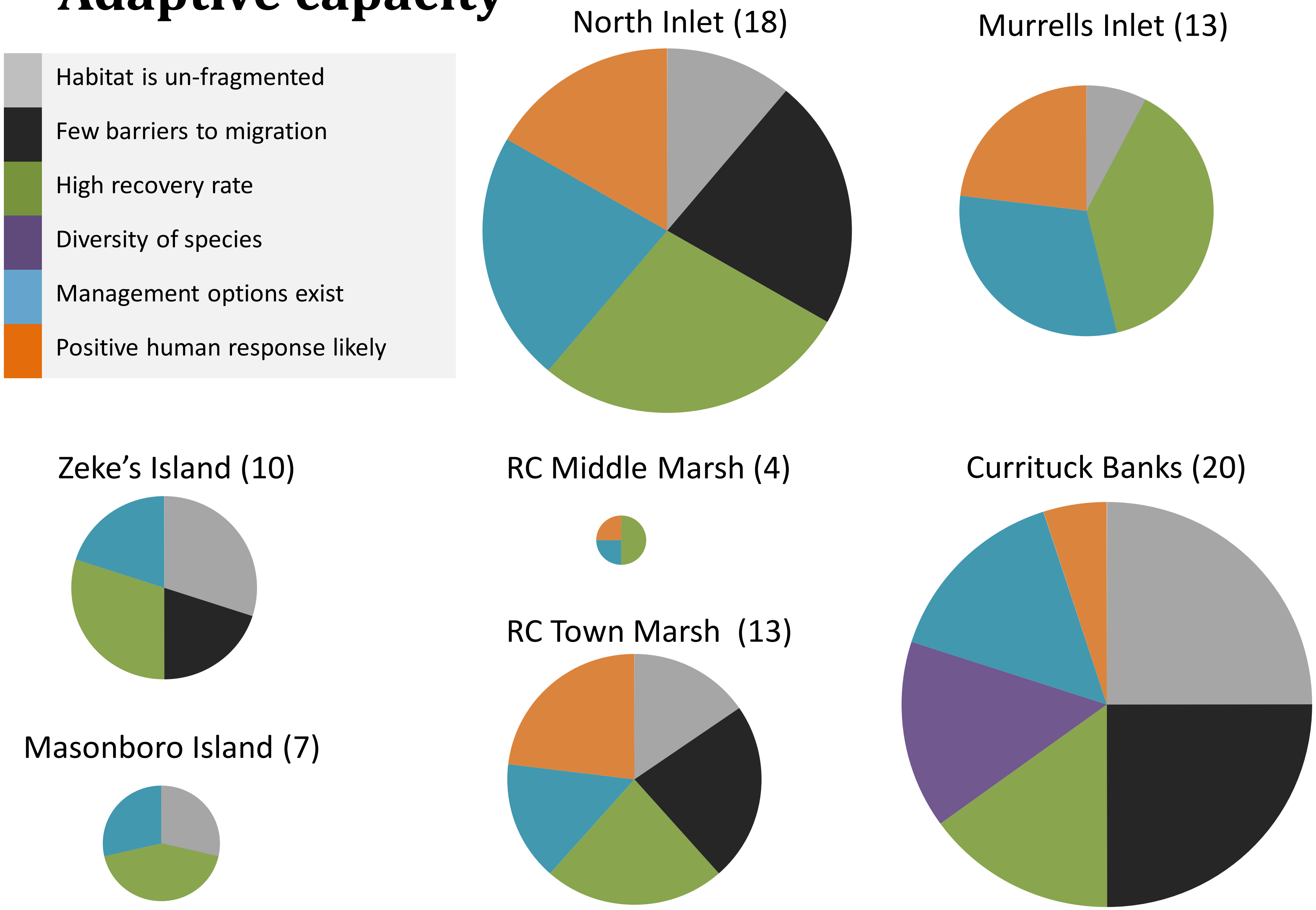


Summary Points:

Conversely, the interaction between nutrients and climate was not very well-understood and it was not felt that predicted climate change impacts would have severe interactions with nutrients.

Interestingly, some assessment teams thought that increases in precipitation might benefit the interaction if they introduced more nutrients into the marshes, promoting more marsh vertical accretion over extended periods of time.

Adaptive capacity



Summary Points:

Adaptive capacity is the intrinsic or management potential of a site to modify either the direct climate change effects, or to potentially modify some of the stressor effects. Adaptive capacity can be thought of as a portfolio of assets that might make a site more resilient to climate impacts.

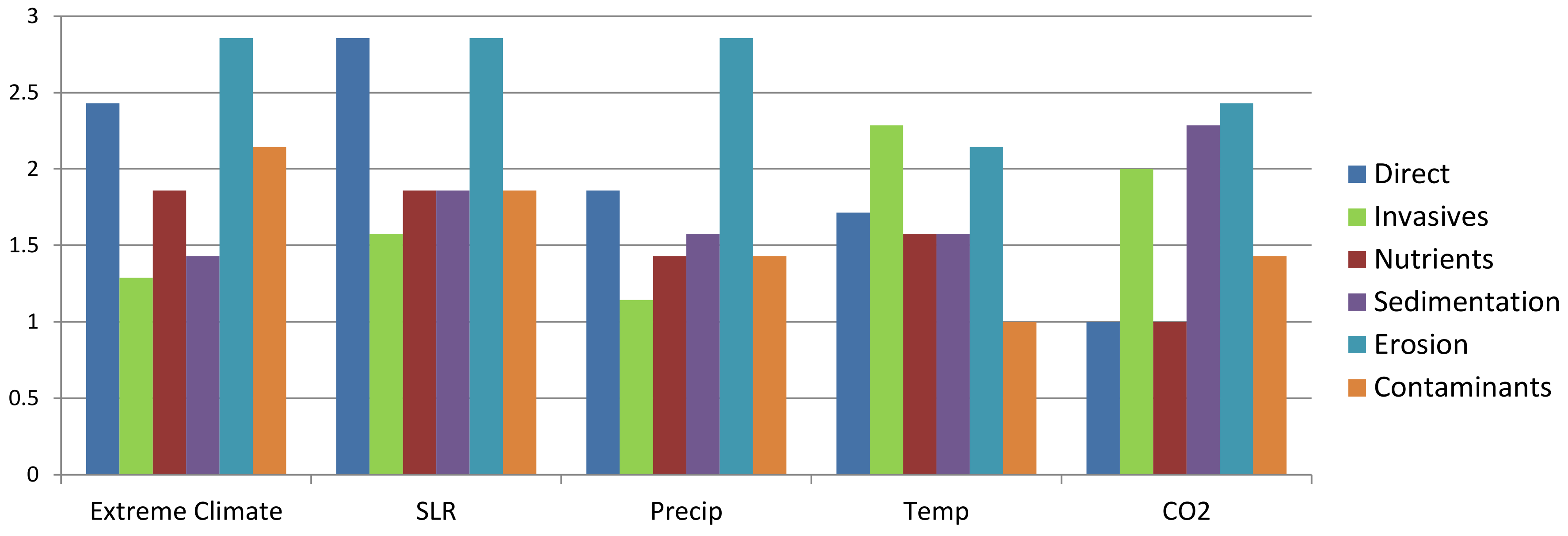
Emergent marsh at all of these sites is dominated by *Spartina* species, which is well adapted to fluctuating conditions, successful in a variety of tidal and temperature regimes, and has demonstrated a high capacity to regenerate following a disturbance.

High recovery rates (green): most marshes received fairly high scores; however, most marshes have low diversity of species. Following a hypothetical *Spartina* blight, in most cases, there would be no species to replace the *Spartina*.

Sites varied in degree of fragmentation, barriers to migration, feasible management options, and positive human response.

In salt marshes there are potential management options, such as allowing marshes to migrate and experimenting with thin layer sediment depostion. Some habitats, such as an old growth forests, may have less management options.

Certainty



Certainty ≤ 1

? Temperature → Contaminants
? CO_2 → Direct
→ Nutrients

Certainty ≤ 1.5

? Extreme → Invasive species
→ Sedimentation
? Precipitation → Invasive species
→Nutrients
→Contaminants
? CO_2 → Contaminants

Summary Points:

The lowest certainties were in the effects of temperature on contaminants and effects of CO2 across all interactions, particularly with the interaction between CO2 and nutrients. There is a lack of research on how CO2 is expected to impact nutrients.

For the interaction between extreme events and invasive species, uncertainty came from a lack of predictive ability surrounding when major invasion events will occur. For the interaction between extreme events and sedimentation, uncertainty came from a lack of predictive ability surrounding when extreme events will occur.

With contaminants, uncertainty comes from a lack of knowledge regarding what could be in the marsh. Observers could make educated guesses of what could be contaminating the marsh based on land use, but there have not been many studies of contaminants in these habitats.

Evaluation to Adaptation

Anticipated Vulnerability	Mitigation/Adaptation Strategies
Direct Effects of Sea Level Rise	• Education to reduce CO_2 emissions • Sediment deposition (thin-layer) • Establish inland migration spaces
Sea Level Rise and Erosion	• Living shorelines • Beach nourishment
Extreme Events and Erosion	• Create (local) response plans
Extreme Events and Contaminants	• Source identification • Information on potential effects • Create/Update response plans
Extreme Events and Invasive Species Temperature and Invasive Species	• Early detection through monitoring • Source identification • Remove existing invasive species

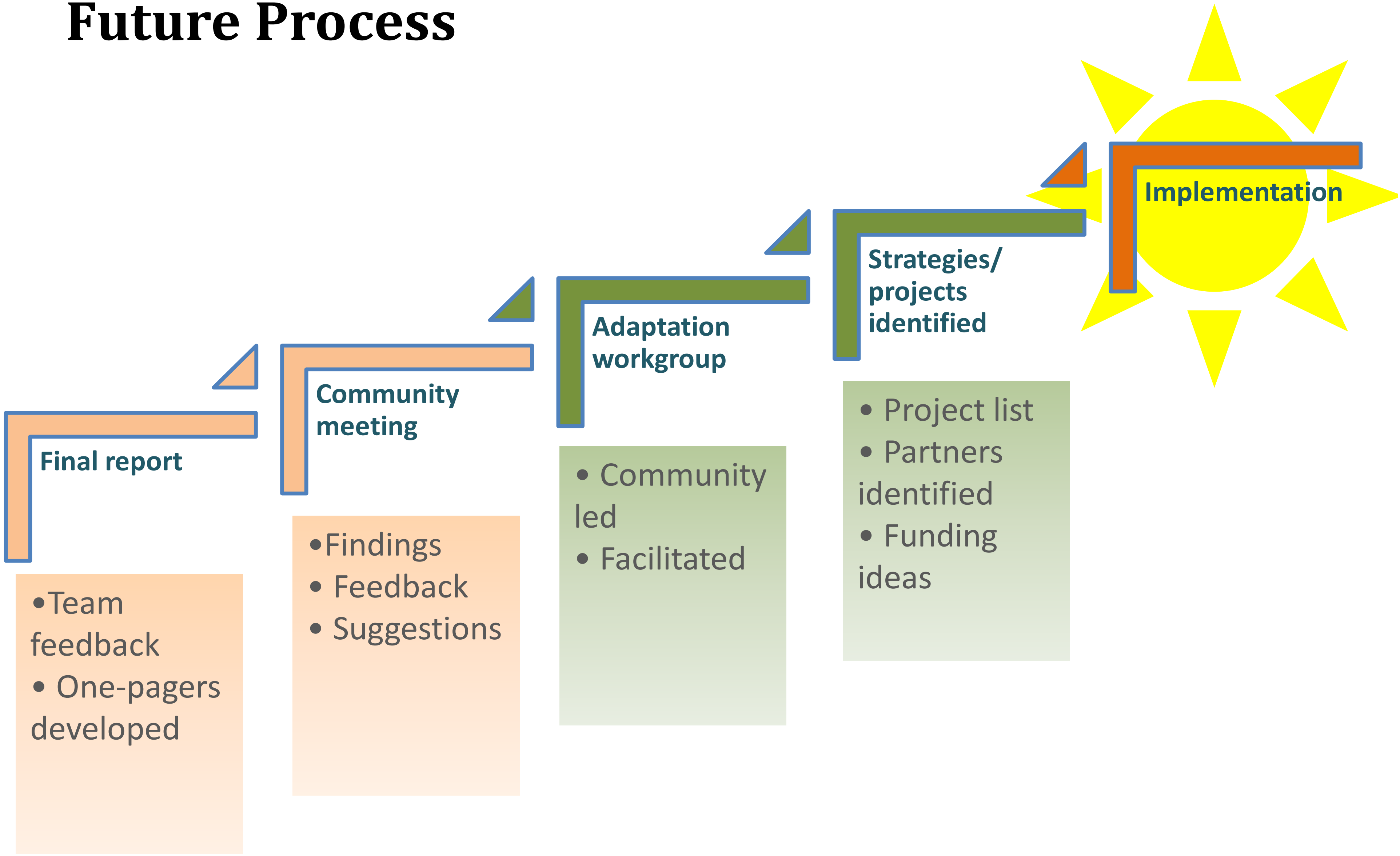
Summary Points:

The team is now working on developing adaptation strategies that fit with these anticipated vulnerabilities, with the eventual goal of creating a menu of options for a given problem.

Key questions to consider:

- What are some of the on-the-ground things other groups have done that could be applied to a site?
- What do we do with this information and how do we put it into good adaptation plans?

Future Process



Summary Points:

The goal is to report back to community. We hope the community will form a community-led adaptation workgroup to look at vulnerabilities and adaptation actions, select some options, and come up with some strategies and projects that can be applied to make these estuaries more resilient.

Assessing Vulnerability of New England Coastal Habitats

Wells (ME) & Great Bay (NH)

Waquoit Bay (MA)

Narragansett Bay (RI)

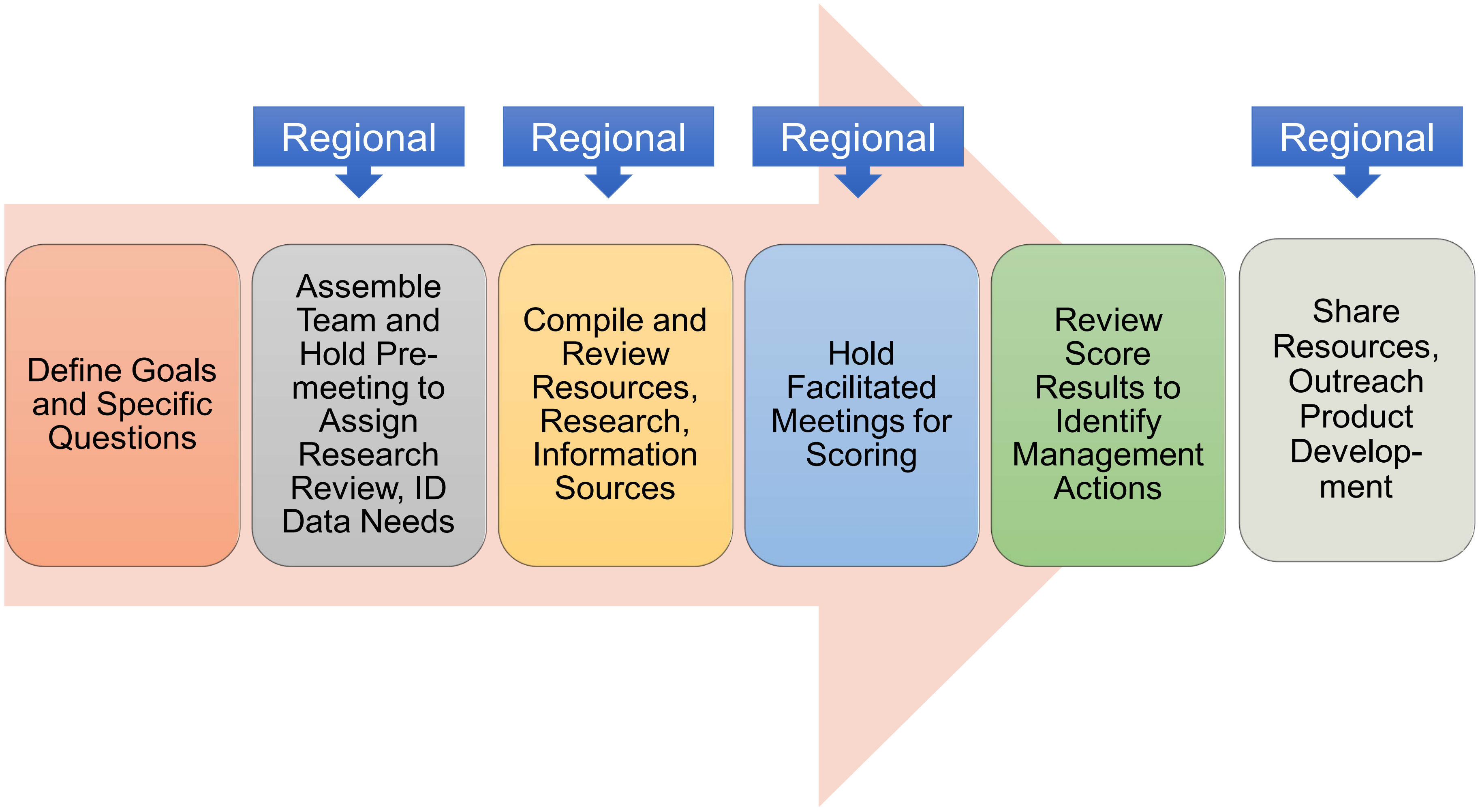
Summary Points:

Robin Weber presenting

The New England (NE) assessment effort involved three discrete projects conducted at four different reserves:

- The Wells and Great Bay reserves collaborated to assess the vulnerability of salt marsh sparrow habitat;
- Waquoit Bay investigated cold water fisheries habitat; and
- Narragansett Bay investigated salt marsh habitat.

General Process



Summary Points:

For these projects, it is not required that CCVATCH be applied at a broad geographic scale; however, the general process remains the same regardless of the scale at which the assessment is performed. First, specific research questions and goals must be defined, assessment team members must be identified, resource materials must be gathered, and scores must be assigned so that they can be applied to inform management.

There were some opportunities to collaborate across the New England region that mostly related to planning and facilitation of meetings. Our opportunity to collaborate was not fully realized because we selected three different habitats for our assessments, which limited opportunities for collaboration on resource collection and outreach product development.

Resource Collection and Scoring

Environmental Contaminants

Current Condition:

- Presumed tolerance to historic and persistent levels of exposure however "cost" may be reduced ability to tolerate climatic stress

CO_2:

- Increased plant productivity may positively influence accretion rates

Temperature:

- Increased contaminant uptake
- Enhanced contaminant toxicity
- Increase in pesticide exposure

Precipitation:

- Short term seasonal drought concentrates contaminant levels beyond tolerance
- Altered land use may enhance exposure

Sea Level:

- Increased sensitivity to contaminants at elevated salinity levels

Extreme Climate:

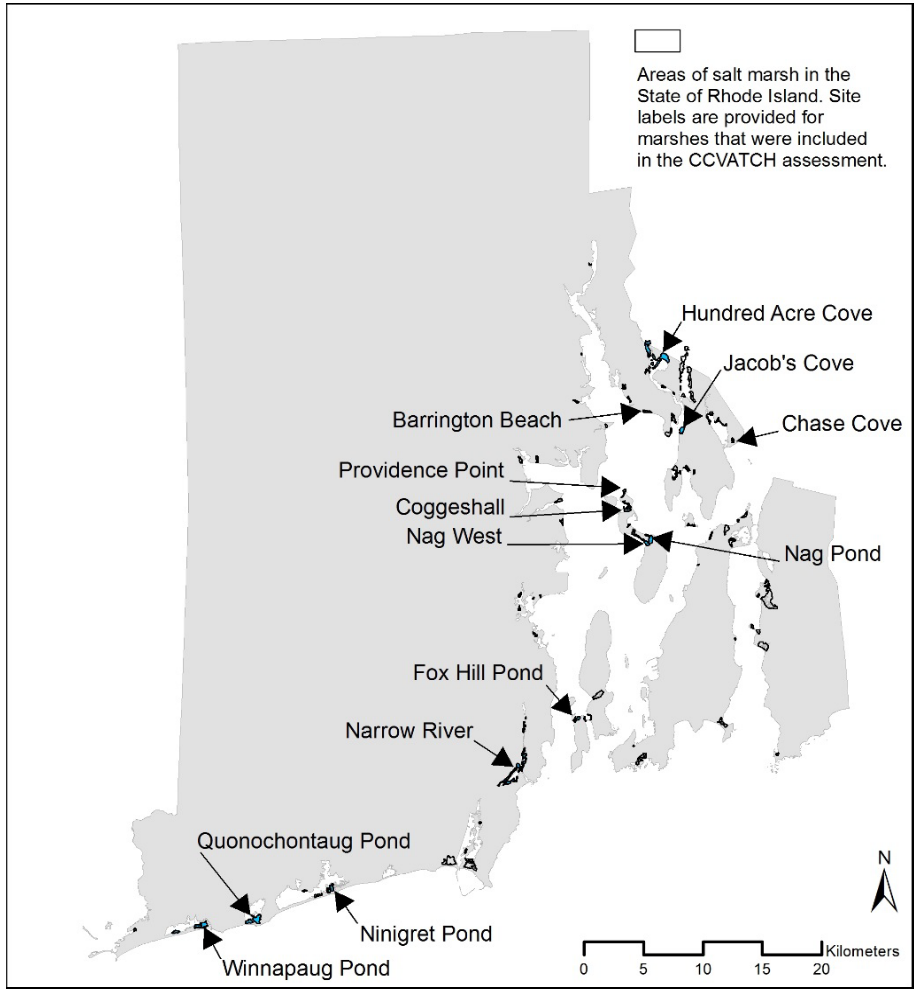
- Greater risk of high levels of contaminant exposure due to runoff, coastal flooding

Summary Points:

The greatest effort performed during the assessment should be dedicated to ensuring an understanding of how individual stressor interactions are likely to impact the habitat you are assessing. This requires expert elicitation and lengthy review of reference material.

RI Salt Marsh

- Stratified random site selection (N, C, S)
- Further restricted to sites that at least one assessment team member was familiar with (current condition and site characteristics)
- Initially a single assessment team, then break-out into multiple teams
- 14 sites assessed



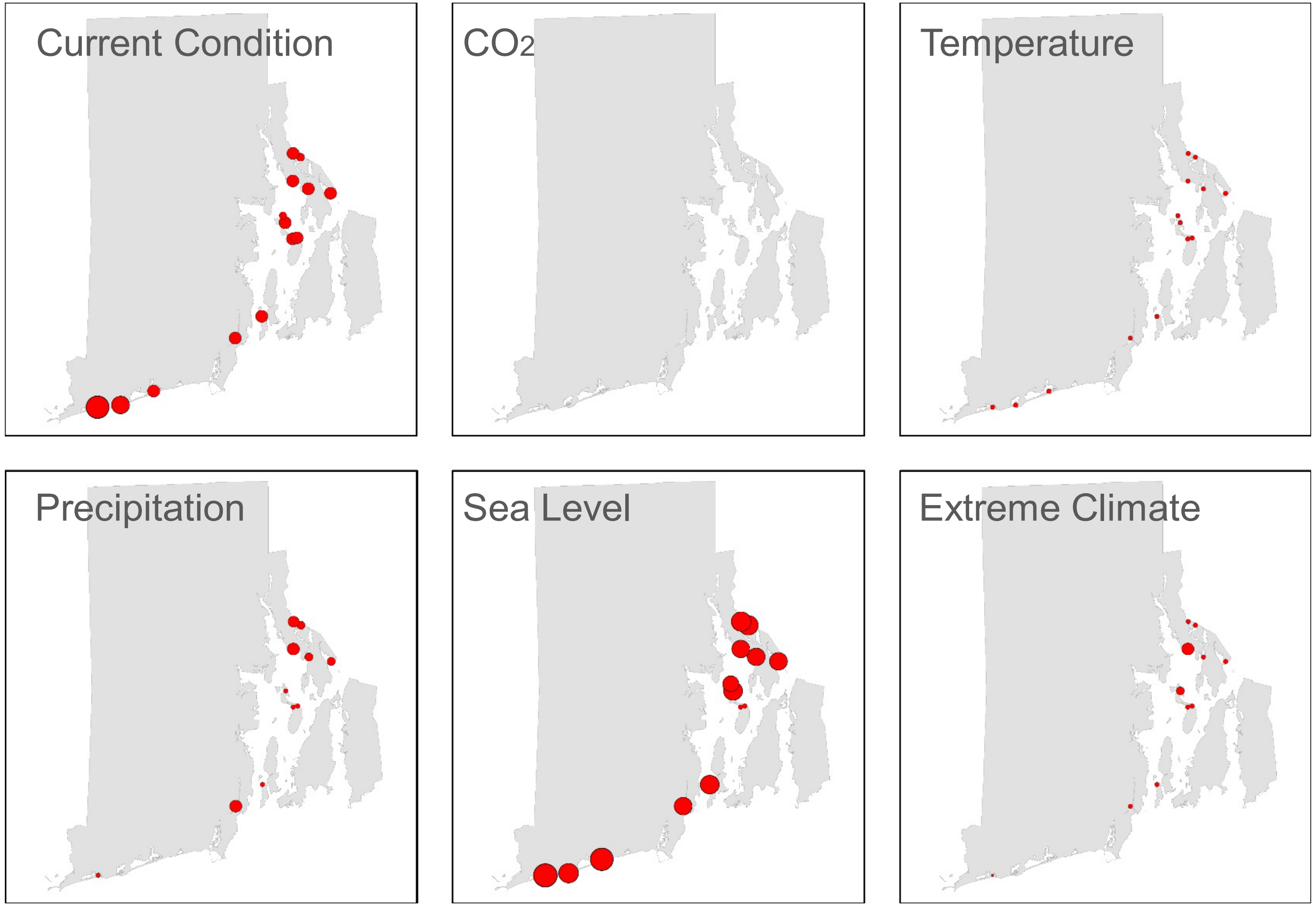
Summary Points:

In Rhode Island, we assessed salt marsh habitat throughout the sate. We randomly selected marshes from north, central, and south portions of the state, then limited those to areas where at least one team member was familiar with the site; this ensured thorough understanding of critical site characteristics such as elevation and stormwater input.

The first site assessment took more than one day to complete due to the large number of potential impacts requiring discussion and the size of the team. Breaking into multiple, smaller teams allowed later assessments to be completed in less than two hours; deep understanding of the drivers and how stressors would vary from site to site also contributed to the decreased assessment time.

Relative Scores

DIRECT EFFECTS



Summary Points:

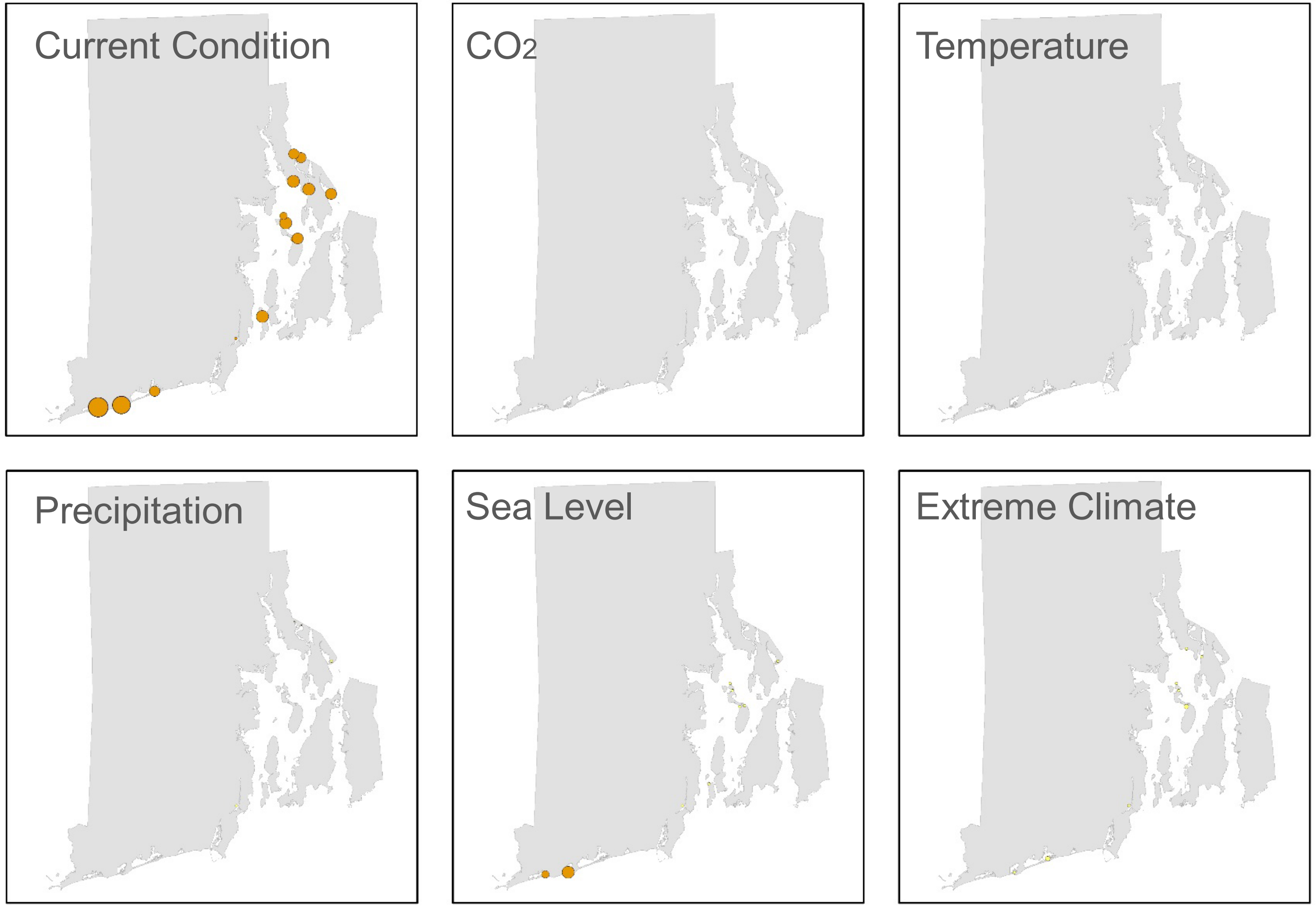
Small circles represent lower vulnerability scores, while larger circles represent higher vulnerabiltiy scores. The figures to the left show relative scores across salt marshes in Rhode Island.

Note that direct effects of changing climate conditions are already measurable across the state, which is evident by current degraded marsh conditions.

The greatest potential future impact is changing sea level rise; however, other climate stressors will also variably impact different sites. This variation is generally associated with specific site characteristics like geomorphology, proximity to specific land use features, etc.

Relative Scores

SEDIMENTATION



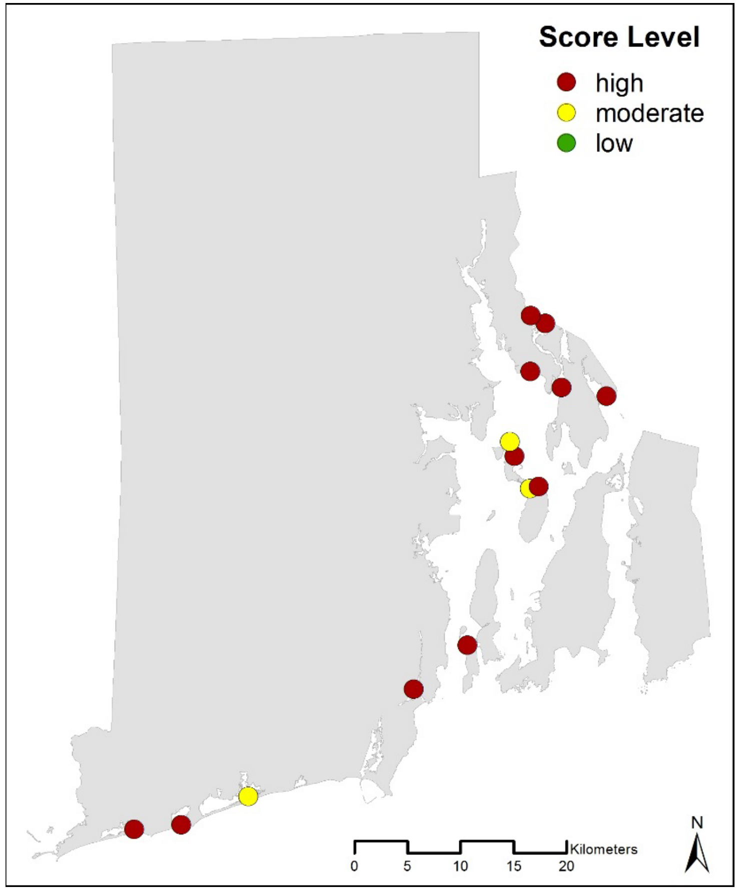
Summary Points:

By contrast, although sediment supply is limited throughout the state (historically and in present day), there is no expectation that future climate stressors will have an impact.

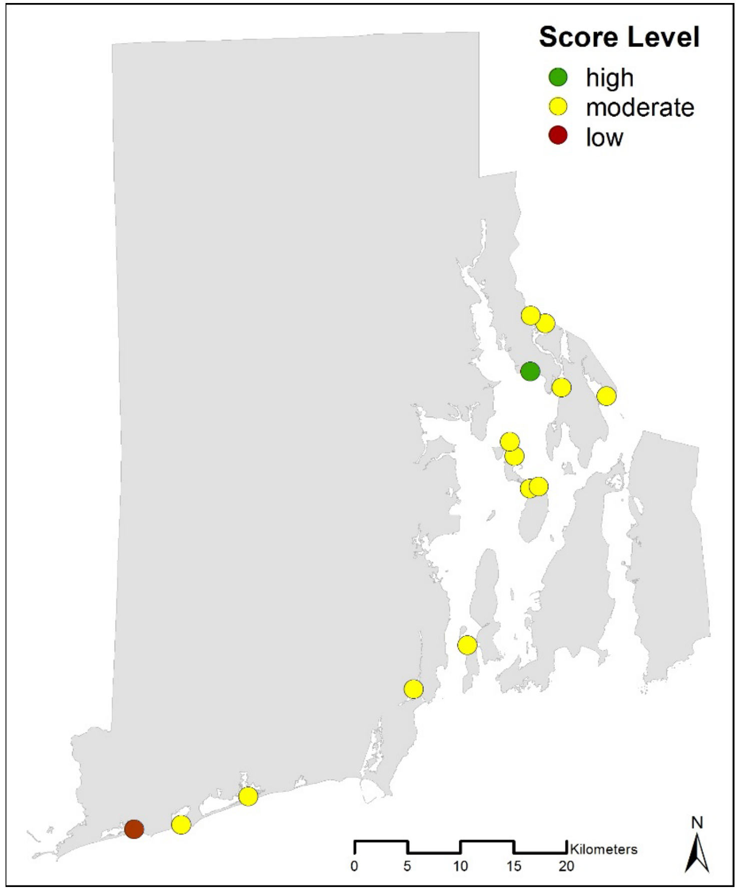
An exception to this observation is seen along the south coast, where sediment supply is expected to be further impacted by changing sea level due to heavy development that is expected to further impede sediment supply in barrier systems.

Scoring Levels

Sensitivity-Exposure Levels



Adaptive Capacity Levels

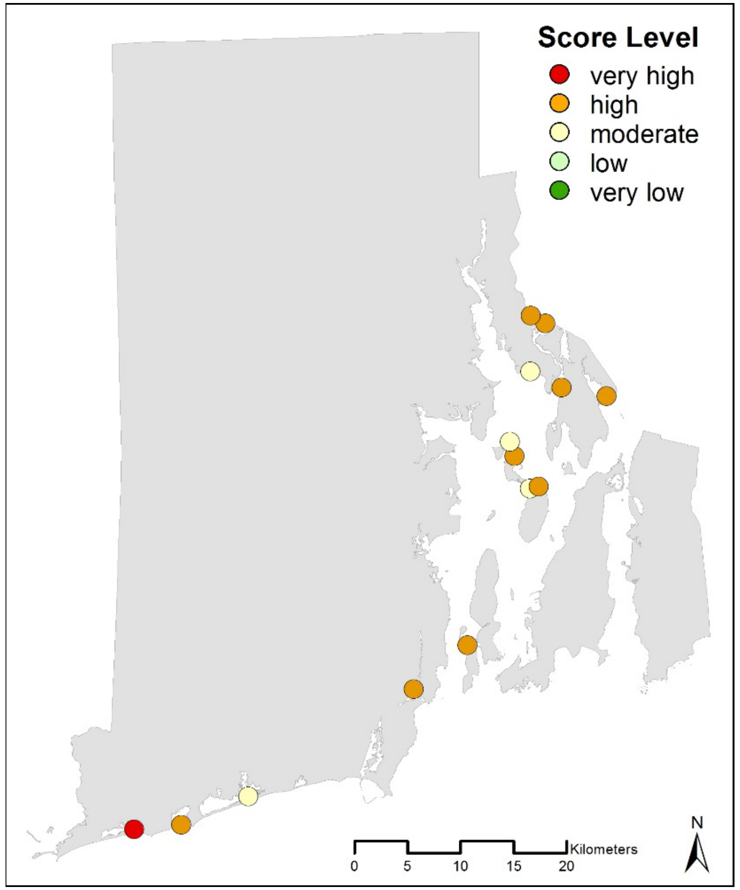


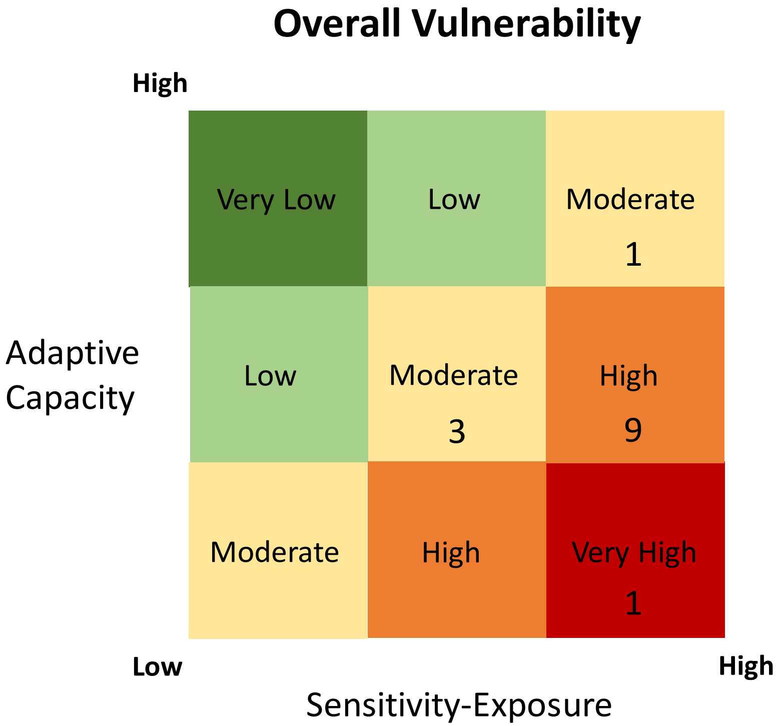
Summary Points:

Exposure-sensitivity scores were high across most sites. Most locations received moderate adaptive capacity scores; one site showed a high score because of its ability to migrate. Another site scored lower because predictions identified so many future stressors that to address them collectively and individually would be extremely challenging.

Overall Vulnerability

Overall Vulnerability Levels



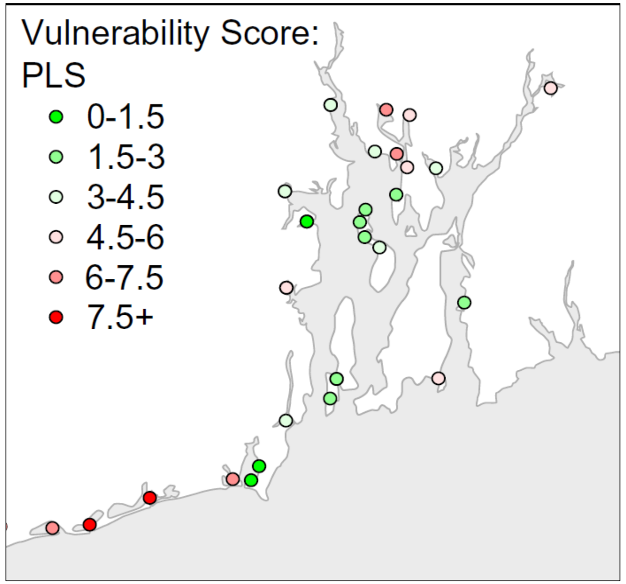


Summary Points:

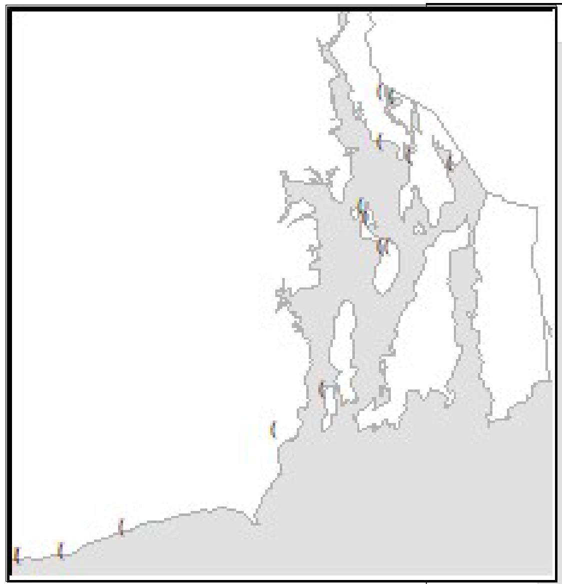
Unsurprisingly, most sites were found to be highly vulnerable (9 of 14 had high sensitivity exposure levels and moderate adaptive capacity).

Four sites were moderately vulnerable due to either slightly lower levels of exposure sensitivity or higher levels of adaptive capacity.

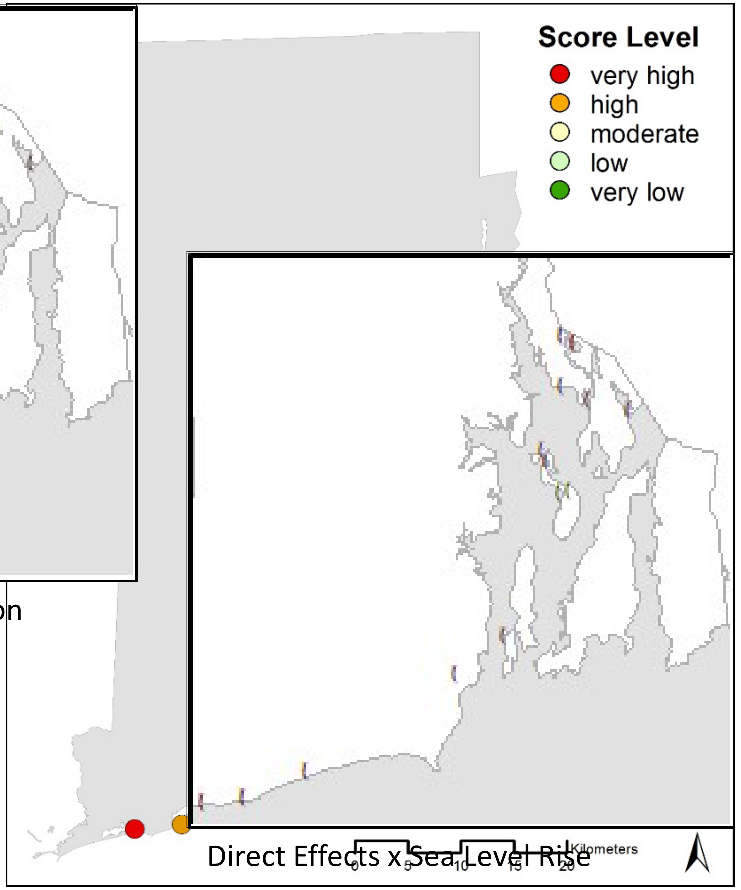
Other State Assessments



From Ekberg et al. 2017



Direct Effects Current Condition



Overall Vulnerability

Summary Points:

A recently-published article in *Estuaries and Coasts* evaluated several metrics (e.g. plant distribution and height) as predictors of vulnerability. They used rates of loss over the last 40 years as a surrogate for future vulnerability.

Due to the timing of these efforts in the state, we had been asked to compare our assessment to that of the article; there was no strong agreement between the two, although the basic assumption was that using the same metrics (i.e. elevation of marsh relative to mean high water) should show emergence of the same patterns. We believe the primary difference is that one assessment is based on a 40-year change in condition, while the other (using CCVATCH) looks at current and recent (over 5-6 years) change. The predicted change under conditions of elevated sea level is different in the two assessments because different assumptions were made, and recent rates of change are not comparable to decadal rates of change.

Case Studies

Nag Marsh [Prudence Island, RI]

Final Score
Exposure-Sensitivity 36.7
Adaptive Capacity 9.0
Certainty 2.2
Overall Vulnerability - Moderate

Primary considerations

- Rural and natural setting
- Limited invasives
- Moderate elevation
- Intact dune

- Limited capacity to migrate
- Fully protected
- Agency supports restoration
- Isolated location

Summary Points:

One product of this effort was the development of numerous case studies. Sites vary depending on a number of considerations, but lessons learned from the assessment of multiple sites can be directly applied to comparable sites elsewhere.

Case Studies

Chase Cove [Warren, RI]

Final Score
Exposure-Sensitivity 59.5
Adaptive Capacity 10.0
Certainty 2.0
Overall Vulnerability - High

Primary considerations

- Tidal restriction
- Buffered: Red maple swamp/agriculture
- Limited invasives
- High elevation

- Modest migration possible
- Fully protected
- Agency supports restoration
- Geomorphic setting

Summary Points:

There was significant tidal restriction at this site; it did not fare as well as the first.

Case Studies

Winnapaug Pond[Westerly, RI]

Final Score
Exposure-Sensitivity 64.7
Adaptive Capacity 5.0
Certainty 2.2
Overall Vulnerability – Very High

Primary considerations

- Built environment
- High nutrient levels
- Lagoonal system
- Low elevation
- Limited sediment supply

- Extreme 'waffle' marsh
- Limited capacity to migrate
- Not fully protected
- Limited restoration potential

Summary Points:

This marsh is in dire straits due to various anthropogenic stressors, including:

- Dense residential development;
- The adjacent golf courses, agriculture, and residential areas are not sewered, resulting in high nutrient loads; and
- Past management actions have led to degraded conditions associated with poor drainage.

Research Needs

Direct stressor or stressor interactions with identified research needs for RI salt marsh

	Current Condition	CO_2	Temp.	Precip.	Sea Level	Extreme Climate
Direct Effects						●
Invasive /Nuisance Sp.			●	●		
Nutrients		●	●	●	●	●
Sedimentation		●	---			
Erosion						●
Env. Contaminants	●	●	●	●	●	●

Summary Points:

Another product is the identification of research needs. As Jennifer noted, there are some certainty scores that are so low (in this case, less than 2) that they indicate a lack of data or reference materials from which to draw. Specifically, we will need to learn more about nutrient and contaminant impacts under future climate scenarios if we are to better plan for future changing conditions.

Applications

- ❑ Determine main sources of vulnerability
- ❑ Prioritize restoration & resiliency planning efforts and acquisition areas
- ❑ Education and outreach to decision makers
- ❑ Guide policy and funding decisions
- ❑ Compare relative vulnerability across geographic locations
- ❑ Identify research and monitoring needs

Summary Points:

Those relative vulnerability scores and collective support documentation represent a huge component for contextualizing why sites varied and why we scored any given site higher than another.

Creating an effective management strategy requires that all climate and non-climate stressors are addressed, with the intent that the effort will guide future management efforts across the state.

Acknowledgements

This work was sponsored by the National Estuarine Research Reserve System Science Collaborative, which supports collaborative research that addresses coastal management problems important to the reserves. The Science Collaborative is funded by the National Oceanic and Atmospheric Administration and managed by the University of Michigan Water Center.

Additional CCVATCH resources are available at www.ccvatch.com

Contact: Jennifer Plunket, jen@belle.baruch.sc.edu

Robin Weber, robin@nbnerr.org

Questions:

How do you assess 'room to migrate potential' and 'positive human response'?
Highly subjective. For room to migrate potential, we looked at maps and on a scale of low to high; is it completely surrounded by development or is there a lot of protected land around it? Human response is largely based on how people responded in the past. For example, Murrells Inlet received a good human response score because the community has rallied to develop a watershed management plan.

Next steps: In your experience, has the communication from scoring the vulnerability to action been successful? Are there case studies of this approach guiding management actions?
We're just getting to that now. So stay tuned! But I do want to make a plug for next steps - we're working on developing a web tool version of CCVATCH - taking printed guidance document and making it an online resource for groups to use to help them walk through the tool.

Have you thought about applying this CCVATCH approach in some way to prioritize buffer lands or lands wetlands might migrate to?
That was one of the products we hoped might come out of this. In the pilot study, we initially had a lot of involvement with The Nature Conservancy and land trust people and that's what they were interested in. They were thinking about if we have a choice between two plots of land, how do we decide, based on future vulnerabilities, which might be the better bet in the long run?