Office of National Marine Sanctuaries
National Oceanic and Atmospheric Administration

Appendices:

Marine Protected Area Climate Vulnerability Assessment Guide

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Cover photo: Volunteers study and count seabirds at Stellwagen Bank National Marine Sanctuary. Photo: Evelyn Ganson/NOAA

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Appendix A:
Additional Resources

AA.1 Choosing a CVA Scope: Considerations and Decision Tree

The primary guidance document discusses two scopes of CVA: "Limited" and "Extensive". Chapter 3 of the full guidance document discusses each of these scopes in detail and notes that neither scope is necessarily "better" than the other and that they use the same fundamental approach and components, differing primarily in the number of focal resources, resource scales/types, and hazards being assessed. The primary guidance document provides a range of considerations that can help an MPA manager decide which scope of CVA to conduct and, ultimately, either scope will often provide sufficient information to move forward successfully with climate adaptation planning. The ultimate decision will come down to a variety of factors including the number of hazards to assess, the diversity of resources of concern to the site (i.e. habitats, species, heritage resources, ecosystem services), the capacity and resources available to the site to conduct the CVA, the level and amount of information desired, and the size of the MPA or area to be assessed. While the final decision is a balance of these and other considerations, this section provides a few "rules of thumb" and a decision tree to help guide managers in making this decision. These resources should not be seen as hard and fast rules, but rather are provided to help make the decision easier for those that find this decision difficult. In addition to using the resources below, it is suggested that managers speak with others who have experience conducting CVAs to help make this decision.

Some general rules of thumb that can help guide the decision of which CVA scope to choose include:

Hazards of concern: A limited CVA allows for the inclusion of only three climate and three non-climate hazards in the assessment of each resource. Thus, sites that have a large number or diversity of climate or non-climate hazards of concern, or where determining the relative importance of multiple hazards is a primary objective of the assessment, will often find that an extensive scope CVA is more appropriate.

Number and Diversity of Resources Protected: Sites that contain a large number, or large diversity of resources will often find that an extensive scope CVA is most appropriate. In contrast, sites that protect only a small number or type of key resources will often find that a limited scope CVA fits their needs (although an extensive scope could still be conducted if more detailed vulnerability information is desired).

Staff Capacity and Resources: If the capacity, time, and resources to conduct the CVA are limited, and other considerations do not require an extensive CVA, a limited CVA is a good way to effectively leverage limited resources.

Size/complexity of the MPA: Large MPAs will often find that an extensive scope CVA is most appropriate as it provides the time, flexibility, and detail to assess the vulnerability of the diversity of focal resources and resource types that are often found in a large MPA.

The above listed "rules of thumb" should not be taken as hard and fast rules, but are instead intended to help guide decisions if managers are having difficulty deciding on the correct CVA scope. In addition, Figure A1 provides a decision tree that can help managers determine the appropriate CVA scope.

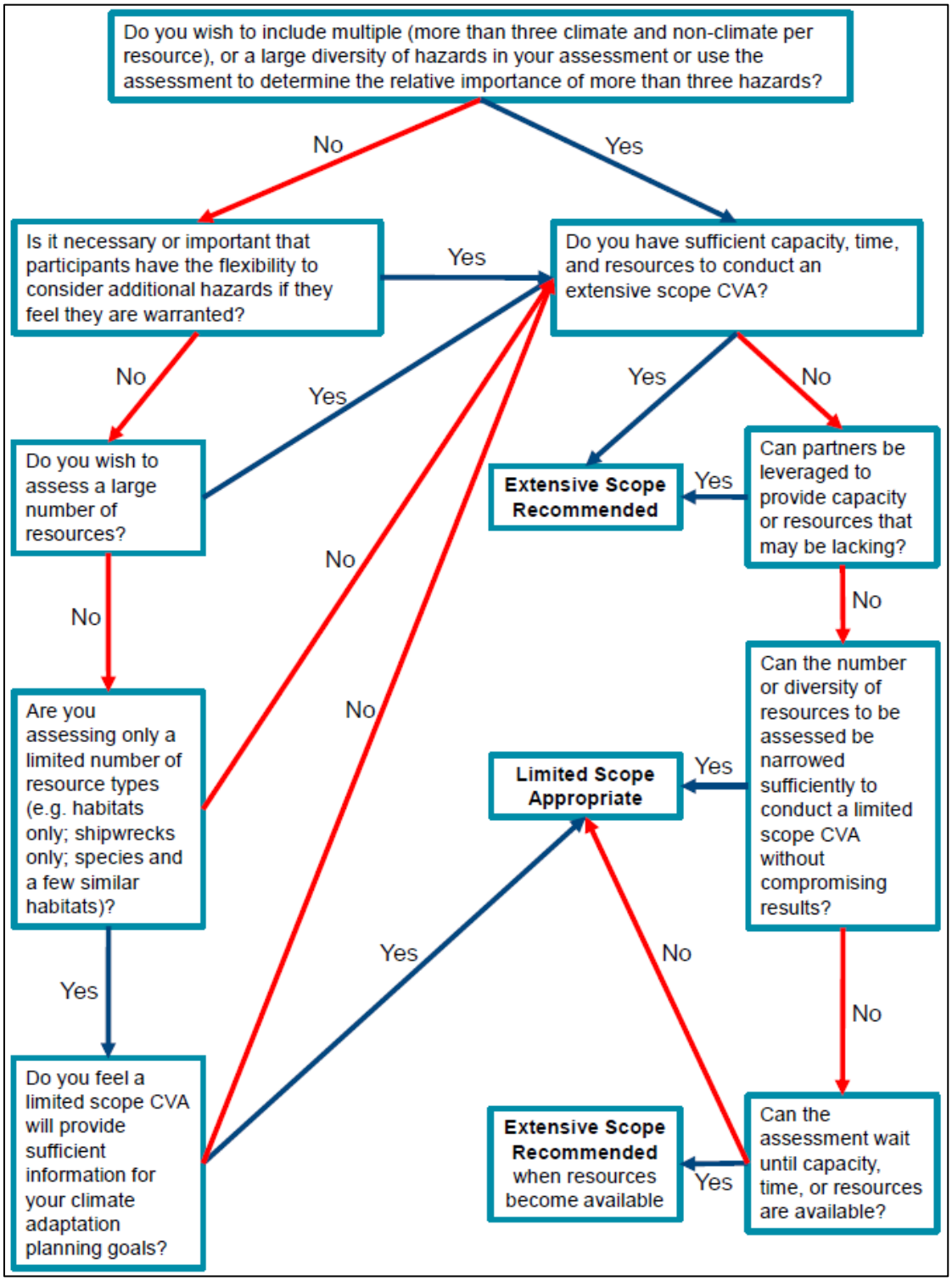

Figure A1. CVA scope decision tree. Image: NOAA

AA.2 Examples of CVA Workshop Background Materials

As noted in chapter 4.4 of the full guidance document, it is often useful to provide CVA workshop participants with information that can help with the assessment, such as the current and projected state of the hazards to be considered in the assessment area over the timescale being assessed, as well as relevant information about the impact of hazards on focal resources. This information is often provided to workshop participants ahead of the workshop and in a format that can be referenced during the workshop, such as a report or table. Below is an example of such a resource that was used during a CVA workshop conducted by the National Marine Sanctuary of American Samoa.

> American Samoa Climate Change Trends and Projections Table – used during the National Marine Sanctuary of American Samoa Extensive CVA (2017)

AA.3 Example CVA Timeline

The timing and order of the tasks necessary to prepare for and complete a CVA are similar regardless of the scope chosen. Provided below is a bulleted timeline of tasks that *most* MPAs will take to prepare and complete a CVA. However, every MPA and every CVA is different. An MPA may find that some steps are unnecessary, or that others need to be added. Many of the steps below can also be undertaken in a different order than listed. Further, the timeline below is relatively rapid, but has proven to be feasible. It is reasonable to extend the example timeline and take more time in preparation. It is also possible to shorten the timeline if the resources and capacity to do so are available. The step that is often the most time-limiting is allowing participants sufficient notice of the workshop to ensure that they are able to attend.

Given the above noted considerations and caveats, the steps below are intended to act as *guidance, not a prescription* for the steps and timing of preparing for and conducting a CVA. Unless otherwise stated, all actions are conducted by the MPA staff/planning team in charge of developing and conducting the CVA. Further, the chapter within the main guidance document where more information can be found is listed next to each topic.

Month 1

- Make initial selection of focal resources, hazards, and timescale (see Chapter 4)
- Select CVA scope (see Chapter 3)
- Compile background information on climate projections and impacts in the MPA/area of assessment (see Chapter 4)
- Vet selected focal resources with subject matter experts, advisory groups, community groups, and/or others deemed appropriate (see Chapter 4)
- Select and invite CVA participants (see Chapter 5)

Month 2

- Finalize background materials (see Chapter 4)
- Finalize focal resources, hazards, and timescale (see Chapter 4)
- Hold pre-workshop informational meeting with CVA participants (see Chapter 5)

- Train facilitators and note takers (see Chapter 6)

Month 3

- Finalize workshop materials (including worksheets) and agenda (see Chapter 6 and Appendix A)
- Hold CVA workshop (see Chapter 6)
- Analyze workshop results (see Chapter 6 and 8)
- Begin writing report (see Chapter 8)

Month 4

- Complete writing report (see Chapter 8)
- Report review by CVA participants and others deemed necessary (see Chapter 8)

Month 5

- Finalize and publish CVA report (see Chapter 8)

AA.4 Climate Adaptation Management Resources

As noted in chapter 8 of the full guidance document, there are abundant published resources that can help guide MPA managers through the process of climate adaptation planning. This section includes a non-exhaustive list of such resources that are publicly available. The inclusion of a resource on this list does not imply an endorsement by the US Department of Commerce, the National Oceanic and Atmospheric Administration, the Office of National Marine Sanctuaries, or any subsidiaries of the aforementioned organizations. Rather, these resources are provided to help managers better understand adaptation planning process and begin to pursue resources and guidance appropriate to their MPA.

Climate Adaptation Toolkit for Marine and Coastal Protected Areas - EcoAdapt

US Climate Resilience Toolkit - US climate.gov

Panorama

Resist-Accept-Direct (RAD)—A Decision Framework for the 21st-century Natural Resource Manager - US National Park Service (2020)

Planning for a Changing Climate - US National Park Service (2021)

Marine Protected Areas and Climate Change - IUCN (2016)

Coastal Adaptation Strategies Handbook - US National Park Service (2016)

National Fish, Wildlife and Plants Adaptation Strategy - US Fish and Wildlife service (2012)

AA.5 Example CVA Workshop Worksheets

AA.5.1 Extensive CVA Worksheets

The extensive CVA worksheets in this section were adapted from EcoAdapt products created for use in the Greater Farallones-Cornell Bank National Marine Sanctuary Climate Vulnerability Assessment. While the worksheets provided are ready to use, many aspects, can be edited and customized to fit the needs of a particular MPA or CVA. This is particularly true of the hazards provided in the sensitivity and exposure tables (both climate and non-climate) and the adaptive capacity factors provided in both the intrinsic and extrinsic adaptive capacity tables.

Extensive Climate Vulnerability Assessment Species Assessment Worksheet

This worksheet is designed to be consistent with the Office of National Marine Sanctuaries Marine Protected Area Climate Vulnerability Assessment Guide.

Please prioritize the gray boxes in each section. If time is limiting, the project team may also populate the non-gray fields.

Species: _____

1. Sensitivity to Climate Hazards

***Please Note: Sensitivity is a measure of whether and how a species is likely to be affected by a given change in climate or another environmental hazard. Exposure (covered in another section below) addresses how much change in climate or another environmental hazard a species is likely to experience.**

Consider both direct (e.g., physiology) and indirect (e.g., ecological relationships) sensitivities of the species. Physiological sensitivity reflects the impacts that a climate hazards may have on a species' physiology. Species life history or behavior may also be affected by climate hazards. Species' ecological relationships may also be affected by climate or climate-driven factors. Ecological relationships could include: predator/prey, foraging, competition, habitat, pollination, dispersal, symbiont/mutualist/parasite, and others.

Please evaluate the sensitivity of the species to the following climate hazards. IF THE SPECIES IS NOT SENSITIVE TO THE FACTOR, PLEASE WRITE "N" AND LEAVE THE ROW BLANK.

CLIMATE HAZARD	SENSITIVE TO FACTOR (Y/N)	DEGREE OF SENSITIVITY 1 (very low) – 5 (very high)	CONFIDENCE 1 (low) – 3 (high)	RELEVANT REFERENCES
Air temperature				
Sea surface temperature				
Precipitation				
Salinity				
Deoxygenation				
pH				
Sea level rise				
Wave action				
Upwelling				
Currents/mixing/ stratification				
Coastal erosion				
Other (please specify)				

Do any of the climate or climate-driven factors listed above BENEFIT the species? If so, please list the factor and describe how the species benefits. *Please include any relevant citations.*	
Overall, to what degree is the species sensitive to climate and climate-driven factors? *Given your experience and knowledge, what would be your gut assessment for this species? Just express your opinion. 1 – 5 (1=low degree; 5=high degree)* _____	**Confidence in your overall assessment of the sensitivity of the species to climate and climate-driven factors:** *1 – 3 (1=low confidence; 3=high confidence)* _____
Comments: *Please provide any comments to support or clarify your conclusions above.*	

2. Exposure to Climate Hazards

Exposure addresses how much change in climate or another environmental hazard a species is likely to experience.

Please evaluate the exposure of the species to the following climate hazards. IF THE SPECIES IS NOT SENSITIVE TO THE FACTOR (previous section), PLEASE LEAVE THE ROW BLANK.

If the hazard does not apply to the species, do not evaluate it.

CLIMATE HAZARD	DEGREE OF EXPOSURE 1 (very low) – 5 (very high)	CONFIDENCE 1 (low) – 3 (high)	Potential Areas of Refugia from Factor?
Air temperature			
Sea surface temperature			
Precipitation			
Salinity			
Deoxygenation			
pH			
Sea level rise			
Wave action			
Upwelling			
Currents/mixing/ stratification			
Coastal erosion			
Other (please specify)			

Overall confidence in your assessment of exposure: *1 – 3 (1=low confidence; 3=high confidence)* _____

3. Sensitivity and Current Exposure to Non-Climate Hazards

Sensitivity of the species to climate hazards may be highly influenced by the existence, extent of, and exposure to non-climate hazards. For non-climate hazards, exposure is the **current** level of impact experienced by the species.

Using the list provided, please write the non-climate hazards most likely to increase sensitivity of the species to climate change in the table below.

Ocean Sound
Harvest/Fishing
Submarine Cables
Aquaculture
Marine Debris
Recreation/Increased Visitation
Other (please specify):

Military Activities
Contaminants
Invasive and other problematic species
Offshore Energy
Research Activities
Maritime Transportation

NON-CLIMATE STRESSOR	DEGREE HAZARD AFFECTS SENSITIVITY 1 (very low) – 5 (very high)	CONFIDENCE 1 (low) – 3 (high)	DEGREE OF CURRENT EXPOSURE 1 (very low) – 5 (very high)	CONFIDENCE 1 (low) – 3 (high)

Overall, to what degree do these non-climate hazards make the species more sensitive to climate change? *1 – 5 (1= very low degree; 5= very high degree)* _____	**Confidence in your overall assessment of the degree to which non-climate hazards affect the species' sensitivity:** *1 – 3 (1=low confidence; 3=high confidence)* _____
Comments and Citations: *Please briefly describe how each of the hazards selected above are likely to make the species more sensitive to climate change. If the hazard occurs only in localized areas, please identify those locations.*	

4. Overall User Ranking of Sensitivity

In your opinion, how would you rank the overall sensitivity of this species? *Given your experience and knowledge, what would be your gut assessment for this species? Just express your opinion. 1 – 5 (1= very low sensitivity; 5= very high sensitivity)* _____	**Confidence in your overall assessment of the sensitivity of this species:** *1 – 3 (1=low confidence; 3=high confidence)* _____
Comments:	

5. Overall User Ranking of Exposure

In your opinion, how would you rank the overall exposure of this species? *Given your experience and knowledge, what would be your gut assessment for this species? Just express your opinion. 1 – 5 (1= very low exposure; 5= very high exposure)* _____	**Confidence in your overall assessment of the exposure of this species:** *1 – 3 (1=low confidence; 3=high confidence)* _____
Comments:	

6. Potential Impact

Use the matrix below to calculate the Potential Impact likely to be experienced by the species using the assessed values of Sensitivity (Box 4) and Exposure (Box 5):

Potential Impact
Exposure →

Sensitivity↓	*Very Low (1)*	*Low (2)*	*Medium (3)*	*High (4)*	*Very High (5)*
Very Low (1)	Very Low (1)	Very Low (1)	Low (2)	Medium (3)	Medium (3)
Low (2)	Very Low (1)	Low (2)	Low (2)	Medium (3)	High (4)
Medium (3)	Low (2)	Low (2)	Medium (3)	High (4)	High (4)
High (4)	Low (2)	Medium (3)	High (4)	High (4)	Very High (5)
Very High (5)	Medium (3)	Medium (3)	High (4)	Very High (5)	Very High (5)

Potential Impact: _____

7. Intrinsic Adaptive Capacity

***Please Note: Adaptive Capacity is a measure of the ability of a species to adapt to the effects or impacts of an environmental or climate hazard. The INTRINSIC adaptive capacity of a species includes those factors that are inherent to the species itself while EXTRINSIC adaptive capacity (covered in another section below) includes those factors that are external to the species but can affect its adaptive capacity.**

Please evaluate the following intrinsic adaptive capacity factors. A higher score signifies that this factor as it applies to the species being evaluated will increase its adaptive capacity. For example, a species with high genetic diversity may be better able to adapt to climate hazards. For such a species, the adaptive capacity score for genetic diversity would be higher than for a species with low genetic diversity. See the supplemental tables for exercises that can help determine these factors if needed.

CHARACTERISTIC	Adaptive Capacity 1 (very low) – 5 (very high)	CONFIDENCE 1 (low) – 3 (high)	COMMENTS AND RELEVANT REFERENCES
Life history strategy			
Genetic Diversity			
Behavioral Plasticity			
Phenotypic Plasticity			
Distribution/Extent			
Population Connectivity			
Dispersal Ability			
Dependencies (Generalist/Specialist)			
Population Status			
Other:			

Overall, what is the degree of intrinsic adaptive capacity? *1 – 5 (1=very low adaptive capacity; 5=very high adaptive capacity)* _____	**Confidence in your overall assessment of intrinsic adaptive capacity:** *1 – 3 (1=low confidence; 3=high confidence)* _____
Comments and Citations: *Please provide any comments or citations to describe or clarify the adaptive capacity of the species.*	

8. Extrinsic Adaptive Capacity

***Please Note: Adaptive Capacity is a measure of the ability of a species to adapt to the effects or impacts of an environmental or climate hazard. The EXTRINSIC adaptive capacity includes those factors that are external to the species but can affect its adaptive capacity while INTRINSIC adaptive capacity (covered in the section above) includes those factors that are inherent to the species itself.**

Please evaluate the following extrinsic adaptive capacity factors. A higher score signifies that this factor as it applies to the species being evaluated will increase its adaptive capacity. For example, if the MPA has high staff capacity, it may be better able to address the impacts of climate hazards on the species than an MPA with low staff capacity. In such an instance, the adaptive capacity score for staff capacity would be higher than for an MPA with low staff capacity. See the supplemental tables for exercises that can help determine these factors.

CHARACTERISTIC	Adaptive Capacity 1 (very low) – 5 (very high)	CONFIDENCE 1 (low) – 3 (high)	COMMENTS AND RELEVANT REFERENCES
MPA Staff Capacity			
Species Value/ Socioeconomic/Cultural Importance			
MPA Responsiveness			
MPA Relationship with Communities and Stakeholders			
Management Mandate			
Monitoring and Evaluation Capacity			
Management Flexibility			
Science/Technical Support			
Potential for Proactive Management			
Other:			

Overall, what is the degree of extrinsic adaptive capacity? *1 – 5 (1=very low adaptive capacity; 5=very high adaptive capacity)* _____	**Confidence in your overall assessment of extrinsic adaptive capacity:** *1 – 3 (1=low confidence; 3=high confidence)* _____
Comments and Citations: *Please provide any comments or citations to describe or clarify the adaptive capacity of the species.*	

9. Overall User Ranking of Adaptive Capacity

In your opinion, how would you rank the overall adaptive capacity of this species to climate change? *Given your experience and knowledge, as well as your assessment of intrinsic and extrinsic adaptive capacity factors, what would be your gut assessment for this species? 1 – 5 (1=very low adaptive capacity; 5=very high adaptive capacity)* _____	**Confidence in your overall assessment of the adaptive capacity of this species to climate change:** *1 – 3 (1=low confidence; 3=high confidence)* _____
Comments:	

10. Vulnerability

Using the matrix below, calculate the Vulnerability of the species using the assessed values of Potential Impact (Box 6) and Adaptive Capacity (Box 9):

Vulnerability

Potential Impact →

Adaptive Capacity ↓	*Very Low (1)*	*Low (2)*	*Medium (3)*	*High (4)*	*Very High (5)*
Very Low (1)	Medium (3)	Medium (3)	High (4)	Very High (5)	Very High (5)
Low (2)	Low (2)	Medium (3)	High (4)	High (4)	Very High (5)
Medium (3)	Low (2)	Low (2)	Medium (3)	High (4)	High (4)
High (4)	Very Low (1)	Low (2)	Low (2)	Medium (3)	High (4)
Very High (5)	Very Low (1)	Very Low (1)	Low (2)	Medium (3)	Medium (3)

Vulnerability: _____

Supplemental Tables

S1. Life History

Species with longer generation times (e.g., K-selection) = more sensitive

Species with shorter generation times and many offspring (e.g., R-selection) = less sensitive

Species reproductive strategy:
→ R-selection: a species that produces many offspring and has a short generation time (e.g., fruit fly).
→ K-selection: a species that produces few offspring and has high parental investment (e.g., elephant).
→ A mid-range example would be a species that produces 3-5 young/year.

Please select a value that corresponds to the reproductive strategy above.
1 – 5 (1=R-selection; 5=K-selection)

_____

Confidence in your assessment of the species' reproductive strategy: *1 – 3 (1=low confidence; 3=high confidence)*

_____

Is the species polycyclic, iteroparous, or semelparous? *Please circle the one that applies.*

Polycyclic (reproduces intermittently throughout a lifespan)

Semelparous (reproduces only once; characteristic of R-strategists; e.g., salmon, insects, annual plants, bamboo)

Iteroparous (reproduces in successive cycles; characteristic of K-strategists; e.g., perennial plants, most animals)

Average length of time to reproductive maturity (in days): _____

How many reproductive events can an individual undergo in a single year under optimal conditions? Please circle the number: 1 2 3 >4

S2. Extent, Status and Dispersal Ability

Species that are currently widespread in their geographic extent, with a robust population status, high connectivity, and a high ability to disperse may be more likely to withstand and persist into the future despite non-climate and climate hazards (= more adaptive capacity).

Species that are endemic, endangered, have isolated or fragmented populations and/or limited ability to disperse, or are currently undergoing major losses due to climate and non-climate hazards may be less likely to persist into the future (= less adaptive capacity).

What is the geographic extent of the species? *1 – 5 (1=endemic to my particular area; 5=transboundary)* _____	**Confidence in extent:** *1 – 3 (1=low confidence; 3=high confidence)* _____
What is the population status of the species? *1 – 5 (1=endangered; 5=robust)* _____	**Confidence in status:** *1 – 3 (1=low confidence; 3=high confidence)* _____
What is the population connectivity for the species? *1 – 5 (1=isolated/quite fragmented; 5=continuous)* _____	**Confidence in connectivity:** *1 – 3 (1=low confidence; 3=high confidence)* _____
What is the ability of the species to disperse? *1 – 5 (1=very low ability; 5=very high ability)* _____	**Confidence in dispersal ability:** *1 – 3 (1=low confidence; 3=high confidence)* _____
Maximum annual dispersal distance: The maximum average distance a species will likely move to establish a new population in a more suitable habitat. We are interested in how quickly a species could spread across the coast or ocean in response to climate change. This should reflect a distance that is feasible (not just possible). **Please circle one.** >100 km 50-75 km 5-25 km 75-100 km 25-50km 1-5 km <1 km	**Confidence in maximum annual dispersal distance:** *1 – 3 (1=low confidence; 3=high confidence)* _____
Comments and Citations: *Please provide any comments or citations to support or clarify your conclusions above.*	

S3. Dependencies (Generalist/Specialist)

Generalist: Species that use multiple habitats or have multiple prey or forage species = less sensitive

Specialist: Species that use few or a single habitat, or have few or a single prey or forage species = more sensitive

How much does the species depend on one or more sensitive habitat types? (e.g., kelp forest, biogenic habitat) *1 – 5 (1=very low dependency; 5=very high dependency)* _____	**Confidence in habitat dependency:** *1 – 3 (1=low confidence; 3=high confidence)* _____
Please list any sensitive habitats upon which this species depends.	
How much does the species depend on a specific prey or forage species? (i.e., does the species have prey or forage dependencies?) *1 – 5 (1=very low dependency; 5=very high dependency)* _____	**Confidence in prey/forage dependency:** *1 – 3 (1=low confidence; 3=high confidence)* _____
Are there other critical dependencies that have not been addressed that influence the species' sensitivity to climate change (e.g., reproductive dependency)? If so, please list below and rank degree of dependency. *1 – 5 (1=very low dependency; 5=very high dependency)* _____	**Confidence in other dependencies:** *1 – 3 (1=low confidence; 3=high confidence)* _____
Please list any other dependencies. If none, please write *N/A*.	
Broadly, where does this species fall on the spectrum of generalist to specialist? *1 – 5 (1=generalist; 5=specialist)* _____	**Confidence in generalist/specialist:** *1 – 3 (1=low confidence; 3=high confidence)* _____

S4. Management Potential

Management potential reflects our ability to impact a species' adaptive capacity and resilience to climate and climate-driven changes. Management potential can be evaluated in two ways:

(1) Societal value: Is the species highly valued? Species with a high societal value (e.g., treaty resource, commercial fishery species) likely have higher adaptive capacity, as people may have greater interest in protecting and/or maintaining their populations.

(2) Managing or alleviating impacts: Can impacts on the species be managed or alleviated? If human intervention or management has a high likelihood of alleviating climate impacts, the adaptive capacity of a species is likely higher.

How much do people value this species? *1 – 5 (1=very low value; 5=very high value)* _____	**Confidence in species value:** *1 – 3 (1=low confidence; 3=high confidence)* _____
Is this species important for exercising tribal treaty rights or other ceremonial and subsistence activities? If so, please describe the species value or importance.	
What is the likelihood of managing or alleviating climate impacts for this species? *1 – 5 (1=very low likelihood; 5=very high likelihood)* _____	**Confidence in likelihood:** *1 – 3 (1=low confidence; 3=high confidence)* _____
Please describe likelihood of managing or alleviating climate impacts.	

Extensive Climate Vulnerability Assessment Habitat Assessment Worksheet

This worksheet is designed to be consistent with the Office of National Marine Sanctuaries Marine Protected Area Climate Vulnerability Assessment Guide.

Please prioritize the gray boxes in each section. If time is limiting, the project team may also populate the non-gray fields.

Habitat: _____

1. Sensitivity to Climate Hazards

***Please Note: Sensitivity is a measure of whether and how a habitat is likely to be affected by a given change in climate or another environmental hazard. Exposure (covered in another section below) addresses how much change in climate or another environmental hazard a habitat is likely to experience.**

Consider both direct (e.g., damage to structure/key species) and indirect (e.g., ecological relationships) sensitivities of the habitat. Direct sensitivity reflects the impacts that a climate hazards may have on physical or chemical aspects of the habitat. Ecological relationships may also be affected by climate or climate-driven factors and have impacts on habitat structure and function. Ecological relationships could include: species moving in or out of the habitat, changes in habitat-forming species, alterations to ecological interactions that affect habitat function, etc.

Please evaluate the sensitivity of the habitat to the following climate hazards. IF THE HABITAT IS NOT SENSITIVE TO THE FACTOR, PLEASE WRITE "N" AND LEAVE THE ROW BLANK.

CLIMATE HAZARD	SENSITIVE TO FACTOR (Y/N)	DEGREE OF SENSITIVITY 1 (very low) – 5 (very high)	CONFIDENCE 1 (low) – 3 (high)	RELEVANT REFERENCES
Air temperature				
Sea surface temperature				
Precipitation				
Salinity				
Deoxygenation				
pH				
Sea level rise				
Wave action				
Upwelling				
Currents/mixing/ stratification				
Coastal erosion				
Other (please specify)				

Do any of the climate or climate-driven factors listed above BENEFIT the habitat? If so, please list the factor and describe how the habitat benefits. *Please include any relevant citations.*	
Overall, to what degree is the habitat sensitive to climate and climate-driven factors? *Given your experience and knowledge, what would be your gut assessment for this habitat? Just express your opinion. 1 – 5 (1=low degree; 5=high degree)* _____	**Confidence in your overall assessment of the sensitivity of the habitat to climate and climate-driven factors:** *1 – 3 (1=low confidence; 3=high confidence)* _____
Comments: *Please provide any comments to support or clarify your conclusions above.*	

2. Exposure to Climate Hazards

Exposure addresses how much change in climate or another environmental hazard a habitat is likely to experience.

Please evaluate the exposure of the habitat to the following climate hazards. IF THE HABITAT IS NOT SENSITIVE TO THE FACTOR (previous section), PLEASE LEAVE THE ROW BLANK.

If the hazard does not apply to the habitat, do not evaluate it.

CLIMATE HAZARD	DEGREE OF EXPOSURE 1 (very low) – 5 (very high)	CONFIDENCE 1 (low) – 3 (high)	Potential Areas of Refugia from Factor?
Air temperature			
Sea surface temperature			
Precipitation			
Salinity			
Deoxygenation			
pH			
Sea level rise			
Wave action			
Upwelling			
Currents/mixing/ stratification			
Coastal erosion			
Other (please specify)			

Overall confidence in your assessment of exposure: *1 – 3 (1=low confidence; 3=high confidence)* _____

3. Sensitivity and Current Exposure to Non-Climate Hazards

Sensitivity of the habitat to climate hazards may be highly influenced by the existence, extent of, and exposure to non-climate hazards. For non-climate hazards, exposure is the **current** level of impact experienced by the habitat.

Using the list provided, please write the non-climate hazards most likely to increase sensitivity of the habitat to climate change in the table below.

Ocean Sound
Harvest/Fishing
Submarine Cables
Aquaculture
Marine Debris
Recreation/Increased Visitation
Other (please specify):

Military Activities
Contaminants
Invasive and other problematic species
Offshore Energy
Research Activities
Maritime Transportation

NON-CLIMATE STRESSOR	DEGREE HAZARD AFFECTS SENSITIVITY 1 (very low) – 5 (very high)	CONFIDENCE 1 (low) – 3 (high)	DEGREE OF CURRENT EXPOSURE 1 (very low) – 5 (very high)	CONFIDENCE 1 (low) – 3 (high)

Overall, to what degree do these non-climate hazards make the habitat more sensitive to climate change? *1 – 5 (1= very low degree; 5= very high degree)* _____	**Confidence in your overall assessment of the degree to which non-climate hazards affect the habitat's sensitivity:** *1 – 3 (1=low confidence; 3=high confidence)* _____
Comments and Citations: *Please briefly describe how each of the hazards selected above are likely to make the habitat more sensitive to climate change. If the hazard occurs only in localized areas, please identify those locations.*	

4. Overall User Ranking of Sensitivity

In your opinion, how would you rank the overall sensitivity of this habitat? *Given your experience and knowledge, what would be your gut assessment for this habitat? Just express your opinion. 1 – 5 (1= very low sensitivity; 5= very high sensitivity)* _____	**Confidence in your overall assessment of the sensitivity of this habitat:** *1 – 3 (1=low confidence; 3=high confidence)* _____
Comments:	

5. Overall User Ranking of Exposure

In your opinion, how would you rank the overall exposure of this habitat? *Given your experience and knowledge, what would be your gut assessment for this habitat? Just express your opinion. 1 – 5 (1= very low exposure; 5= very high exposure)* _____	**Confidence in your overall assessment of the exposure of this habitat:** *1 – 3 (1=low confidence; 3=high confidence)* _____
Comments:	

6. Potential Impact

Use the matrix below to calculate the Potential Impact likely to be experienced by the habitat using the assessed values of Sensitivity (Box 4) and Exposure (Box 5):

Potential Impact

Exposure →

Sensitivity↓	*Very Low (1)*	*Low (2)*	*Medium (3)*	*High (4)*	*Very High (5)*
Very Low (1)	Very Low (1)	Very Low (1)	Low (2)	Medium (3)	Medium (3)
Low (2)	Very Low (1)	Low (2)	Low (2)	Medium (3)	High (4)
Medium (3)	Low (2)	Low (2)	Medium (3)	High (4)	High (4)
High (4)	Low (2)	Medium (3)	High (4)	High (4)	Very High (5)
Very High (5)	Medium (3)	Medium (3)	High (4)	Very High (5)	Very High (5)

Potential Impact: _____

7. Intrinsic Adaptive Capacity

***Please Note: Adaptive Capacity is a measure of the ability of a habitat to adapt to the effects or impacts of an environmental or climate hazard. The INTRINSIC adaptive capacity of a habitat includes those factors that are inherent to the habitat (and its components) itself while EXTRINSIC adaptive capacity (covered in another section below) includes those factors that are external to the habitat but can affect its adaptive capacity.**

Please evaluate the following intrinsic adaptive capacity factors. A higher score signifies that this factor as it applies to the habitat being evaluated will increase its adaptive capacity. For example, a habitat with a large distribution may be better able to adapt to climate hazards. For such a habitat, the adaptive capacity score for distribution/extent would be higher than for a habitat with a limited distribution. See the supplemental tables for exercises that can help determine these factors if needed.

CHARACTERISTIC	Adaptive Capacity 1 (very low) – 5 (very high)	CONFIDENCE 1 (low) – 3 (high)	COMMENTS AND RELEVANT REFERENCES
Recovery from Past Extremes/Stressors			
Structural Diversity			
Biodiversity			
Status of Key Species			
Distribution/Extent			
Habitat Connectivity			
Functional Diversity			
Dependencies (One key species or many?)			
Current Condition			
Other:			

Overall, what is the degree of intrinsic adaptive capacity? *1 – 5 (1=very low adaptive capacity; 5=very high adaptive capacity)* _____	**Confidence in your overall assessment of intrinsic adaptive capacity:** *1 – 3 (1=low confidence; 3=high confidence)* _____
Comments and Citations: *Please provide any comments or citations to describe or clarify the adaptive capacity of the habitat.*	

8. Extrinsic Adaptive Capacity

***Please Note: Adaptive Capacity is a measure of the ability of a habitat to adapt to the effects or impacts of an environmental or climate hazard. The EXTRINSIC adaptive capacity includes those factors that are external to the habitat but can affect its adaptive capacity while INTRINSIC adaptive capacity (covered in the section above) includes those factors that are inherent to the habitat itself.**

Please evaluate the following extrinsic adaptive capacity factors. A higher score signifies that this factor as it applies to the habitat being evaluated will increase its adaptive capacity. For example, if the MPA has high staff capacity, it may be better able to address the impacts of climate hazards on the habitat than an MPA with low staff capacity. In such an instance, the adaptive capacity score for staff capacity would be higher than for an MPA with low staff capacity. See the supplemental tables for exercises that can help determine these factors.

CHARACTERISTIC	Adaptive Capacity 1 (very low) – 5 (very high)	CONFIDENCE 1 (low) – 3 (high)	COMMENTS AND RELEVANT REFERENCES
MPA Staff Capacity			
Habitat Value/ Socioeconomic/Cultural Importance			
MPA Responsiveness			
MPA Relationship with Communities and Stakeholders			
Management Mandate			
Monitoring and Evaluation Capacity			
Management Flexibility			
Science/Technical Support			
Potential for Proactive Management			
Other:			

Overall, what is the degree of extrinsic adaptive capacity? *1 – 5 (1=very low adaptive capacity; 5=very high adaptive capacity)* _____	**Confidence in your overall assessment of extrinsic adaptive capacity:** *1 – 3 (1=low confidence; 3=high confidence)* _____
Comments and Citations: *Please provide any comments or citations to describe or clarify the adaptive capacity of the habitat.*	

9. Overall User Ranking of Adaptive Capacity

In your opinion, how would you rank the overall adaptive capacity of this habitat to climate change? *Given your experience and knowledge, as well as your assessment of intrinsic and extrinsic adaptive capacity factors, what would be your gut assessment for this habitat? 1 – 5 (1=very low adaptive capacity; 5=very high adaptive capacity)* _____	**Confidence in your overall assessment of the adaptive capacity of this habitat to climate change:** *1 – 3 (1=low confidence; 3=high confidence)* _____
Comments:	

10. Vulnerability

Use the matrix below to calculate the Vulnerability of the habitat using the assessed values of Potential Impact (Box 6) and Adaptive Capacity (Box 9):

Vulnerability

Potential Impact →

Adaptive Capacity ↓	*Very Low (1)*	*Low (2)*	*Medium (3)*	*High (4)*	*Very High (5)*
Very Low (1)	Medium (3)	Medium (3)	High (4)	Very High (5)	Very High (5)
Low (2)	Low (2)	Medium (3)	High (4)	High (4)	Very High (5)
Medium (3)	Low (2)	Low (2)	Medium (3)	High (4)	High (4)
High (4)	Very Low (1)	Low (2)	Low (2)	Medium (3)	High (4)
Very High (5)	Very Low (1)	Very Low (1)	Low (2)	Medium (3)	Medium (3)

Vulnerability: _____

Supplemental Tables

S1. Extent and Status

Habitats that are currently widespread in their geographic extent, in good condition, and/or have high connectivity may be more likely to withstand and persist into the future despite non-climate and climate stressors (= more adaptive capacity).

Habitats dependent on are endemic or endangered species, or which are isolated or fragmented, or are currently undergoing major losses due to climate and non-climate stressors may be less likely to persist into the future (= less adaptive capacity).

What is the geographic extent of the habitat? *1 – 5 (1=endemic to a particular area; 5=transboundary)* _____	**Confidence in extent:** *1 – 3 (1=low confidence; 3=high confidence)* _____
What is the current condition of the habitat? *1 – 5 (1=highly degraded; 5=pristine)* _____	**Confidence in condition:** *1 – 3 (1=low confidence; 3=high confidence)* _____
What is the connectivity for the habitat? *1 – 5 (1=isolated/quite fragmented; 5=continuous)* _____	**Confidence in connectivity:** *1 – 3 (1=low confidence; 3=high confidence)* _____
Comments and Citations: *Please provide any comments or citations to support or clarify your conclusions above.*	

S2. Dependencies

Generalist: The habitat is not dependent on only a few key species for its structure or function, and/or has high biodiversity = less sensitive

Specialist: The habitat is dependent on one, or a few species for its structure or function, or has low biodiversity = more sensitive

How much does the habitat depend on one or more sensitive species types? *1 – 5 (1=very high dependency; 5=very low dependency)* _____	**Confidence in dependency:** *1 – 3 (1=low confidence; 3=high confidence)* _____
Please list any sensitive species upon which this habitat depends.	
How much does the habitat depend on a specific species? (i.e., is the structure of the habitat dependent on a single species?): *1 – 5 (1=very high dependency; 5=very low dependency)* _____	**Confidence in dependency:** *1 – 3 (1=low confidence; 3=high confidence)* _____
Are there other critical dependencies that have not been addressed that influence the habitat's sensitivity to climate change? If so, please list below and rank degree of dependency: *1 – 5 (1=very low dependency; 5=very high dependency)* _____	**Confidence in other dependencies:** *1 – 3 (1=low confidence; 3=high confidence)* _____
Please list any other dependencies. If none, please write *N/A*.	

S3. Management Potential

Management potential reflects our ability to impact a habitat's adaptive capacity and resilience to climate and climate-driven changes. Management potential can be evaluated in two ways:

(1) Societal value: Is the habitat highly valued? Habitats with a high societal value (e.g. green infrastructure, supports key economic species) likely have higher adaptive capacity, as people may have greater interest in protecting and/or maintaining them.

(2) Managing or alleviating impacts: Can impacts on the habitat be managed or alleviated? If human intervention or management has a high likelihood of alleviating climate impacts, the adaptive capacity of a habitat is likely higher.

How much do people value this habitat? *1 – 5 (1=very low value; 5=very high value)* _____	**Confidence in habitat value:** *1 – 3 (1=low confidence; 3=high confidence)* _____
Is this habitat important for exercising tribal treaty rights or other ceremonial and subsistence activities? If so, please describe the value or importance.	
What is the likelihood of managing or alleviating climate impacts for this habitat? *1 – 5 (1=very low likelihood; 5=very high likelihood)* _____	**Confidence in likelihood:** *1 – 3 (1=low confidence; 3=high confidence)* _____
Please describe likelihood of managing or alleviating climate impacts.	

Extensive Climate Vulnerability Assessment Ecosystem Service Assessment Worksheet

This worksheet is designed to be consistent with the Office of National Marine Sanctuaries Marine Protected Area Climate Vulnerability Assessment Guide.

Please prioritize the gray boxes in each section. If time is limiting, the project team may also populate the non-gray fields.

Ecosystem Service: _____

1. Sensitivity to Climate Hazards

***Please Note: Sensitivity is a measure of whether and how an ecosystem service is likely to be affected by a given change in climate or another environmental hazard. Exposure (covered in another section below) addresses how much change in climate or another environmental hazard an ecosystem service is likely to experience.**

Consider both direct (e.g., damage to key resources) and indirect (e.g., changes in access) sensitivities of the ecosystem service. Direct sensitivity reflects the impacts that a climate hazard may have on resources or another tangible component of the ecosystem service. Ecosystem services could also have indirect sensitivities to a climate hazard, such as a hazard that affects the ability of a community to access that service. For example, if increasing temperatures make it dangerous for people to access a service, even if the service itself is not directly affected, this would be considered an indirect sensitivity.

Please evaluate the sensitivity of the ecosystem service to the following climate hazards. IF THE ECOSYSTEM SERVICE IS NOT SENSITIVE TO THE FACTOR, PLEASE WRITE "N" AND LEAVE THE ROW BLANK.

CLIMATE HAZARD	SENSITIVE TO FACTOR (Y/N)	DEGREE OF SENSITIVITY 1 (very low) – 5 (very high)	CONFIDENCE 1 (low) – 3 (high)	RELEVANT REFERENCES
Air temperature				
Sea surface temperature				
Precipitation				
Salinity				
Deoxygenation				
pH				
Sea level rise				
Wave action				
Upwelling				
Currents/mixing/ stratification				
Coastal erosion				
Other (please specify)				

Do any of the climate or climate-driven factors listed above BENEFIT the ecosystem service? If so, please list the factor and describe how the ecosystem service benefits. *Please include any relevant citations.*	
Overall, to what degree is the ecosystem service sensitive to climate and climate-driven factors? *Given your experience and knowledge, what would be your gut assessment for this ecosystem service? Just express your opinion. 1 – 5 (1=low degree; 5=high degree)* _____	**Confidence in your overall assessment of the sensitivity of the ecosystem service to climate and climate-driven factors:** *1 – 3 (1=low confidence; 3=high confidence)* _____
Comments: *Please provide any comments to support or clarify your conclusions above.*	

2. Exposure to Climate Hazards

Exposure addresses how much change in climate or another environmental hazard an ecosystem service is likely to experience.

Please evaluate the exposure of the ecosystem service to the following climate hazards. IF THE ECOSYSTEM SERVICE IS NOT SENSITIVE TO THE FACTOR (previous section), PLEASE LEAVE THE ROW BLANK.

If the hazard does not apply to the ecosystem service, do not evaluate it.

CLIMATE HAZARD	DEGREE OF EXPOSURE 1 (very low) – 5 (very high)	CONFIDENCE 1 (low) – 3 (high)	Potential Areas of Refugia from Factor?
Air temperature			
Sea surface temperature			
Precipitation			
Salinity			
Deoxygenation			
pH			
Sea level rise			
Wave action			
Upwelling			
Currents/mixing/ stratification			
Coastal erosion			
Other (please specify)			

Overall confidence in your assessment of exposure: *1 – 3 (1=low confidence; 3=high confidence)* _____

3. Sensitivity and Current Exposure to Non-Climate Hazards

Sensitivity of the ecosystem service to climate hazards may be highly influenced by the existence, extent of, and exposure to non-climate hazards. For non-climate hazards, exposure is the **current** level of impact experienced by the ecosystem service.

Using the list provided, please write the non-climate hazards most likely to increase sensitivity of the ecosystem service to climate change in the table below.

Ocean Sound
Harvest/Fishing
Submarine Cables
Aquaculture
Marine Debris
Recreation/Increased Visitation
Other (please specify):

Military Activities
Contaminants
Invasive and other problematic species
Offshore Energy
Research Activities
Maritime Transportation

NON-CLIMATE STRESSOR	DEGREE HAZARD AFFECTS SENSITIVITY 1 (very low) – 5 (very high)	CONFIDENCE 1 (low) – 3 (high)	DEGREE OF CURRENT EXPOSURE 1 (very low) – 5 (very high)	CONFIDENCE 1 (low) – 3 (high)

Overall, to what degree do these non-climate hazards make the ecosystem service more sensitive to climate change? *1 – 5 (1= very low degree; 5= very high degree)* _____	**Confidence in your overall assessment of the degree to which non-climate hazards affect the ecosystem service's sensitivity:** *1 – 3 (1=low confidence; 3=high confidence)* _____
Comments and Citations: *Please briefly describe how each of the hazards selected above are likely to make the ecosystem service more sensitive to climate change. If the hazard occurs only in localized areas, please identify those locations.*	

4. Overall User Ranking of Sensitivity

In your opinion, how would you rank the overall sensitivity of this ecosystem service? *Given your experience and knowledge, what would be your gut assessment for this ecosystem service? Just express your opinion. 1 – 5 (1= very low sensitivity; 5= very high sensitivity)* _____	**Confidence in your overall assessment of the sensitivity of this ecosystem service:** *1 – 3 (1=low confidence; 3=high confidence)* _____
Comments:	

5. Overall User Ranking of Exposure

In your opinion, how would you rank the overall exposure of this ecosystem service? *Given your experience and knowledge, what would be your gut assessment for this ecosystem service? Just express your opinion. 1 – 5 (1= very low exposure; 5= very high exposure)* _____	**Confidence in your overall assessment of the exposure of this ecosystem service:** *1 – 3 (1=low confidence; 3=high confidence)* _____
Comments:	

6. Potential Impact

Use the matrix below to calculate the Potential Impact likely to be experienced by the ecosystem service using the assessed values of Sensitivity (Box 4) and Exposure (Box 5):

Potential Impact
Exposure →

Sensitivity↓	*Very Low (1)*	*Low (2)*	*Medium (3)*	*High (4)*	*Very High (5)*
Very Low (1)	Very Low (1)	Very Low (1)	Low (2)	Medium (3)	Medium (3)
Low (2)	Very Low (1)	Low (2)	Low (2)	Medium (3)	High (4)
Medium (3)	Low (2)	Low (2)	Medium (3)	High (4)	High (4)
High (4)	Low (2)	Medium (3)	High (4)	High (4)	Very High (5)
Very High (5)	Medium (3)	Medium (3)	High (4)	Very High (5)	Very High (5)

Potential Impact: _____

7. Intrinsic Adaptive Capacity

***Please Note: Adaptive Capacity is a measure of the ability of an ecosystem service to adapt to the effects or impacts of an environmental or climate hazard. The INTRINSIC adaptive capacity includes those factors that are inherent to the ecosystem service (and its components) itself while EXTRINSIC adaptive capacity (covered in another section below) includes those factors that are external to the ecosystem service but can affect its adaptive capacity.**

Please evaluate the following intrinsic adaptive capacity factors. A higher score signifies that this factor as it applies to the ecosystem service being evaluated will increase its adaptive capacity. For example, an ecosystem service that depends on a diversity of key species may be better able to adapt to climate hazards and its adaptive capacity score for diversity of key resources would be higher than for an ecosystem service that depends on one key species. See the supplemental tables for exercises that can help determine these factors. **If a characteristic does not apply to the ecosystem service, leave the row blank**.

CHARACTERISTIC	Adaptive Capacity 1 (very low) – 5 (very high)	CONFIDENCE 1 (low) – 3 (high)	COMMENTS AND RELEVANT REFERENCES
Recovery from Past Extremes/Stressors			
Economic Value			
Socioeconomic/Cultural Importance			
Status of Key Species			
Diversification Potential (i.e. can alternative strategies be used/created to access this service?)			
Dependencies/Specialization (One key species/habitat/ area or many?)			
Current Condition			
Other:			

Overall, what is the degree of intrinsic adaptive capacity? *1 – 5 (1=very low adaptive capacity; 5=very high adaptive capacity)* _____	**Confidence in your overall assessment of intrinsic adaptive capacity:** *1 – 3 (1=low confidence; 3=high confidence)* _____
Comments and Citations: *Provide comments or citations to describe/clarify the adaptive capacity.*	

8. Extrinsic Adaptive Capacity

***Please Note: Adaptive Capacity is a measure of the ability of an ecosystem service to adapt to the effects or impacts of an environmental or climate hazard. The EXTRINSIC adaptive capacity includes those factors that are external to the ecosystem service but can affect its adaptive capacity while INTRINSIC adaptive capacity (covered in the section above) includes those factors that are inherent to the ecosystem service itself.**

Please evaluate the following extrinsic adaptive capacity factors. A higher score signifies that this factor as it applies to the ecosystem service being evaluated will increase its adaptive capacity. For example, if the MPA has high staff capacity, it may be better able to address the impacts of climate hazards on the ecosystem service than an MPA with low staff capacity. In such an instance, the adaptive capacity score for staff capacity would be higher than for an MPA with low staff capacity. See the supplemental tables for exercises that can help determine these factors if needed.

CHARACTERISTIC	Adaptive Capacity 1 (very low) – 5 (very high)	CONFIDENCE 1 (low) – 3 (high)	COMMENTS AND RELEVANT REFERENCES
MPA Staff Capacity			
MPA Responsiveness			
MPA Relationship with Communities and Stakeholders			
Management Mandate			
Monitoring and Evaluation Capacity			
Management Flexibility			
Science/Technical Support			
Potential for Proactive Management			
Other:			

Overall, what is the degree of extrinsic adaptive capacity? *1 – 5 (1=very low adaptive capacity; 5=very high adaptive capacity)* _____	**Confidence in your overall assessment of extrinsic adaptive capacity:** *1 – 3 (1=low confidence; 3=high confidence)* _____
Comments and Citations: *Please provide any comments or citations to describe or clarify the adaptive capacity of the ecosystem service.*	

9. Overall User Ranking of Adaptive Capacity

In your opinion, how would you rank the overall adaptive capacity of this ecosystem service to climate change? *Given your experience and knowledge, as well as your assessment of intrinsic and extrinsic adaptive capacity factors, what would be your gut assessment for this ecosystem service? 1 – 5 (1=very low adaptive capacity; 5=very high adaptive capacity)* _____	**Confidence in your overall assessment of the adaptive capacity of this ecosystem service to climate change:** *1 – 3 (1=low confidence; 3=high confidence)* _____
Comments:	

10. Vulnerability

Use the matrix below to calculate the Vulnerability of the ecosystem service using the assessed values of Potential Impact (Box 6) and Adaptive Capacity (Box 9):

Vulnerability

Potential Impact →

Adaptive Capacity ↓	*Very Low (1)*	*Low (2)*	*Medium (3)*	*High (4)*	*Very High (5)*
Very Low (1)	Medium (3)	Medium (3)	High (4)	Very High (5)	Very High (5)
Low (2)	Low (2)	Medium (3)	High (4)	High (4)	Very High (5)
Medium (3)	Low (2)	Low (2)	Medium (3)	High (4)	High (4)
High (4)	Very Low (1)	Low (2)	Low (2)	Medium (3)	High (4)
Very High (5)	Very Low (1)	Very Low (1)	Low (2)	Medium (3)	Medium (3)

Vulnerability: _____

Supplemental Tables

S1. Dependencies/Specialization

Low Specialization: The ecosystem service is supported by a diverse number of species, habitats, or areas such that if one or a few were to fail, the ecosystem service could persist = less sensitive.

High Specialization: The ecosystem service is dependent on one, or a few species, habitats or areas such that is one or a few were to fail, the ecosystem service would be unlikely to persist = more sensitive.

How much does the ecosystem service depend on one or more sensitive species, habitats, or areas? *1 – 5 (1=very high dependency; 5=very low dependency)* _____	**Confidence in dependency:** *1 – 3 (1=low confidence; 3=high confidence)* _____
Please list any sensitive species, habitats, or areas upon which this ecosystem service depends.	
How much does the ecosystem service depend on a specific species, habitat, or area? (i.e., is the ecosystem service dependent on a single species?) *1 – 5 (1=very high dependency; 5=very low dependency)* _____	**Confidence in dependency:** *1 – 3 (1=low confidence; 3=high confidence)* _____
Are there other critical dependencies that have not been addressed that influence the ecosystem service's sensitivity to climate change? If so, please list below and rank degree of dependency. *1 – 5 (1=very low dependency; 5=very high dependency)* _____	**Confidence in other dependencies:** *1 – 3 (1=low confidence; 3=high confidence)* _____
Please list any other dependencies. If none, please write *N/A*.	

S2. Value and Management Potential

Management potential reflects our ability to impact an ecosystem service's adaptive capacity and resilience to climate and climate-driven changes. Management potential can be evaluated in two ways:

(1) Societal value: Is the ecosystem service highly valued? Ecosystem services with a high societal value (e.g. provides coastal protection, supports key cultural practice) likely have higher adaptive capacity, as people may have greater interest in protecting and/or maintaining them.

(2) Managing or alleviating impacts: Can impacts on the ecosystem service be managed or alleviated? If human intervention or management has a high likelihood of alleviating climate impacts, the adaptive capacity of an ecosystem service is likely higher.

How much do people value this ecosystem service? *1 – 5 (1=very low value; 5=very high value)* _____	**Confidence in value:** *1 – 3 (1=low confidence; 3=high confidence)* _____
Is this ecosystem service important for exercising tribal treaty rights or other ceremonial and subsistence activities?	
Please describe the ecosystem service's value or importance.	
What is the likelihood of managing or alleviating climate impacts for this ecosystem service? *1 – 5 (1=very low likelihood; 5=very high likelihood)* _____	**Confidence in likelihood:** *1 – 3 (1=low confidence; 3=high confidence)* _____
Please describe likelihood of managing or alleviating climate impacts.	

Extensive Climate Vulnerability Assessment Heritage Resource Assessment Worksheet

This worksheet is designed to be consistent with the Office of National Marine Sanctuaries Marine Protected Area Climate Vulnerability Assessment Guide.

Please prioritize the gray boxes in each section. If time is limiting, the project team may also populate the non-gray fields.

Heritage Resource: _____

1. Sensitivity to Climate Hazards

***Please Note: Sensitivity is a measure of whether and how a heritage resource is likely to be affected by a given change in climate or another environmental hazard. Exposure (covered in another section below) addresses how much change in climate or another hazard a heritage resource is likely to experience.**

Consider both direct (e.g., damage to resource) and indirect (e.g., change in/damage to critical processes) sensitivities of the heritage resource. Direct sensitivity reflects the impacts that a climate hazards may have on the heritage resource itself. Heritage resources could also have indirect sensitivities to a climate hazard, such as a hazard that affects an aspect of the environment that is important to the resource. For example, if a strong storm breaks the timbers of an historic shipwreck, this would be a direct sensitivity while if the storm moved sediment in a way that adversely affected the shipwreck, this would be an indirect sensitivity.

Please evaluate the sensitivity of the heritage resource to the following climate hazards. IF THE HERITAGE RESOURCE IS NOT SENSITIVE TO THE FACTOR, PLEASE WRITE "N" AND LEAVE THE ROW BLANK.

CLIMATE HAZARD	SENSITIVE TO FACTOR (Y/N)	DEGREE OF SENSITIVITY 1 (very low) – 5 (very high)	CONFIDENCE 1 (low) – 3 (high)	RELEVANT REFERENCES
Air temperature				
Sea surface temperature				
Precipitation				
Salinity				
Deoxygenation				
pH				
Sea level rise				
Wave/tidal action				
Water flow velocity				
Site erosion				
Sedimentation				
Storm surge/inundation				
Other (please specify)				

Do any of the climate or climate-driven factors listed above BENEFIT the heritage resource? If so, please list the factor and describe how the heritage resource benefits. *Please include any relevant citations.*	
Overall, to what degree is the heritage resource sensitive to climate and climate-driven factors? *Given your experience and knowledge, what would be your gut assessment for this heritage resource? Just express your opinion. 1 – 5 (1=low degree; 5=high degree)* _____	**Confidence in your overall assessment of the sensitivity of the heritage resource to climate and climate-driven factors:** *1 – 3 (1=low confidence; 3=high confidence)* _____
Comments: *Please provide any comments to support or clarify your conclusions above.*	

2. Exposure to Climate Hazards

Exposure addresses how much change in climate or another environmental hazard a heritage resource is likely to experience.

Please evaluate the exposure of the heritage resource to the following climate hazards. IF THE HERITAGE RESOURCE IS NOT SENSITIVE TO THE FACTOR (previous section), PLEASE LEAVE THE ROW BLANK.

If the hazard does not apply to the heritage resource, do not evaluate it.

CLIMATE HAZARD	DEGREE OF EXPOSURE 1 (very low) – 5 (very high)	CONFIDENCE 1 (low) – 3 (high)	Potential Areas of Refugia from Factor?
Air temperature			
Sea surface temperature			
Precipitation			
Salinity			
Deoxygenation			
pH			
Sea level rise			
Wave/tidal action			
Water flow velocity			
Site erosion			
Sedimentation			
Storm surge/inundation			
Other (please specify)			

Overall confidence in your assessment of exposure: *1 – 3 (1=low confidence; 3=high confidence)* _____

3. Sensitivity and Current Exposure to Non-Climate Hazards

Sensitivity of the heritage resource to climate hazards may be highly influenced by the existence, extent of, and exposure to non-climate hazards. For non-climate hazards, exposure is the **current** level of impact experienced by the heritage resource.

Using the list provided, please write the non-climate hazards most likely to increase sensitivity of the heritage resource to climate change based on current knowledge of documented impacts to date in the table below.

Animal Activity; Artifact Movement; Biological Degradation; Boating; Chemical Degradation; Development/Construction; Dredging; Environmental Conditions; Excavation, Explosives; Fishing/Trawling; Hazardous Waste/Materials; Looting/Theft; Loss of Site Access; Mineral Exploration/Extraction; Neglect; Oil Spill; Pollution/Runoff; Research Activities; Stabilization Activities; Structural Modification; Tsunami; Unauthorized Research; Vandalism; Visitation/Visitor Use; Vegetation Growth; Other (please specify):

NON-CLIMATE STRESSOR	DEGREE HAZARD AFFECTS SENSITIVITY 1 (very low) – 5 (very high)	CONFIDENCE 1 (low) – 3 (high)	DEGREE OF CURRENT EXPOSURE 1 (very low) – 5 (very high)	CONFIDENCE 1 (low) – 3 (high)

Overall, to what degree do these non-climate hazards make the heritage resource more sensitive to climate change? *1 – 5 (1= very low degree; 5= very high degree)* _____	**Confidence in your overall assessment of the degree to which non-climate hazards affect the heritage resource's sensitivity:** *1 – 3 (1=low confidence; 3=high confidence)* _____
Comments and Citations: *Please briefly describe how each of the hazards selected above are likely to make the heritage resource more sensitive to climate change. If the hazard occurs only in localized areas, please identify those locations.*	

4. Overall User Ranking of Sensitivity

In your opinion, how would you rank the overall sensitivity of this heritage resource? *Given your experience and knowledge, what would be your gut assessment for this heritage resource? Just express your opinion. 1 – 5 (1= very low sensitivity; 5= very high sensitivity)* _____	**Confidence in your overall assessment of the sensitivity of this heritage resource:** *1 – 3 (1=low confidence; 3=high confidence)* _____
Comments:	

5. Overall User Ranking of Exposure

In your opinion, how would you rank the overall exposure of this heritage resource? *Given your experience and knowledge, what would be your gut assessment for this heritage resource? Just express your opinion. 1 – 5 (1= very low exposure; 5= very high exposure)* _____	**Confidence in your overall assessment of the exposure of this heritage resource:** *1 – 3 (1=low confidence; 3=high confidence)* _____
Comments:	

6. Potential Impact

Use the matrix below to calculate the Potential Impact likely to be experienced by the heritage resource using the assessed values of Sensitivity (Box 4) and Exposure (Box 5):

Potential Impact
Exposure →

Sensitivity↓	*Very Low (1)*	*Low (2)*	*Medium (3)*	*High (4)*	*Very High (5)*
Very Low (1)	Very Low (1)	Very Low (1)	Low (2)	Medium (3)	Medium (3)
Low (2)	Very Low (1)	Low (2)	Low (2)	Medium (3)	High (4)
Medium (3)	Low (2)	Low (2)	Medium (3)	High (4)	High (4)
High (4)	Low (2)	Medium (3)	High (4)	High (4)	Very High (5)
Very High (5)	Medium (3)	Medium (3)	High (4)	Very High (5)	Very High (5)

Potential Impact: _____

7. Intrinsic Adaptive Capacity

***Please Note TANGIBLE HERITAGE RESOURCES ARE NOT ASSESSED FOR ADAPTIVE CAPACITY. If assessing the vulnerability of a tangible heritage resource, SKIP THIS TABLE. In such a case, the vulnerability of the heritage resource is the same as the assessed Potential Impact (step 6). If you are uncertain, ask the workshop/assessment organizers if you should assess the adaptive capacity of this heritage resource.**

Adaptive Capacity is a measure of the ability of a heritage resource to adapt to the effects or impacts of an environmental or climate hazard. The INTRINSIC adaptive capacity of a resource includes those factors that are inherent to the heritage resource (and its components) itself while EXTRINSIC adaptive capacity (covered in another section below) includes those factors that are external to the heritage resource but can affect its adaptive capacity.

Please evaluate the following intrinsic adaptive capacity factors. A higher score signifies that this factor as it applies to the heritage resource being evaluated will increase its adaptive capacity. For example, a heritage resource that depends on a diversity of key species may be better able to better adapt to climate hazards, and its adaptive capacity score for diversity of key species would be higher than for a heritage resource that depends on one key species. See the supplemental tables for exercises that can help determine these factors. **If a characteristic does not apply to the heritage resource leave the row blank**.

CHARACTERISTIC	Adaptive Capacity 1 (very low) – 5 (very high)	CONFIDENCE 1 (low) – 3 (high)	COMMENTS AND RELEVANT REFERENCES
Economic importance/value			
Socio-cultural importance/value			
Flexibility to Change			
Status of Key Species			
Conflicts with other resources/services			
Status or diversity of key species or habitats			
Other:			

Overall, what is the degree of intrinsic adaptive capacity? *1 – 5 (1=very low adaptive capacity; 5=very high adaptive capacity)* _____	**Confidence in your overall assessment of intrinsic adaptive capacity:** *1 – 3 (1=low confidence; 3=high confidence)* _____
Comments and Citations: *Provide comments or citations to describe/clarify the adaptive capacity.*	

8. Extrinsic Adaptive Capacity

***Please Note: TANGIBLE HERITAGE RESOURCES ARE NOT ASSESSED FOR ADAPTIVE CAPACITY. If assessing the vulnerability of a tangible heritage resource, SKIP THIS TABLE. In such a case, the vulnerability of the heritage resource is the same as the assessed Potential Impact (step 6). If you are uncertain, ask the workshop/assessment organizers if you should assess the adaptive capacity of this heritage resource.**

Adaptive Capacity is a measure of the ability of a heritage resource to adapt to the effects or impacts of an environmental or climate hazard. The EXTRINSIC adaptive capacity includes those factors that are external to the heritage resource but can affect its adaptive capacity while INTRINSIC adaptive capacity (covered in another section above) includes those factors that are inherent to the heritage resource itself.

Please evaluate the following extrinsic adaptive capacity factors. A higher score signifies that this factor as it applies to the heritage resource being evaluated will increase its adaptive capacity. For example, if the MPA has high staff capacity, it may be more able to address the impacts of climate hazards on the heritage resource than an MPA with low staff capacity. In such an instance, the adaptive capacity score for staff capacity would be higher than for an MPA with low staff capacity. See the supplemental tables for exercises that can help determine these factors.

CHARACTERISTIC	Adaptive Capacity 1 (very low) – 5 (very high)	CONFIDENCE 1 (low) – 3 (high)	COMMENTS AND RELEVANT REFERENCES
MPA Staff Capacity			
MPA Responsiveness			
MPA Relationship with Communities and Stakeholders			
Management Mandate			
Monitoring and Evaluation Capacity			
Management Flexibility			
Science/Technical Support			
Potential for Proactive Management			
Other:			

Overall, what is the degree of extrinsic adaptive capacity? *1 – 5 (1=very low adaptive capacity; 5=very high adaptive capacity)* _____	**Confidence in your overall assessment of extrinsic adaptive capacity:** *1 – 3 (1=low confidence; 3=high confidence)* _____
Comments and Citations: *Please provide any comments or citations to describe or clarify the adaptive capacity of the heritage resource.*	

9. Overall User Ranking of Adaptive Capacity

***Please Note: TANGIBLE HERITAGE RESOURCES ARE NOT ASSESSED FOR ADAPTIVE CAPACITY. If assessing the vulnerability of a tangible heritage resource, SKIP THIS TABLE. In such a case, the vulnerability of the heritage resource is the same as the assessed Potential Impact (step 6). If you are uncertain, ask the workshop/assessment organizers if you should assess the adaptive capacity of this heritage resource.**

In your opinion, how would you rank the overall adaptive capacity of this heritage resource to climate change? *Given your experience and knowledge, as well as your assessment of intrinsic and extrinsic adaptive capacity factors, what would be your gut assessment for this heritage resource? 1 – 5 (1=very low adaptive capacity; 5=very high adaptive capacity)* _____	**Confidence in your overall assessment of the adaptive capacity of this heritage resource to climate change:** *1 – 3 (1=low confidence; 3=high confidence)* _____
Comments:	

10. Vulnerability

***Please Note: TANGIBLE HERITAGE RESOURCES ARE NOT ASSESSED FOR ADAPTIVE CAPACITY. If assessing the vulnerability of a tangible heritage resource, SKIP THIS STEP. In such a case, the vulnerability of the heritage resource is the same as the assessed Potential Impact (step 6). If you are uncertain, ask the workshop/assessment organizers if you should assess the adaptive capacity of this heritage resource.**

Use the matrix below to calculate the Vulnerability of the heritage resource using the assessed values of Potential Impact (Box 6) and Adaptive Capacity (Box 9):

Vulnerability

Potential Impact →

Adaptive Capacity ↓	*Very Low (1)*	*Low (2)*	*Medium (3)*	*High (4)*	*Very High (5)*
Very Low (1)	Medium (3)	Medium (3)	High (4)	Very High (5)	Very High (5)
Low (2)	Low (2)	Medium (3)	High (4)	High (4)	Very High (5)
Medium (3)	Low (2)	Low (2)	Medium (3)	High (4)	High (4)
High (4)	Very Low (1)	Low (2)	Low (2)	Medium (3)	High (4)
Very High (5)	Very Low (1)	Very Low (1)	Low (2)	Medium (3)	Medium (3)

Vulnerability: _____

Supplemental Tables

S1. Value and Management Potential

Management potential reflects our ability to impact a heritage resource's adaptive capacity and resilience to climate and climate-driven changes. Management potential can be evaluated in two ways:

(1) Societal value: Is the heritage resource highly valued? Heritage resources with a high societal value (e.g. provides coastal protection, supports key cultural practice) likely have higher adaptive capacity, as people may have greater interest in protecting and/or maintaining them.

(2) Managing or alleviating impacts: Can impacts on the heritage resource be managed or alleviated? If human intervention or management has a high likelihood of alleviating climate impacts, the adaptive capacity of a heritage resource is likely higher.

How much do people value this heritage resource? *1 – 5 (1=very low value; 5=very high value)* _____	**Confidence in value:** *1 – 3 (1=low confidence; 3=high confidence)* _____
Is this heritage resource important for exercising tribal treaty rights or other ceremonial and subsistence activities?	
Please describe the heritage resource's value or importance.	
What is the likelihood of maintaining the heritage resource's significance under a changing climate? *1 – 5 (1=very low likelihood; 5=very high likelihood)* _____	**Confidence in likelihood:** *1 – 3 (1=low confidence; 3=high confidence)* _____
Please describe likelihood of maintaining he heritage resource's significance	

S2. Data Management Potential

Management potential reflects our ability to impact a heritage resource's adaptive capacity and resilience to climate and climate-driven changes. The management potential of heritage resources, especially tangible heritage resources, is based on current resource condition and the potential to conduct research. The ability to conduct research and better understand the heritage resource is one means of reducing the impacts of climate change.

Using the list provided, please highlight or circle the management actions that could be conducted to mitigate data loss due to climate change.

Data Recovery	Stabilization
Mapping	Protection
Oral History Interviews	Special Research
Site Recording	Interpretation/Outreach
Threats/Disturbance Analysis	NRHP Evaluation
Historical Research	Remote Sensing Survey
Material Cultural Analysis	Other (please specify):

Are there current restrictions in accessing or conducting research on the resource?	
What is the likelihood of managing data loss due to climate impacts for this heritage resource? *1 – 5 (1=low potential; 5=high potential)* _____	**Confidence in your overall assessment of data management potential?** *1 – 3 (1=low confidence; 3=high confidence)* _____
What is the likelihood of managing or alleviating climate impacts for this heritage resource category? *1 – 5 (1=low potential; 5=high potential)* _____	**Confidence in your overall assessment of climate management potential?** *1 – 3 (1=low confidence; 3=high confidence)* _____
Please describe the data and climate management potential of this heritage resource.	

AA.5.2 Limited CVA Worksheets

The limited CVA worksheets in this section were adapted from the Commission for Environmental Cooperation North American Marine Protected Area Rapid Vulnerability Assessment Tool (CEC 2017). While the worksheets provided are ready to use, many aspects, can be edited and customized to fit the needs of a particular MPA or CVA. This is particularly true of the hazards (both climate and non-climate) provided in the hazard selection tables and the adaptive capacity factors provided in both the adaptive capacity tables.

Limited Climate Vulnerability Assessment Species Assessment Worksheet

This worksheet is designed to be consistent with the Office of National Marine Sanctuaries Marine Protected Area Climate Vulnerability Assessment Guide.

Adapted from: CEC 2017. North American Marine Protected Area Rapid Vulnerability Assessment Tool. Montreal, Canada: Commission for Environmental Cooperation. 30 pp.

Species and Hazard Selection

The first step in your limited vulnerability assessment is to define the scope of the assessment. This includes selecting the timescale over which you will be assessing the vulnerability of your focal resources, the species you will be assessing throughout the assessment and/or using this worksheet, and the climate and non-climate hazards (up to three of each) that affect your species and which you will assess. If you require guidance in addition to that which is included in this worksheet, please see the Office of National Marine Sanctuaries Marine Protected Area Climate Vulnerability Assessment Guide.

Record the timeframe of the assessment below. Remember to also record this timeframe in the appropriate location within tables throughout the worksheet.

Timeframe of Assessment:

Record the species that are being assessed during this assessment and/or using this worksheet. If recording all species being assessed during the assessment, it is recommended that you note which species is/are being assessed using this worksheet. Remember to also record the species being assessed in the appropriate location within tables throughout the worksheet

Species Being Assessed:

Using the **Hazards Selection Table** on the next page (page 3), select the climate and non-climate hazards being assessed using this worksheet. First, list the species being assessed using this worksheet. Then select up to three climate hazards that are expected to affect the species over the timeframe being assessed, and up to three non-climate hazards that currently affect the species being assessed. These hazards will be transferred to appropriate locations on subsequent tables throughout the worksheet.

Hazard Selection Table

Species:

Climate Hazards	Selected Hazards
Warming Water Temperatures	
Ocean Acidification	
Deoxygenation/Decreasing Oxygen Levels	
Sea Level Rise	
Altered Precipitation	
Altered Currents	
Altered Upwelling/Mixing (incl. Stratification)	
Changing Salinity	
Changing Turbidity	
Changing Wave Action	
Increasing Coastal Erosion	
Changing Storm Frequency and/or Severity	
Harmful Algal Blooms (HABs)	
Changing Large-Scale Climate Processes (e.g. ENSO, PDO)	
Other:	

Non-Climate Hazards	Selected Hazards
Nutrient Pollution	
Terrestrial Non-Nutrient Pollution	
Marine-Sourced Pollution and Spills	
Coastal Development/Population Growth	
Commercial Harvest	
Non-Commercial Harvest	
Tourism and/or Recreation	
Aquaculture	
Disease	
Invasive Species	
Transportation/Shipping	
Oil, Mineral, and Gas Extraction	
Energy Production (e.g. offshore wind, wave energy, etc.)	
Ocean Noise	
Coastal Armoring	
In-Water Structures	
Dredging	
Boat/Ship Grounding	
Changes to Sediment Transport	
Researcher Disturbance	
Carbon Dioxide Removal Infrastructure	
Other:	

Conducting the Assessment

To assess vulnerability, you will complete a number of tables included on the following pages. Instructions for completing these tables are included below.

Primary Table

The **Primary Table**, included on page 8, is used to both assess exposure, and to collate the information gathered from other tables in one location for the final assessment of vulnerability. The steps to complete this table are:

1. Enter the species and timescale being assessed at the top of the table.
2. In the *Climate hazard* column, list the climate hazards selected in the **Hazards Selection Table**.
3. In the *Observed or projected direction and magnitude of change in hazard* column, describe how each climate hazard is projected to change in the area being assessed over the timeframe being assessed.
4. In the *Impacts of hazard on resource* column, describe the anticipated effects of each climate hazard on the species being assessed.
5. In the *Exposure* column, use the information you know about the species and hazards to assign a degree of exposure to the climate hazard that the species is likely to experience over the time period being assessed. **Exposure** is defined as "the measure of how much change in climate or another environmental hazard the species is likely to experience". Assign the degree of exposure using a value of 1 (very low) to 5 (very high). Also assign the confidence level from 1 (low) to 3 (high) that you have in this assessment of exposure.
6. In the row labeled *Overall/Average*, calculate the overall exposure of the species being assessed by taking the average of the values recorded in the *Exposure* column.
7. Complete the **Sensitivity Table** (instructions on page 5).
8. In the *Sensitivity* column, record the sensitivity value assigned to each climate hazard using the **Sensitivity Table** in the corresponding row of this column.
9. In the row labeled *Overall/Average*, calculate the overall sensitivity of the species being assessed by taking the average of the values recorded in the S*ensitivity* column.
10. Calculate the **potential impact** that each climate hazard is likely to have on the species being assessed by using Figure 1 (page 7) and the assessed values for exposure and sensitivity. Record this value in the appropriate cell of the *Potential Impact* column.
11. In the row labeled *Overall/Average*, calculate the overall potential impact the species being assessed is likely to experience by taking the average of the values recorded in the *Potential Impact* column.
12. Complete the **Adaptive Capacity Table** (instructions on page 6).
13. In the *Adaptive Capacity* column, record the overall adaptive capacity value assigned to each climate hazard using the **Adaptive Capacity Table** in the corresponding row of

this column. If adaptive capacity was not assessed independently for each climate hazard, this value will be the same for each cell in this column.

14. In the row labeled *Overall/Average*, calculate the overall adaptive capacity of the species being assessed by taking the average of the values recorded in the *Adaptive Capacity* column.

15. Calculate the **vulnerability** that the species has to each climate hazard by using Figure 2 (page 7) and the assessed values for potential impact and adaptive capacity. Record this value in the appropriate cell of the *Vulnerability* column.

16. In the row labeled *Overall/Average*, calculate the overall vulnerability of the assessed species. This score can be calculated in one of two ways. The first method is to take the average of the vulnerability scores assessed for each hazard in the *Vulnerability* column. The second option is to use Figure 2 and the assessed overall/average values of potential impact and adaptive capacity found in the row labeled *Overall/Average*. Whichever method is chosen, use that same method for all resources assessed during the workshop. Ask the workshop/assessment organizers which method should be employed if such instructions were not provided.

Sensitivity Table

The **Sensitivity Table**, included on page 9, is used to assess the sensitivity of the species being assessed to the combined impacts of the climate and non-climate hazards being assessed. **Sensitivity** is defined as "a measure of whether and how a species is likely to be affected by a given change in climate or another environmental hazard." The steps to complete this table are:

1. Enter the species and timescale being assessed at the top of the table.

2. Enter the climate hazards being assessed in the appropriate cells within the three columns under the label *Combined impact of non-climate hazard and climate hazards*.

3. In the *Non-climate hazard* column, list the non-climate hazards selected in the **Hazards Selection Table**.

4. In the *Impacts of hazard on resource* column, describe the current effects of each non-climate hazard on the species being assessed.

5. In the *Will climate change make impact of hazard better or worse?* column, describe if climate change is expected to make the effects of these non-climate hazards on the species being assessed better (less problematic), worse (more problematic), or have no effect.

6. In each of the cells of the three sub-columns under the *Will climate change make impact of hazard better or worse?* column, describe the combined effects of each climate and non-climate hazard on the species being assessed.

7. For each climate hazard, in the bottom row of the table (labeled Sensitivity) assign a sensitivity of the species to each the climate hazards being assessed in the corresponding column for that hazard. This assessment should take into consideration the combined effects of the climate hazard and each of the non-climate hazards on the species being assessed. Assign the degree of sensitivity using a value of 1 (very low) to 5 (very high).

Also assign the confidence level from 1 (low) to 3 (high) that you have in this assessment of sensitivity.

8. Transfer the assigned sensitivity value for each climate hazard to the appropriate cell of the *Sensitivity* column in the **Primary Table**.

Adaptive Capacity Table

The **Adaptive Capacity Table**, included on page 10, is used to assess both the intrinsic and extrinsic factors that affect the adaptive capacity of the species being assessed. **Adaptive capacity** is defined as "a measure of the ability of a species to adapt to the impacts of climate change or other hazards." The steps to complete this table are:

1. Enter the species and timescale being assessed at the top of the table. If assessing adaptive capacity independently for different climate hazards, include the hazard being assessed in addition to the species.
2. In the *Intrinsic Factors* section, complete the *Adaptive Capacity* column by assigning a value between 1 (very low) and 5 (very high) for each factor. These values correspond to the level at which this factor contributes to the adaptive capacity of the species being assessed. In the same column, assign a confidence level from 1 (low) to 3 (high) that you have in each assessment of adaptive capacity.
3. In the row labeled *Intrinsic Factor Average*, record the average of the adaptive capacity scores assigned to the intrinsic factors.
4. In the *Extrinsic Factors* section, complete the *Adaptive Capacity* column by assigning a value between 1 (very low) and 5 (very high) for each factor. These values correspond to the level at which this factor contributes to the adaptive capacity of the species being assessed. In the same column, assign a confidence level from 1 (low) to 3 (high) that you have in each assessment of adaptive capacity.
5. In the row labeled *Extrinsic Factor Average*, record the average of the adaptive capacity scores assigned to the extrinsic factors.
6. In the row labeled *Overall Adaptive Capacity*, calculate the average of the intrinsic factor average and the extrinsic factor average by adding these scores together and dividing by two. Record this value in the cell.
7. Transfer the assigned overall adaptive capacity value to the appropriate cell of the *Adaptive Capacity* column in the **Primary Table**. If adaptive capacity was not assessed independently for each climate hazard, this value will be the same for each cell in the column.

Figures

Potential Impact Exposure →					
Sensitivity↓	*Very Low (1)*	*Low (2)*	*Medium (3)*	*High (4)*	*Very High (5)*
Very Low (1)	Very Low (1)	Very Low (1)	Low (2)	Medium (3)	Medium (3)
Low (2)	Very Low (1)	Low (2)	Low (2)	Medium (3)	High (4)
Medium (3)	Low (2)	Low (2)	Medium (3)	High (4)	High (4)
High (4)	Low (2)	Medium (3)	High (4)	High (4)	Very High (5)
Very High (5)	Medium (3)	Medium (3)	High (4)	Very High (5)	Very High (5)

Figure 1: Matrix used to calculate Potential Impact. The Potential Impact score corresponds to the cell where the assessed Exposure and Sensitivity scores intersect.

Vulnerability Potential Impact →					
Adaptive Capacity ↓	*Very Low (1)*	*Low (2)*	*Medium (3)*	*High (4)*	*Very High (5)*
Very Low (1)	Medium (3)	Medium (3)	High (4)	Very High (5)	Very High (5)
Low (2)	Low (2)	Medium (3)	High (4)	High (4)	Very High (5)
Medium (3)	Low (2)	Low (2)	Medium (3)	High (4)	High (4)
High (4)	Very Low (1)	Low (2)	Low (2)	Medium (3)	High (4)
Very High (5)	Very Low (1)	Very Low (1)	Low (2)	Medium (3)	Medium (3)

Figure 2: Matrix used to calculate Vulnerability. The Vulnerability score corresponds to the cell where the assessed Potential Impact and Adaptive Capacity scores intersect.

Primary Table

Species: **Timescale:**

Climate hazard	Observed or projected direction and magnitude of change in hazard	Impacts of hazard on resource	Exposure	Sensitivity (from sensitivity table)	Potential Impact	Adaptive Capacity (adaptive capacity table)	Vulnerability (list key drivers)
		Average/Overall					

Sensitivity Table

Species: **Timescale:**

Non-climate hazard	Impacts of hazard on resource	Will climate change make impact of hazard better or worse?	Combined impact of non-climate hazard and climate hazards (list below)		
Sensitivity: (transfer to column 5 of Primary Table)					

Adaptive Capacity Table

Species (and hazard if applicable): **Timescale:**

Intrinsic Factors	Adaptive Capacity	Rationale
Extent, Distribution, & Connectivity		
Dispersal		
Phenotypic and Behavioral Plasticity		
Genetic Diversity		
Generalist/Specialist ranking		
Other:		
Other:		
Intrinsic Factor Average:		

Extrinsic Factors	Adaptive Capacity	Rationale
MPA Organizational Capacity	---	----
Staff Capacity (training, time)		
Responsiveness		
Community/Stakeholder Relationships		
Stability/Longevity of MPA		
Other:		
Management Potential	---	----
Existing Mandate		
Resource Value/Importance		
Monitoring & Evaluation Capacity		
Ability to Learn and Change		
Proactive Management		
Partner Relationships		
Science/Technical Support		
Other:		
Extrinsic Factor Average:		

Overall Adaptive Capacity (Average of Intrinsic and Extrinsic Factor Averages):	

Limited Climate Vulnerability Assessment Habitat Assessment Worksheet

This worksheet is designed to be consistent with the Office of National Marine Sanctuaries Marine Protected Area Climate Vulnerability Assessment Guide.

Adapted from: CEC 2017. North American Marine Protected Area Rapid Vulnerability Assessment Tool. Montreal, Canada: Commission for Environmental Cooperation. 30 pp.

Habitat and Hazard Selection

The first step in your limited vulnerability assessment is to define the scope of the assessment. This includes selecting the timescale over which you will be assessing the vulnerability of your focal resources, the habitats you will be assessing throughout the assessment and/or using this worksheet, and the climate and non-climate hazards (up to three of each) that affect your habitats and which you will assess. If you require guidance in addition to that which is included in this worksheet, please see the Office of National Marine Sanctuaries Marine Protected Area Climate Vulnerability Assessment Guide.

Record the timeframe of the assessment below. Remember to also record this timeframe in the appropriate location within tables throughout the worksheet.

Timeframe of Assessment:

Record the habitats that are being assessed during this assessment and/or using this worksheet. If recording all habitats being assessed during the assessment, it is recommended that you note which habitats is/are being assessed using this worksheet. Remember to also record the habitat being assessed in the appropriate location within tables throughout the worksheet

Habitats Being Assessed:

Using the **Hazards Selection Table** on the next page (page 3), select the climate and non-climate hazards being assessed using this worksheet. First, list the habitat being assessed using this worksheet. Then select up to three climate hazards that are expected to affect the habitat over the timeframe being assessed, and up to three non-climate hazards that currently affect the habitat being assessed. These hazards will be transferred to appropriate locations on subsequent tables throughout the worksheet.

Hazard Selection Table

Habitat:

Climate Hazards	Selected Hazards
Warming Water Temperatures	
Ocean Acidification	
Deoxygenation/Decreasing Oxygen Levels	
Sea Level Rise	
Altered Precipitation	
Altered Currents	
Altered Upwelling/Mixing (incl. Stratification)	
Changing Salinity	
Changing Turbidity	
Changing Wave Action	
Increasing Coastal Erosion	
Changing Storm Frequency and/or Severity	
Harmful Algal Blooms (HABs)	
Changing Large-Scale Climate Processes (e.g. ENSO, PDO)	
Other:	

Non-Climate Hazards	Selected Hazards
Nutrient Pollution	
Terrestrial Non-Nutrient Pollution	
Marine-Sourced Pollution and Spills	
Coastal Development/Population Growth	
Commercial Harvest	
Non-Commercial Harvest	
Tourism and/or Recreation	
Aquaculture	
Disease	
Invasive Species	
Transportation/Shipping	
Oil, Mineral, and Gas Extraction	
Energy Production (e.g. offshore wind, wave energy, etc.)	
Ocean Noise	
Coastal Armoring	
In-Water Structures	
Dredging	
Boat/Ship Grounding	
Changes to Sediment Transport	
Researcher Disturbance	
Carbon Dioxide Removal Infrastructure	
Other:	

Conducting the Assessment

To assess vulnerability, you will complete a number of tables included on the following pages. Instructions for completing these tables are included below.

Primary Table

The **Primary Table**, included on page 8, is used to both assess exposure, and to collate the information gathered from other tables in one location for the final assessment of vulnerability. The steps to complete this table are:

1. Enter the habitat and timescale being assessed at the top of the table.
2. In the *Climate hazard* column, list the climate hazards selected in the **Hazards Selection Table**.
3. In the *Observed or projected direction and magnitude of change in hazard* column, describe how each climate hazard is projected to change in the area being assessed over the timeframe being assessed.
4. In the *Impacts of hazard on resource* column, describe the anticipated effects of each climate hazard on the habitat being assessed.
5. In the *Exposure* column, use the information you know about the habitat and hazards to assign a degree of exposure to the climate hazard that the habitat is likely to experience over the time period being assessed. **Exposure** is defined as "the measure of how much change in climate or another environmental hazard the habitat is likely to experience". Assign the degree of exposure using a value of 1 (very low) to 5 (very high). Also assign the confidence level from 1 (low) to 3 (high) that you have in this assessment of exposure.
6. In the row labeled *Overall/Average*, calculate the overall exposure of the habitat being assessed by taking the average of the values recorded in the *Exposure* column.
7. Complete the **Sensitivity Table** (instructions on page 5).
8. In the *Sensitivity* column, record the sensitivity value assigned to each climate hazard using the **Sensitivity Table** in the corresponding row of this column.
9. In the row labeled *Overall/Average*, calculate the overall sensitivity of the habitat being assessed by taking the average of the values recorded in the S*ensitivity* column.
10. Calculate the **potential impact** that each climate hazard is likely to have on the habitat being assessed by using Figure 1 (page 7) and the assessed values for exposure and sensitivity. Record this value in the appropriate cell of the *Potential Impact* column.
11. In the row labeled *Overall/Average*, calculate the overall potential impact the habitat being assessed is likely to experience by taking the average of the values recorded in the *Potential Impact* column.
12. Complete the **Adaptive Capacity Table** (instructions on page 6).
13. In the *Adaptive Capacity* column, record the overall adaptive capacity value assigned to each climate hazard using the **Adaptive Capacity Table** in the corresponding row of

this column. If adaptive capacity was not assessed independently for each climate hazard, this value will be the same for each cell in this column.

14. In the row labeled *Overall/Average*, calculate the overall adaptive capacity of the habitat being assessed by taking the average of the values recorded in the *Adaptive Capacity* column.

15. Calculate the **vulnerability** that the habitat has to each climate hazard by using Figure 2 (page 7) and the assessed values for potential impact and adaptive capacity. Record this value in the appropriate cell of the *Vulnerability* column.

16. In the row labeled *Overall/Average*, calculate the overall vulnerability of the assessed habitat. This score can be calculated in one of two ways. The first method is to take the average of the vulnerability scores assessed for each hazard in the *Vulnerability* column. The second option is to use Figure 2 and the assessed overall/average values of potential impact and adaptive capacity found in the row labeled *Overall/Average*. Whichever method is chosen, use that same method for all resources assessed during the workshop. Ask the workshop/assessment organizers which method should be employed if such instructions were not provided.

Sensitivity Table

The **Sensitivity Table**, included on page 9, is used to assess the sensitivity of the habitat being assessed to the combined impacts of the climate and non-climate hazards being assessed. **Sensitivity** is defined as "a measure of whether and how a habitat is likely to be affected by a given change in climate or another environmental hazard." The steps to complete this table are:

1. Enter the habitat and timescale being assessed at the top of the table.

2. Enter the climate hazards being assessed in the appropriate cells within the three columns under the label *Combined impact of non-climate hazard and climate hazards*.

3. In the *Non-climate hazard* column, list the non-climate hazards selected in the **Hazards Selection Table**.

4. In the *Impacts of hazard on resource* column, describe the current effects of each non-climate hazard on the habitat being assessed.

5. In the *Will climate change make impact of hazard better or worse?* column, describe if climate change is expected to make the effects of these non-climate hazards on the habitat being assessed better (less problematic), worse (more problematic), or have no effect.

6. In each of the cells of the three sub-columns under the *Will climate change make impact of hazard better or worse?* column, describe the combined effects of each climate and non-climate hazard on the habitat being assessed.

7. For each climate hazard, in the bottom row of the table (labeled *Sensitivity*) assign a sensitivity of the habitat to each the climate hazards being assessed in the corresponding column for that hazard. This assessment should take into consideration the combined effects of the climate hazard and each of the non-climate hazards on the habitat being assessed. Assign the degree of sensitivity using a value of 1 (very low) to 5 (very high).

Also assign the confidence level from 1 (low) to 3 (high) that you have in this assessment of sensitivity.

8. Transfer the assigned sensitivity value for each climate hazard to the appropriate cell of the *Sensitivity* column in the **Primary Table**.

Adaptive Capacity Table

The **Adaptive Capacity Table**, included on page 10, is used to assess both the intrinsic and extrinsic factors that affect the adaptive capacity of the habitat being assessed. **Adaptive capacity** is defined as "a measure of the ability of a habitat to adapt to the impacts of climate change or other hazards." The steps to complete this table are:

1. Enter the habitat and timescale being assessed at the top of the table. If assessing adaptive capacity independently for different climate hazards, include the hazard being assessed in addition to the habitat.
2. In the *Intrinsic Factors* section, complete the *Adaptive Capacity* column by assigning a value between 1 (very low) and 5 (very high) for each factor. These values correspond to the level at which this factor contributes to the adaptive capacity of the habitat being assessed. In the same column, assign a confidence level from 1 (low) to 3 (high) that you have in each assessment of adaptive capacity.
3. In the row labeled *Intrinsic Factor Average*, record the average of the adaptive capacity scores assigned to the intrinsic factors.
4. In the *Extrinsic Factors* section, complete the *Adaptive Capacity* column by assigning a value between 1 (very low) and 5 (very high) for each factor. These values correspond to the level at which this factor contributes to the adaptive capacity of the habitat being assessed. In the same column, assign a confidence level from 1 (low) to 3 (high) that you have in each assessment of adaptive capacity.
5. In the row labeled *Extrinsic Factor Average*, record the average of the adaptive capacity scores assigned to the extrinsic factors.
6. In the row labeled *Overall Adaptive Capacity*, calculate the average of the intrinsic factor average and the extrinsic factor average by adding these scores together and dividing by two. Record this value in the cell.
7. Transfer the assigned overall adaptive capacity value to the appropriate cell of the *Adaptive Capacity* column in the **Primary Table**. If adaptive capacity was not assessed independently for each climate hazard, this value will be the same for each cell in the column.

Figures

Potential Impact Exposure →					
Sensitivity↓	*Very Low (1)*	*Low (2)*	*Medium (3)*	*High (4)*	*Very High (5)*
Very Low (1)	Very Low (1)	Very Low (1)	Low (2)	Medium (3)	Medium (3)
Low (2)	Very Low (1)	Low (2)	Low (2)	Medium (3)	High (4)
Medium (3)	Low (2)	Low (2)	Medium (3)	High (4)	High (4)
High (4)	Low (2)	Medium (3)	High (4)	High (4)	Very High (5)
Very High (5)	Medium (3)	Medium (3)	High (4)	Very High (5)	Very High (5)

Figure 2: Matrix used to calculate Potential Impact. The Potential Impact score corresponds to the cell where the assessed Exposure and Sensitivity scores intersect.

Vulnerability Potential Impact →					
Adaptive Capacity ↓	*Very Low (1)*	*Low (2)*	*Medium (3)*	*High (4)*	*Very High (5)*
Very Low (1)	Medium (3)	Medium (3)	High (4)	Very High (5)	Very High (5)
Low (2)	Low (2)	Medium (3)	High (4)	High (4)	Very High (5)
Medium (3)	Low (2)	Low (2)	Medium (3)	High (4)	High (4)
High (4)	Very Low (1)	Low (2)	Low (2)	Medium (3)	High (4)
Very High (5)	Very Low (1)	Very Low (1)	Low (2)	Medium (3)	Medium (3)

Figure 2: Matrix used to calculate Vulnerability. The Vulnerability score corresponds to the cell where the assessed Potential Impact and Adaptive Capacity scores intersect.

Primary Table

Habitat: **Timescale:**

Climate hazard	Observed or projected direction and magnitude of change in hazard	Impacts of hazard on resource	Exposure	Sensitivity (from sensitivity table)	Potential Impact	Adaptive Capacity (adaptive capacity table)	Vulnerability (list key drivers)
		Average/Overall					

Sensitivity Table

Habitat: **Timescale:**

Non-climate hazard	Impacts of hazard on resource	Will climate change make impact of hazard better or worse?	Combined impact of non-climate hazard and climate hazards (list below)		
Sensitivity: (transfer to column 5 of Primary Table)					

Adaptive Capacity Table

Habitat (and hazard if applicable): **Timescale:**

Intrinsic Factors	Adaptive Capacity	Rationale
Extent, Distribution, & Connectivity		
Recovery from Past Extremes		
Physical Diversity		
Biodiversity		
Status of Key Species		
Other:		
Other:		
Intrinsic Factor Average:		

Extrinsic Factors	Adaptive Capacity	Rationale
MPA Organizational Capacity	---	----
Staff Capacity (training, time)		
Responsiveness		
Community/Stakeholder Relationships		
Stability/Longevity of MPA		
Other:		
Management Potential	---	----
Existing Mandate		
Resource Value/Importance		
Monitoring & Evaluation Capacity		
Ability to Learn and Change		
Proactive Management		
Partner Relationships		
Science/Technical Support		
Other:		
Extrinsic Factor Average:		

Overall Adaptive Capacity (Average of Intrinsic and Extrinsic Factor Averages):	

Limited Climate Vulnerability Assessment Ecosystem Service Assessment Worksheet

This worksheet is designed to be consistent with the Office of National Marine Sanctuaries Marine Protected Area Climate Vulnerability Assessment Guide.

Adapted from: CEC 2017. North American Marine Protected Area Rapid Vulnerability Assessment Tool. Montreal, Canada: Commission for Environmental Cooperation. 30 pp.

Ecosystem Service and Hazard Selection

The first step in your limited vulnerability assessment is to define the scope of the assessment. This includes selecting the timescale over which you will be assessing the vulnerability of your focal resources, the ecosystem services you will be assessing throughout the assessment and/or using this worksheet, and the climate and non-climate hazards (up to three of each) that affect your ecosystem services and which you will assess. If you require guidance in addition to that which is included in this worksheet, please see the Office of National Marine Sanctuaries Marine Protected Area Climate Vulnerability Assessment Guide.

Record the timeframe of the assessment below. Remember to also record this timeframe in the appropriate location within tables throughout the worksheet.

Timeframe of Assessment:

Record the ecosystem services that are being assessed during this assessment and/or using this worksheet. If recording all ecosystem services being assessed during the assessment, it is recommended that you note which ecosystem services is/are being assessed using this worksheet. Remember to also record the ecosystem service being assessed in the appropriate location within tables throughout the worksheet

Ecosystem Services Being Assessed:

Using the **Hazards Selection Table** on the next page (page 3), select the climate and non-climate hazards being assessed using this worksheet. First, list the ecosystem service being assessed using this worksheet. Then select up to three climate hazards that are expected to affect the ecosystem service over the timeframe being assessed, and up to three non-climate hazards that currently affect the ecosystem service being assessed. These hazards will be transferred to appropriate locations on subsequent tables throughout the worksheet.

Hazard Selection Table

Ecosystem Service:

Climate Hazards	Selected Hazards
Warming Water Temperatures	
Ocean Acidification	
Deoxygenation/Decreasing Oxygen Levels	
Sea Level Rise	
Altered Precipitation	
Altered Currents	
Altered Upwelling/Mixing (incl. Stratification)	
Changing Salinity	
Changing Turbidity	
Changing Wave Action	
Increasing Coastal Erosion	
Changing Storm Frequency and/or Severity	
Harmful Algal Blooms (HABs)	
Changing Large-Scale Climate Processes (e.g. ENSO, PDO)	
Other:	

Non-Climate Hazards	Selected Hazards
Nutrient Pollution	
Terrestrial Non-Nutrient Pollution	
Marine-Sourced Pollution and Spills	
Coastal Development/Population Growth	
Commercial Harvest	
Non-Commercial Harvest	
Tourism and/or Recreation	
Aquaculture	
Disease	
Invasive Species	
Transportation/Shipping	
Oil, Mineral, and Gas Extraction	
Energy Production (e.g. offshore wind, wave energy, etc.)	
Ocean Noise	
Coastal Armoring	
In-Water Structures	
Dredging	
Boat/Ship Grounding	
Changes to Sediment Transport	
Researcher Disturbance	
Carbon Dioxide Removal Infrastructure	
Other:	

Conducting the Assessment

To assess vulnerability, you will complete a number of tables included on the following pages. Instructions for completing these tables are included below.

Primary Table

The **Primary Table**, included on page 8, is used to both assess exposure, and to collate the information gathered from other tables in one location for the final assessment of vulnerability. The steps to complete this table are:

1. Enter the ecosystem service and timescale being assessed at the top of the table.
2. In the *Climate hazard* column, list the climate hazards selected in the **Hazards Selection Table**.
3. In the *Observed or projected direction and magnitude of change in hazard* column, describe how each climate hazard is projected to change in the area being assessed over the timeframe being assessed.
4. In the *Impacts of hazard on resource* column, describe the anticipated effects of each climate hazard on the ecosystem service being assessed.
5. In the *Exposure* column, use the information you know about the ecosystem service and hazards to assign a degree of exposure to the climate hazard that the ecosystem service is likely to experience over the time period being assessed. **Exposure** is defined as "the measure of how much change in climate or another environmental hazard the ecosystem service is likely to experience". Assign the degree of exposure using a value of 1 (very low) to 5 (very high). Also assign the confidence level from 1 (low) to 3 (high) that you have in this assessment of exposure.
6. In the row labeled *Overall/Average*, calculate the overall exposure of the ecosystem service being assessed by taking the average of the values recorded in the *Exposure* column.
7. Complete the **Sensitivity Table** (instructions on page 5).
8. In the *Sensitivity* column, record the sensitivity value assigned to each climate hazard using the **Sensitivity Table** in the corresponding row of this column.
9. In the row labeled *Overall/Average*, calculate the overall sensitivity of the ecosystem service being assessed by taking the average of the values recorded in the *Sensitivity* column.
10. Calculate the **potential impact** that each climate hazard is likely to have on the ecosystem service being assessed by using Figure 1 (page 7) and the assessed values for exposure and sensitivity. Record this value in the appropriate cell of the *Potential Impact* column.
11. In the row labeled *Overall/Average*, calculate the overall potential impact the ecosystem service being assessed is likely to experience by taking the average of the values recorded in the *Potential Impact* column.

12. Complete the **Adaptive Capacity Table** (instructions on page 6).
13. In the *Adaptive Capacity* column, record the overall adaptive capacity value assigned to each climate hazard using the **Adaptive Capacity Table** in the corresponding row of this column. If adaptive capacity was not assessed independently for each climate hazard, this value will be the same for each cell in this column.
14. In the row labeled *Overall/Average*, calculate the overall adaptive capacity of the ecosystem service being assessed by taking the average of the values recorded in the *Adaptive Capacity* column.
15. Calculate the **vulnerability** that the ecosystem service has to each climate hazard by using Figure 2 (page 7) and the assessed values for potential impact and adaptive capacity. Record this value in the appropriate cell of the *Vulnerability* column.
16. In the row labeled *Overall/Average*, calculate the overall vulnerability of the assessed ecosystem service. This score can be calculated in one of two ways. The first method is to take the average of the vulnerability scores assessed for each hazard in the *Vulnerability* column. The second option is to use Figure 2 and the assessed overall/average values of potential impact and adaptive capacity found in the row labeled *Overall/Average*. Whichever method is chosen, use that same method for all resources assessed during the workshop. Ask the workshop/assessment organizers which method should be employed if such instructions were not provided.

Sensitivity Table

The **Sensitivity Table**, included on page 9, is used to assess the sensitivity of the ecosystem service being assessed to the combined impacts of the climate and non-climate hazards being assessed. **Sensitivity** is defined as "a measure of whether and how an ecosystem service is likely to be affected by a given change in climate or another environmental hazard." The steps to complete this table are:

1. Enter the ecosystem service and timescale being assessed at the top of the table.
2. Enter the climate hazards being assessed in the appropriate cells within the three columns under the label *Combined impact of non-climate hazard and climate hazards*.
3. In the *Non-climate hazard* column, list the non-climate hazards selected in the **Hazards Selection Table**.
4. In the *Impacts of hazard on resource* column, describe the current effects of each non-climate hazard on the ecosystem service being assessed.
5. In the *Will climate change make impact of hazard better or worse?* column, describe if climate change is expected to make the effects of these non-climate hazards on the ecosystem service being assessed better (less problematic), worse (more problematic), or have no effect.
6. In each of the cells of the three sub-columns under the *Will climate change make impact of hazard better or worse?* column, describe the combined effects of each climate and non-climate hazard on the ecosystem service being assessed.

7. For each climate hazard, in the bottom row of the table (labeled Sensitivity) assign a sensitivity of the ecosystem service to each the climate hazards being assessed in the corresponding column for that hazard. This assessment should take into consideration the combined effects of the climate hazard and each of the non-climate hazards on the ecosystem service being assessed. Assign the degree of sensitivity using a value of 1 (very low) to 5 (very high). Also assign the confidence level from 1 (low) to 3 (high) that you have in this assessment of sensitivity.

8. Transfer the assigned sensitivity value for each climate hazard to the appropriate cell of the *Sensitivity* column in the **Primary Table**.

Adaptive Capacity Table

The **Adaptive Capacity Table**, included on page 10, is used to assess both the intrinsic and extrinsic factors that affect the adaptive capacity of the ecosystem service being assessed. **Adaptive capacity** is defined as "a measure of the ability of an ecosystem service to adapt to the impacts of climate change or other hazards." The steps to complete this table are:

1. Enter the ecosystem service and timescale being assessed at the top of the table. If assessing adaptive capacity independently for different climate hazards, include the hazard being assessed in addition to the ecosystem service.

2. In the *Intrinsic Factors* section, complete the *Adaptive Capacity* column by assigning a value between 1 (very low) and 5 (very high) for each factor. These values correspond to the level at which this factor contributes to the adaptive capacity of the ecosystem service being assessed. In the same column, assign a confidence level from 1 (low) to 3 (high) that you have in each assessment of adaptive capacity.

3. In the row labeled *Intrinsic Factor Average*, record the average of the adaptive capacity scores assigned to the intrinsic factors.

4. In the *Extrinsic Factors* section, complete the *Adaptive Capacity* column by assigning a value between 1 (very low) and 5 (very high) for each factor. These values correspond to the level at which this factor contributes to the adaptive capacity of the ecosystem service being assessed. In the same column, assign a confidence level from 1 (low) to 3 (high) that you have in each assessment of adaptive capacity.

5. In the row labeled *Extrinsic Factor Average*, record the average of the adaptive capacity scores assigned to the extrinsic factors.

6. In the row labeled *Overall Adaptive Capacity*, calculate the average of the intrinsic factor average and the extrinsic factor average by adding these scores together and dividing by two. Record this value in the cell.

7. Transfer the assigned overall adaptive capacity value to the appropriate cell of the *Adaptive Capacity* column in the **Primary Table**. If adaptive capacity was not assessed independently for each climate hazard, this value will be the same for each cell in the column.

Figures

Potential Impact
Exposure →

Sensitivity↓	*Very Low (1)*	*Low (2)*	*Medium (3)*	*High (4)*	*Very High (5)*
Very Low (1)	Very Low (1)	Very Low (1)	Low (2)	Medium (3)	Medium (3)
Low (2)	Very Low (1)	Low (2)	Low (2)	Medium (3)	High (4)
Medium (3)	Low (2)	Low (2)	Medium (3)	High (4)	High (4)
High (4)	Low (2)	Medium (3)	High (4)	High (4)	Very High (5)
Very High (5)	Medium (3)	Medium (3)	High (4)	Very High (5)	Very High (5)

Figure 3: Matrix used to calculate Potential Impact. The Potential Impact score corresponds to the cell where the assessed Exposure and Sensitivity scores intersect.

Vulnerability
Potential Impact →

Adaptive Capacity ↓	*Very Low (1)*	*Low (2)*	*Medium (3)*	*High (4)*	*Very High (5)*
Very Low (1)	Medium (3)	Medium (3)	High (4)	Very High (5)	Very High (5)
Low (2)	Low (2)	Medium (3)	High (4)	High (4)	Very High (5)
Medium (3)	Low (2)	Low (2)	Medium (3)	High (4)	High (4)
High (4)	Very Low (1)	Low (2)	Low (2)	Medium (3)	High (4)
Very High (5)	Very Low (1)	Very Low (1)	Low (2)	Medium (3)	Medium (3)

Figure 2: Matrix used to calculate Vulnerability. The Vulnerability score corresponds to the cell where the assessed Potential Impact and Adaptive Capacity scores intersect.

Primary Table

Ecosystem Service: **Timescale:**

Climate hazard	Observed or projected direction and magnitude of change in hazard	Impacts of hazard on resource	Exposure	Sensitivity (from sensitivity table)	Potential Impact	Adaptive Capacity (adaptive capacity table)	Vulnerability (list key drivers)
		Average/Overall					

Sensitivity Table

Ecosystem Service: **Timescale:**

Non-climate hazard	Impacts of hazard on resource	Will climate change make impact of hazard better or worse?	Combined impact of non-climate hazard and climate hazards (list below)		
Sensitivity: (transfer to column 5 of Primary Table)					

Adaptive Capacity Table

Ecosystem Service (and hazard if applicable): **Timescale:**

Intrinsic Factors	Adaptive Capacity	Rationale
Economic Importance/Value		
Socio-cultural Importance/Value		
Flexibility to Change		
Conflicts with Other Services		
Status of Key Species or Habitats		
Other:		
Other:		
Intrinsic Factor Average:		

Extrinsic Factors	Adaptive Capacity	Rationale
MPA Organizational Capacity	---	----
Staff Capacity (training, time)		
Responsiveness		
Community/Stakeholder Relationships		
Stability/Longevity of MPA		
Other:		
Management Potential	---	----
Existing Mandate		
Value/Importance of Key Resources		
Monitoring & Evaluation Capacity		
Ability to Learn and Change		
Proactive Management		
Partner Relationships		
Science/Technical Support		
Other:		
Extrinsic Factor Average:		

Overall Adaptive Capacity (Average of Intrinsic and Extrinsic Factor Averages):	

Limited Climate Vulnerability Assessment Heritage Resource Assessment Worksheet

This worksheet is designed to be consistent with the Office of National Marine Sanctuaries Marine Protected Area Climate Vulnerability Assessment Guide.

Adapted from: CEC 2017. North American Marine Protected Area Rapid Vulnerability Assessment Tool. Montreal, Canada: Commission for Environmental Cooperation. 30 pp.

Heritage Resource and Hazard Selection

The first step in your limited vulnerability assessment is to define the scope of the assessment. This includes selecting the timescale over which you will be assessing the vulnerability of your focal resources, the heritage resources you will be assessing throughout the assessment and/or using this worksheet, and the climate and non-climate hazards (up to three of each) that affect your heritage resources and which you will assess. If you require guidance in addition to that which is included in this worksheet, please see the Office of National Marine Sanctuaries Marine Protected Area Climate Vulnerability Assessment Guide.

Record the timeframe of the assessment below. Remember to also record this timeframe in the appropriate location within tables throughout the worksheet.

Timeframe of Assessment:

Record the heritage resources that are being assessed during this assessment and/or using this worksheet. If recording all heritage resources being assessed during the assessment, it is recommended that you note which heritage resources is/are being assessed using this worksheet. Remember to also record the heritage resource being assessed in the appropriate location within tables throughout the worksheet

Heritage Resources Being Assessed:

Using the **Hazards Selection Table** on the next page (page 3), select the climate and non-climate hazards being assessed using this worksheet. First, list the heritage resource being assessed using this worksheet. Then select up to three climate hazards that are expected to affect the heritage resource over the timeframe being assessed, and up to three non-climate hazards that currently affect the heritage resource being assessed. These hazards will be transferred to appropriate locations on subsequent tables throughout the worksheet.

Hazard Selection Table

Heritage Resource:

Climate Hazards	Selected Hazards
Warming Water Temperatures	
Ocean Acidification	
Deoxygenation/Decreasing Oxygen Levels	
Sea Level Rise	
Altered Precipitation	
Altered Currents	
Altered Upwelling/Mixing (incl. Stratification)	
Changing Salinity	
Changing Turbidity	
Changing Wave Action	
Increasing Coastal Erosion	
Changing Storm Frequency and/or Severity	
Harmful Algal Blooms (HABs)	
Changing Large-Scale Climate Processes (e.g. ENSO, PDO)	
Other:	

Non-Climate Hazards	Selected Hazards
Nutrient Pollution	
Terrestrial Non-Nutrient Pollution	
Marine-Sourced Pollution and Spills	
Coastal Development/Population Growth	
Commercial Harvest	
Non-Commercial Harvest	
Tourism and/or Recreation	
Aquaculture	
Disease	
Invasive Species	
Transportation/Shipping	
Oil, Mineral, and Gas Extraction	
Energy Production (e.g. offshore wind, wave energy, etc.)	
Ocean Noise	
Coastal Armoring	
In-Water Structures	
Dredging	
Boat/Ship Grounding	
Changes to Sediment Transport	
Researcher Disturbance	
Carbon Dioxide Removal Infrastructure	
Other:	

Conducting the Assessment

To assess vulnerability, you will complete a number of tables included on the following pages. Instructions for completing these tables are included below.

Primary Table

The **Primary Table**, included on page 8, is used to both assess exposure, and to collate the information gathered from other tables in one location for the final assessment of vulnerability. The steps to complete this table are:

1. Enter the heritage resource and timescale being assessed at the top of the table.
2. In the *Climate hazard* column, list the climate hazards selected in the **Hazards Selection Table**.
3. In the *Observed or projected direction and magnitude of change in hazard* column, describe how each climate hazard is projected to change in the area being assessed over the timeframe being assessed.
4. In the *Impacts of hazard on resource* column, describe the anticipated effects of each climate hazard on the heritage resource being assessed.
5. In the *Exposure* column, use the information you know about the heritage resource and hazards to assign a degree of exposure to the climate hazard that the heritage resource is likely to experience over the time period being assessed. **Exposure** is defined as "the measure of how much change in climate or another environmental hazard the heritage resource is likely to experience". Assign the degree of exposure using a value of 1 (very low) to 5 (very high). Also assign the confidence level from 1 (low) to 3 (high) that you have in this assessment of exposure.
6. In the row labeled *Overall/Average*, calculate the overall exposure of the heritage resource being assessed by taking the average of the values recorded in the *Exposure* column.
7. Complete the **Sensitivity Table** (instructions on page 5).
8. In the *Sensitivity* column, record the sensitivity value assigned to each climate hazard using the **Sensitivity Table** in the corresponding row of this column.
9. In the row labeled *Overall/Average*, calculate the overall sensitivity of the heritage resource being assessed by taking the average of the values recorded in the *Sensitivity* column.
10. Calculate the **potential impact** that each climate hazard is likely to have on the heritage resource being assessed by using Figure 1 (page 7) and the assessed values for exposure and sensitivity. Record this value in the appropriate cell of the *Potential Impact* column.
11. In the row labeled *Overall/Average*, calculate the overall potential impact the heritage resource being assessed is likely to experience by taking the average of the values recorded in the *Potential Impact* column.

12. Tangible heritage resources are not assessed for adaptive capacity. If assessing the vulnerability of a tangible heritage resource, skip the **Adaptive Capacity Table** and jump to number 16. If you are uncertain, ask the workshop/assessment organizers if you should assess the adaptive capacity of this resource. For more information on why the adaptive capacity of tangible heritage resources is not assessed, see the Office of National Marine Sanctuaries Marine Protected Area Climate Vulnerability Assessment Guide.
13. Complete the **Adaptive Capacity Table** (instructions on page 6).
14. In the *Adaptive Capacity* column, record the overall adaptive capacity value assigned to each climate hazard using the **Adaptive Capacity Table** in the corresponding row of this column. If adaptive capacity was not assessed independently for each climate hazard, this value will be the same for each cell in this column.
15. In the row labeled *Overall/Average*, calculate the overall adaptive capacity of the heritage resource assessed by taking the average of the values recorded in the *Adaptive Capacity* column.
16. Calculate the **vulnerability** that the heritage resource has to each climate hazard by using Figure 2 (page 7) and the assessed values for potential impact and adaptive capacity. Record this value in the appropriate cell of the *Vulnerability* column. If you did not assess the resource for adaptive capacity, use the previously calculated score for potential impact as the vulnerability of the heritage resource and do not continue to step 17.
17. In the row labeled *Overall/Average*, calculate the overall vulnerability of the assessed heritage resource. This score can be calculated in one of two ways. The first method is to take the average of the vulnerability scores assessed for each hazard in the *Vulnerability* column. The second option is to use Figure 2 and the assessed overall/average values of potential impact and adaptive capacity found in the row labeled *Overall/Average*. Whichever method is chosen, use that same method for all resources assessed during the workshop. Ask the workshop/assessment organizers which method should be employed if such instructions were not provided.

Sensitivity Table

The **Sensitivity Table**, included on page 9, is used to assess the sensitivity of the heritage resource being assessed to the combined impacts of the climate and non-climate hazards being assessed. **Sensitivity** is defined as "a measure of whether and how a heritage resource is likely to be affected by a given change in climate or another environmental hazard." The steps to complete this table are:

1. Enter the heritage resource and timescale being assessed at the top of the table.
2. Enter the climate hazards being assessed in the appropriate cells within the three columns under the label *Combined impact of non-climate hazard and climate hazards*.
3. In the *Non-climate hazard* column, list the non-climate hazards selected in the **Hazards Selection Table**.
4. In the *Impacts of hazard on resource* column, describe the current effects of each non-climate hazard on the heritage resource being assessed.

5. In the *Will climate change make impact of hazard better or worse?* column, describe if climate change is expected to make the effects of these non-climate hazards on the heritage resource being assessed better (less problematic), worse (more problematic), or have no effect.
6. In each of the cells of the three sub-columns under the *Will climate change make impact of hazard better or worse?* column, describe the combined effects of each climate and non-climate hazard on the heritage resource being assessed.
7. For each climate hazard, in the bottom row of the table (labeled Sensitivity) assign a sensitivity of the heritage resource to each the climate hazards being assessed in the corresponding column for that hazard. This assessment should take into consideration the combined effects of the climate hazard and each of the non-climate hazards on the heritage resource being assessed. Assign the degree of sensitivity using a value of 1 (very low) to 5 (very high). Also assign the confidence level from 1 (low) to 3 (high) that you have in this assessment of sensitivity.
8. Transfer the assigned sensitivity value for each climate hazard to the appropriate cell of the *Sensitivity* column in the **Primary Table**.

Adaptive Capacity Table

The **Adaptive Capacity Table**, included on page 10, is used to assess both the intrinsic and extrinsic factors that affect the adaptive capacity of the heritage resource being assessed. **Adaptive capacity** is defined as "a measure of the ability of a heritage resource to adapt to the impacts of climate change or other hazards." Tangible heritage resources are not assessed for adaptive capacity. If assessing the vulnerability of a tangible heritage resource, skip this table. If you are uncertain, ask the workshop/assessment organizers if you should assess the adaptive capacity of this resource. For more information on why the adaptive capacity of tangible heritage resources is not assessed, see the Office of National Marine Sanctuaries Marine Protected Area Climate Vulnerability Assessment Guide. The steps to complete this table are:

1. Enter the heritage resource and timescale being assessed at the top of the table. If assessing adaptive capacity independently for different climate hazards, include the hazard being assessed in addition to the heritage resource.
2. In the *Intrinsic Factors* section, complete the *Adaptive Capacity* column by assigning a value between 1 (very low) and 5 (very high) for each factor. These values correspond to the level at which this factor contributes to the adaptive capacity of the heritage resource being assessed. In the same column, assign a confidence level from 1 (low) to 3 (high) that you have in each assessment of adaptive capacity.
3. In the row labeled *Intrinsic Factor Average*, record the average of the adaptive capacity scores assigned to the intrinsic factors.
4. In the *Extrinsic Factors* section, complete the *Adaptive Capacity* column by assigning a value between 1 (very low) and 5 (very high) for each factor. These values correspond to the level at which this factor contributes to the adaptive capacity of the heritage resource being assessed. In the same column, assign a confidence level from 1 (low) to 3 (high) that you have in each assessment of adaptive capacity.

5. In the row labeled *Extrinsic Factor Average*, record the average of the adaptive capacity scores assigned to the extrinsic factors.
6. In the row labeled *Overall Adaptive Capacity*, calculate the average of the intrinsic factor average and the extrinsic factor average by adding these scores together and dividing by two. Record this value in the cell.
7. Transfer the assigned overall adaptive capacity value to the appropriate cell of the *Adaptive Capacity* column in the **Primary Table**. If adaptive capacity was not assessed independently for each climate hazard, this value will be the same for each cell in the column.

Figures

Potential Impact

Exposure →

Sensitivity↓	*Very Low (1)*	*Low (2)*	*Medium (3)*	*High (4)*	*Very High (5)*
Very Low (1)	Very Low (1)	Very Low (1)	Low (2)	Medium (3)	Medium (3)
Low (2)	Very Low (1)	Low (2)	Low (2)	Medium (3)	High (4)
Medium (3)	Low (2)	Low (2)	Medium (3)	High (4)	High (4)
High (4)	Low (2)	Medium (3)	High (4)	High (4)	Very High (5)
Very High (5)	Medium (3)	Medium (3)	High (4)	Very High (5)	Very High (5)

Figure 4: Matrix used to calculate Potential Impact. The Potential Impact score corresponds to the cell where the assessed Exposure and Sensitivity scores intersect.

Vulnerability

Potential Impact →

Adaptive Capacity ↓	*Very Low (1)*	*Low (2)*	*Medium (3)*	*High (4)*	*Very High (5)*
Very Low (1)	Medium (3)	Medium (3)	High (4)	Very High (5)	Very High (5)
Low (2)	Low (2)	Medium (3)	High (4)	High (4)	Very High (5)
Medium (3)	Low (2)	Low (2)	Medium (3)	High (4)	High (4)
High (4)	Very Low (1)	Low (2)	Low (2)	Medium (3)	High (4)
Very High (5)	Very Low (1)	Very Low (1)	Low (2)	Medium (3)	Medium (3)

Figure 2: Matrix used to calculate Vulnerability. The Vulnerability score corresponds to the cell where the assessed Potential Impact and Adaptive Capacity scores intersect.

Primary Table

Heritage Resource: **Timescale:**

Climate hazard	Observed or projected direction and magnitude of change in hazard	Impacts of hazard on resource	Exposure	Sensitivity (from sensitivity table)	Potential Impact	Adaptive Capacity (adaptive capacity table)	Vulnerability (list key drivers)
		Average/Overall					

Sensitivity Table

Heritage Resource: **Timescale:**

Non-climate hazard	Impacts of hazard on resource	Will climate change make impact of hazard better or worse?	Combined impact of non-climate hazard and climate hazards (list below)		
Sensitivity: (transfer to column 5 of Primary Table)					

Adaptive Capacity Table

Heritage Resource (and hazard if applicable): **Timescale:**

Intrinsic Factors	Adaptive Capacity	Rationale
Economic Importance/Value		
Socio-cultural Importance/Value		
Flexibility to Change		
Conflicts with Other Resources/Services		
Status of Key Species or Habitats		
Other:		
Other:		
Intrinsic Factor Average:		

Extrinsic Factors	Adaptive Capacity	Rationale
MPA Organizational Capacity	---	----
Staff Capacity (training, time)		
Responsiveness		
Community/Stakeholder Relationships		
Stability/Longevity of MPA		
Other:		
Management Potential	---	----
Existing Mandate		
Value/Importance of Key Resources		
Monitoring & Evaluation Capacity		
Ability to Learn and Change		
Proactive Management		
Partner Relationships		
Science/Technical Support		
Other:		
Extrinsic Factor Average:		

Overall Adaptive Capacity (Average of Intrinsic and Extrinsic Factor Averages):	

AA.5.3 Adaptation Action Development Worksheet

The adaptation action development worksheet below was adapted from the Commission for Environmental Cooperation North American Marine Protected Area Rapid Vulnerability Assessment Tool (CEC 2017). This worksheet is designed to be used with both extensive and limited scope CVAs.

Climate Vulnerability Assessment Adaptation Strategies Worksheet

This worksheet is designed to be consistent with the Office of National Marine Sanctuaries Marine Protected Area Climate Vulnerability Assessment Guide.

Adapted from: CEC 2017. North American Marine Protected Area Rapid Vulnerability Assessment Tool. Montreal, Canada: Commission for Environmental Cooperation. 30 pp.

Developing Adaptation Strategies

This worksheet is designed to help guide you through the process of developing possible adaptation strategies after completing a climate vulnerability assessment. It can be used with either a limited or extensive CVA. It is designed to help you *begin* thinking about adaptation strategies. As such, this worksheet should be seen as a first step in adaptation planning, not a final decision-making tool. For more guidance and advice on post-CVA adaptation planning, please see the Office of National Marine Sanctuaries Marine Protected Area Climate Vulnerability Assessment Guide.

Adaptation Strategy Development

Adaptation Strategy Development Table

The **Adaptation Strategy Development Table**, included on page 4, is designed to help you begin to think about possible adaptation actions. This can be seen as the "ideas" table. While filling it out, be creative. Feel free to include strategies that may seem outlandish or unreasonable alongside those that are common sense. The following table will help you narrow down adaptation strategies to those that are most feasible, but you might be surprised how discussing an idea that at first seems outlandish can lead to a creative, feasible solution. The steps to use this table are:

1. Enter the resource for which you are developing adaptation strategies at the top of the table.
2. Select factors that affect the vulnerability of the resource for which you would like to develop adaptation strategies. These vulnerabilities can be climate hazards, non-climate hazards, adaptive capacity factors, or any other factor that led to increased vulnerability during the assessment of this resource's vulnerability. Add the factor(s) for which you would like to develop adaptation strategies to the *Vulnerability to Address* column.
3. In the *Strategies* column, brainstorm and discuss adaptation strategies that could be implemented to address the vulnerability in the corresponding row. You can include multiple strategies in the same cell.
4. In the *Cost* column, rate the cost to implement each of the strategies described in the *Strategies* column as low (L), medium (M), or high (H).
5. In the *Efficacy* column, rate the potential efficacy of each of the strategies described in the *Strategies* column as low (L), medium (M), or high (H).

Adaptation Strategy Implementation Table

The **Adaptation Strategy Implementation Table**, included on page 5, is designed to help you narrow down and begin to further develop the adaptation actions brainstormed in the **Adaptation Strategy Development Table**. This can be seen as the "reality" table. In this table you will transfer your favorite or most promising adaptation strategies from the **Adaptation Strategy Development Table,** begin to assess how these strategies could be reasonably implemented, and begin to develop their implementation. The best strategies to transfer to this table are those that were rated as having a high or medium efficacy and a low or

medium cost. However, the final decision of strategies to assess is up to you. The steps to use this table are:

1. Enter the resource for which you are developing adaptation strategies at the top of the table.
2. In the *Strategy* column, list the adaptation strategies that you wish to implement. These should be strategies that you brainstormed in the **Adaptation Strategy Development Table**.
3. In the *Potential Partners* column, list the partners that will be important engage in the implementation and further development of the strategy being developed/assessed.
4. In the *Criteria for Monitoring and Evaluating* column, list criteria that will be important to track in order to understand if the strategy is performing successfully. It can also be useful to list thresholds that may trigger a particular action or reevaluation of the strategy.
5. In the *Funding* column, begin to brainstorm ways that you may be able to obtain funding to implement the strategy. Are there grants available? Partners? Fundraising? Other financing mechanisms? Essentially, how are you going to pay for this?
6. In the *Existing or needed management mechanisms* column, describe management mechanisms or policies that may facilitate the implementation of this strategy. You can also list changes that need to be made, or new policies that may need to be developed, in order to successfully implement the strategy.
7. In the *Timeline* column, describe how long it would take to implement this action.

Once you have completed the **Adaptation Strategy Implementation Table**, you should be able to identify adaptation strategies that are most favorable and realistic as well as ways to go about implementing those strategies. In this way, this adaptation strategy development exercise allows you to leverage the expertise of workshop participants to give you a head-start on adaptation planning. For more information and resources on adaptation planning, please see the Office of National Marine Sanctuaries Marine Protected Area Climate Vulnerability Assessment Guide.

Adaptation Strategy Development Table

Resource:

Vulnerability to Address	Strategies	Cost (H/M/L)	Efficacy (H/M/L)

Adaptation Strategy Implementation Table

Resource:

Strategy	Potential Partners	Criteria for Monitoring and Evaluating	Funding	Existing or needed management mechanisms	Timeline

Appendix B:
Additional Resources for National Marine Sanctuaries

AB.1 A Brief History of National Marine Sanctuary CVAs

The Office of National Marine Sanctuaries strongly encourages national marine sanctuaries to conduct climate vulnerability assessments to help inform the management of climate impacts. Understanding past CVAs, and reviewing their reports and processes, can be helpful in developing CVAs for other sanctuaries and MPAs. To date, seven national marine sanctuaries have completed CVAs. Below is a list of CVAs that have been conducted by national marine sanctuaries to date, as well as links to materials and reports associated with those CVAs where they are available.

Greater Farallones and Cordell Bank National Marine Sanctuaries completed a joint, extensive scope CVA in 2015. This CVA was the first of its kind in the national marine sanctuary system and assessed the vulnerability of 31 species and eight habitats to multiple climate and non-climate hazards. The sanctuaries plan to review and update this CVA in 2023, which will be the first time a national marine sanctuary has updated its CVA. More information about this CVA, including a copy of the CVA report, can be found here: https://sanctuaries.noaa.gov/science/conservation/vulnerability-assessment-gfnms.html

Papahānaumokuākea Marine National Monument completed an extensive scope CVA in 2016. This CVA assessed the vulnerability of nine ecosystems/habitats, 10 species/species assemblages, and four cultural/heritage resources to a range of climate and non-climate hazards. More information about this CVA, including a copy of the CVA report, can be found here: https://sanctuaries.noaa.gov/science/conservation/pmnm-climate-change.html

National Marine Sanctuary of American Samoa completed a limited scope CVA in 2017. This CVA assessed the vulnerability of two habitats, five species/species assemblages, and water quality to multiple climate and non-climate hazards. More information about this CVA, including a copy of the CVA report, can be found here: https://www.cakex.org/documents/rapid-vulnerability-assessment-and-adaptation-strategies-national-marine-sanctuary-and-territory-american-samoa

Gray's Reef National Marine Sanctuary completed a limited scope CVA in 2019. This CVA assessed the vulnerability of 11 species to multiple climate and non-climate drivers. More information about this CVA, including a copy of the CVA report, can be found here: https://sanctuaries.noaa.gov/science/conservation/2019-grnms-rapid-vulnerability-assessment.html

Olympic Coast National Marine Sanctuary completed an extensive scope CVA in 2022. This CVA assessed the vulnerability of 50 species/species assemblages, 6 habitats, 11 ecosystem services, and maritime heritage resources (as a group). A report is scheduled to be completed in 2023.

Flower Garden banks National Marine Sanctuary completed a limited scope CVA in 2022. This CVA assessed the vulnerability of 25 species/species assemblages and two habitats to multiple non-climate hazards and three climate hazards: warming water temperatures, ocean acidification, and changes in tropical storm and precipitation patterns and strength. A report is scheduled to be completed in 2023.

AB.2 How a CVA Fits in the ONMS Planning Process

National marine sanctuaries undergo a planning process that involves the evaluation of the status and trends of the resources under their stewardship, called a Condition Report, followed by a review and update to the sanctuary's Management Plan informed by the condition report. This Condition Report-Management Plan Review cycle occurs about every 10 years.

Through this process, a condition report assesses the current condition of resources by analyzing data and trends since the last condition report conducted by that site. While this is an incredibly useful process to inform management of these resources, it can create challenges for managing resources under climate change as past trends may not be representative of future conditions. However, a CVA helps managers assess the vulnerability of resources to future conditions, providing information that, combined with information obtained from the condition report process, can greatly enhance the ability to inform actions within the management plan that address both current and future threats (Figure A2). As such, Olympic Coast National Marine Sanctuary piloted a process whereby a CVA is conducted shortly after the condition report and before the management plan update. This process allows sanctuaries to leverage the information gained from the condition report to inform the CVA. Both processes are then used to inform a management plan review that is responsive to both current and future threats to resources.

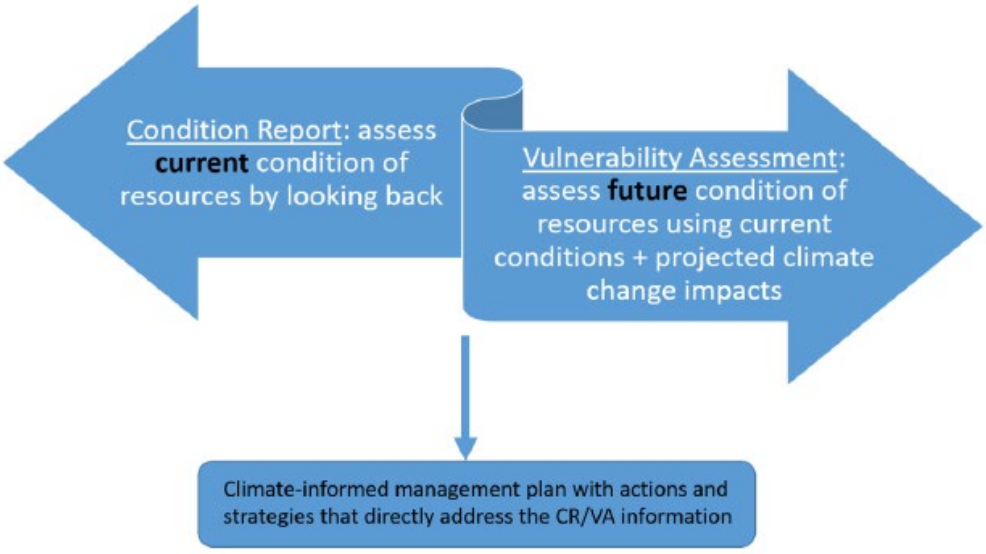

Figure A2. Visual representation of the role of a CVA within the ONMS Condition Report-Management Plan Update process. Image: NOAA

This process of integrating a CVA into the ONMS planning process (Figure A3) has proven effective and is being adopted by other sanctuaries including Flower Garden Banks, Greater Farallones, Cordell Bank, and others. However, while this strategy has proven effective, sanctuaries should not wait to conduct a CVA until the "ideal" time. National marine sanctuaries participate in this condition report-management plan cycle at different times. If it will be a number of years before a site is scheduled to complete its next condition report, it is still advisable to complete a CVA as soon as the resources are available. Even outside of the condition report-management plan cycle, a CVA can provide valuable information that guides management decisions critical to addressing the impacts of climate change on resources.

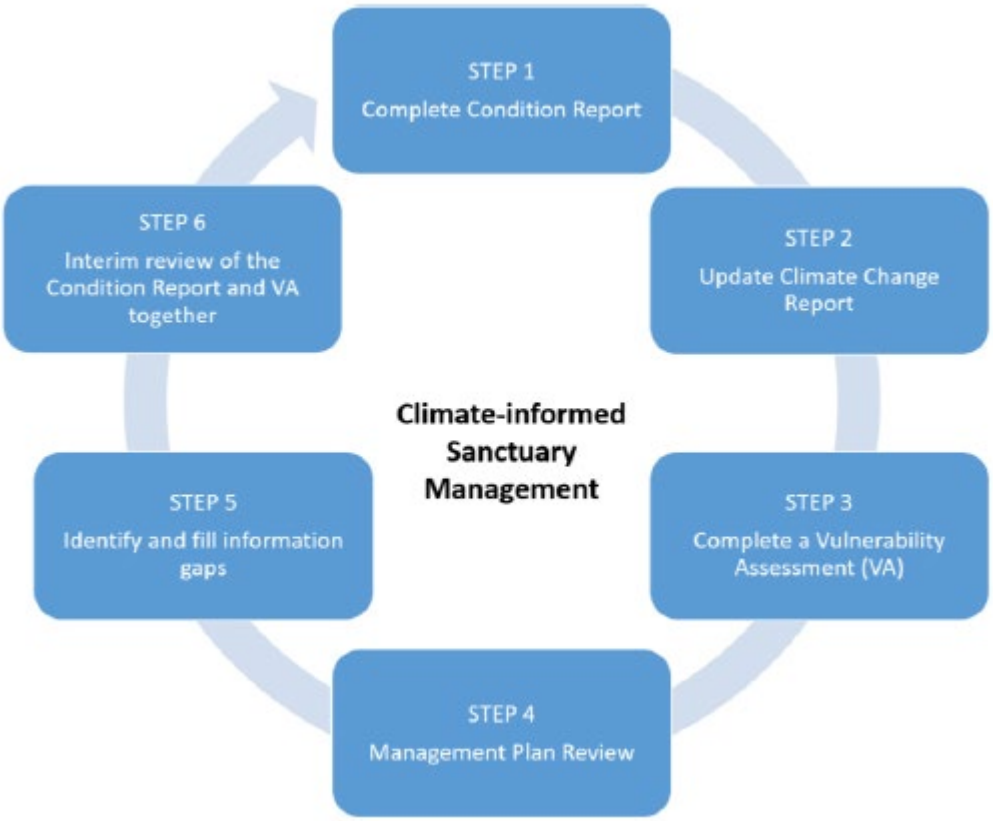

Figure A3. Visual representation of the cycle of climate-informed sanctuary management incorporating aspects of the ONMS planning process. Image: NOAA

NATIONAL MARINE
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AMERICA'S UNDERWATER TREASURES