Climate-Smart Adaptation for North-central California Coast and Ocean Habitats, Species, and Ecosystem Services

Gulf of the Farallones National Marine Sanctuary
Ocean Climate Initiative

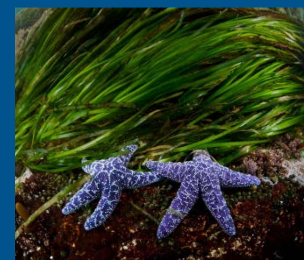
Sanctuary Advisory Council Meeting
February 25, 2015

Sara Hutto, Ocean Climate Initiative Specialist

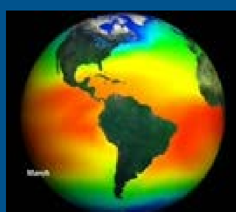
GFNMS Climate Smart Conservation

Integrating climate change….

mitigation



adaptation



science

communication

monitoring

….into sanctuary management

Climate-Smart Adaptation for the North-central California Coast and Ocean

Goal

Protect and maintain healthy ecosystems by enhancing the resilience of species, habitats and ecosystem services to the impacts of climate change through collaboratively developed adaptation actions that are feasible, effective, and nature-based.

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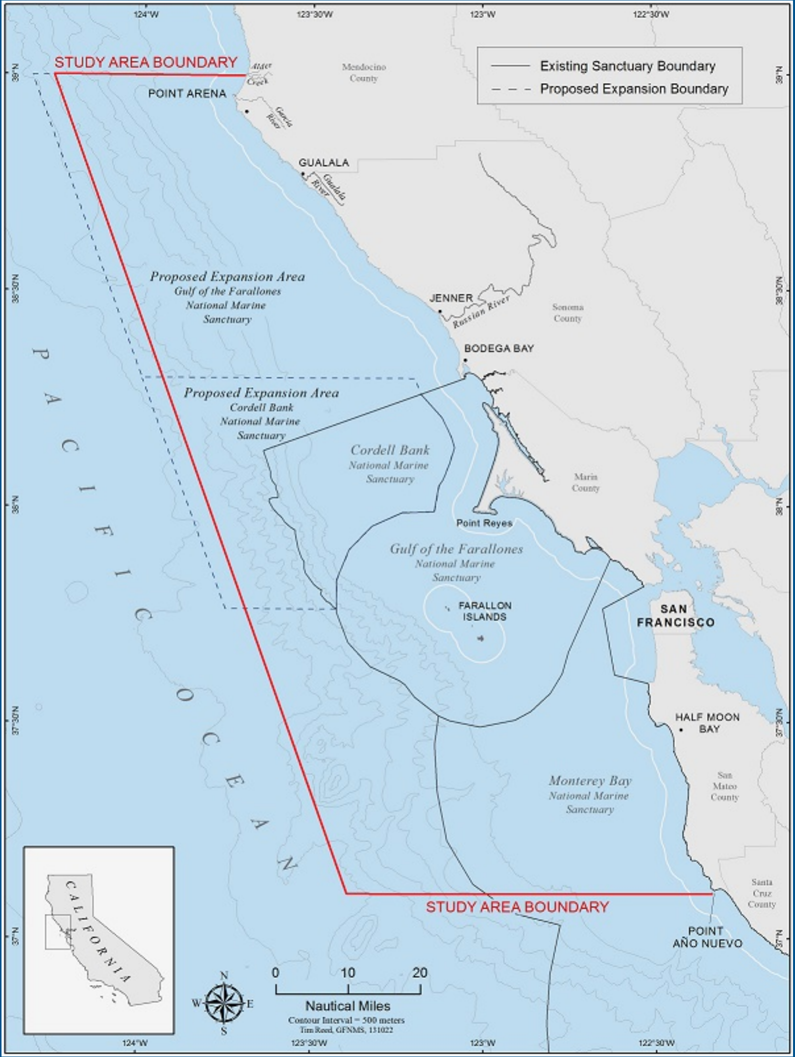
Geographic Scope

Año Nuevo, San Mateo County to Alder Creek, Mendocino County



Two Big Questions:

1. How vulnerable to climate change are the species, habitats, and ecosystem services that we manage? [Vulnerability Assessment]

2. What can we do to limit or reduce vulnerability? [Adaptation Planning]

Project Partners

FMSA
Farallones Marine Sanctuary Association

National Marine Sanctuaries
Gulf of the Farallones

Bay Area Ecosystems Climate Change Consortium

California Academy of Sciences

CA LCC

National Park Service

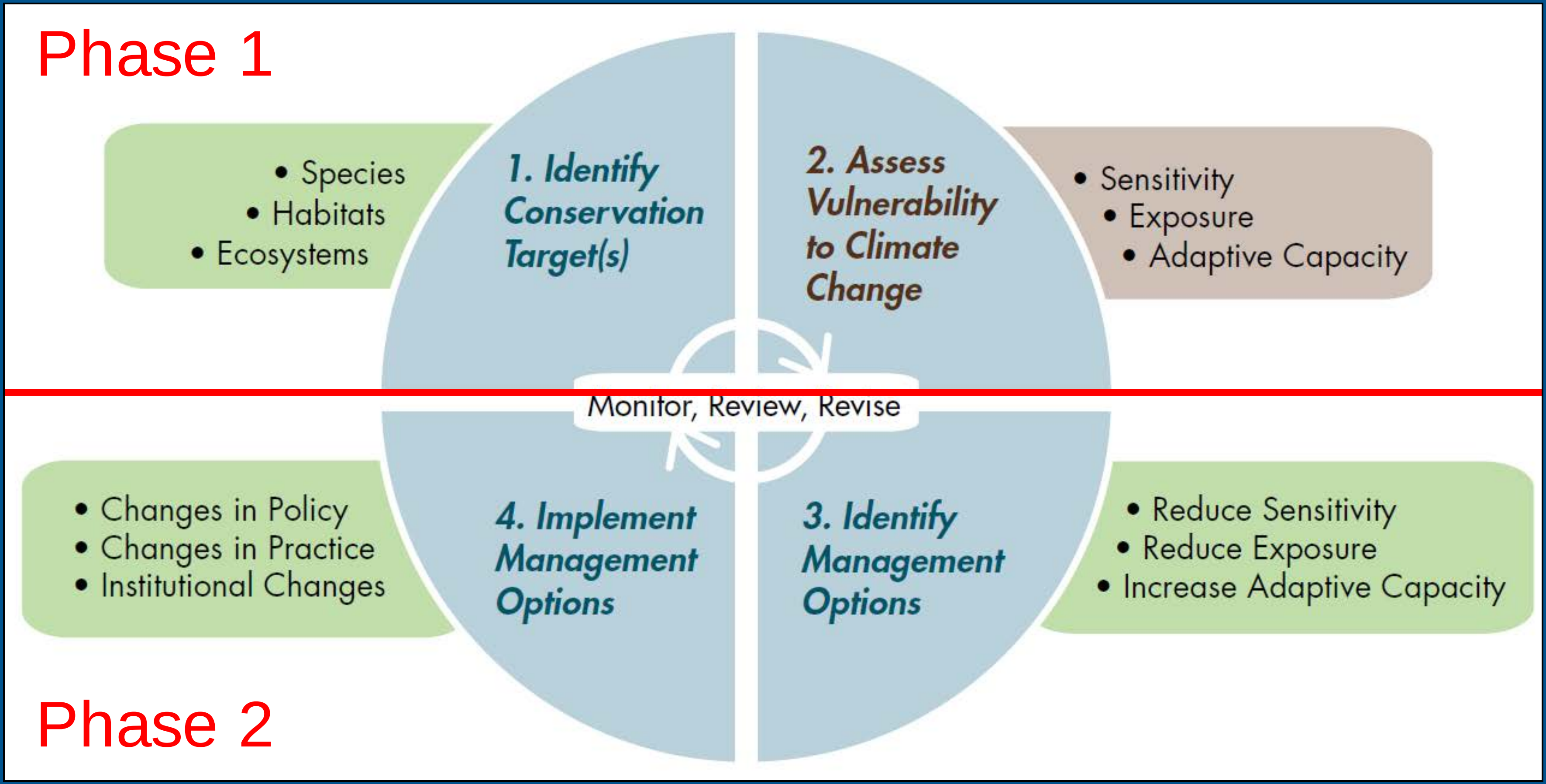
Point Blue Conservation Science

U.S. Fish & Wildlife Service
Department of the Interior

U.S. Department of the Interior
U.S. Fish and Wildlife Service
National Wildlife Refuge System

EcoAdapt™

Climate-Smart Adaptation Process

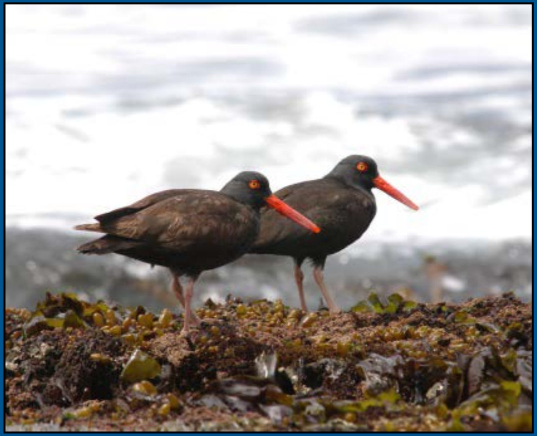


Glick et al. 2011 Scanning the Conservation Horizon

Phase 1: Vulnerability Assessment

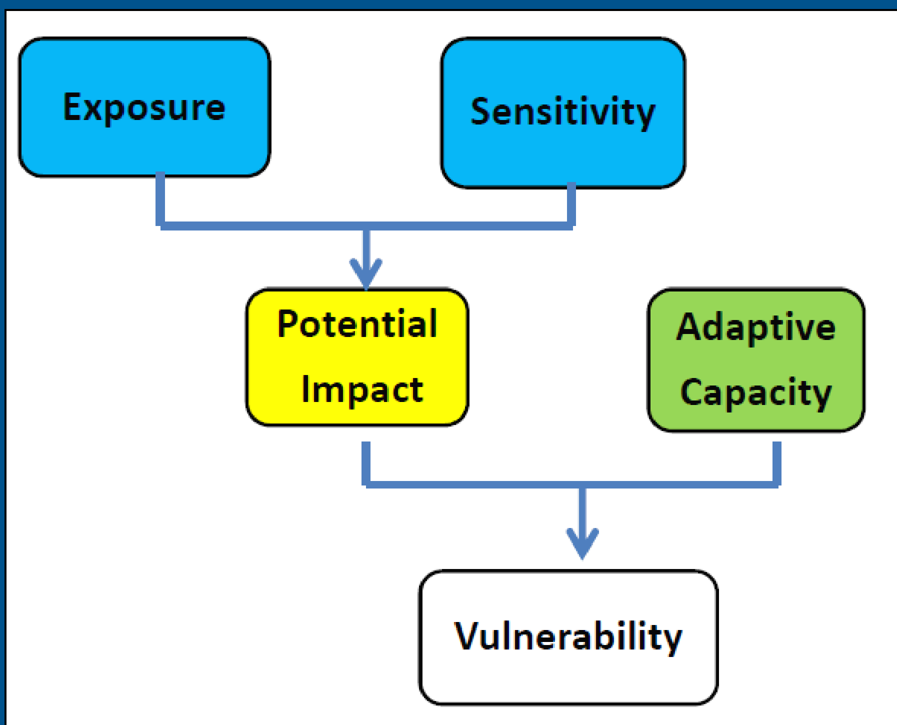
Two Decision-Support Workshops:

1. Define focal resources (11 Feb 2014)
2. Assess resource vulnerability (10-11 June 2014)



Defining Vulnerability

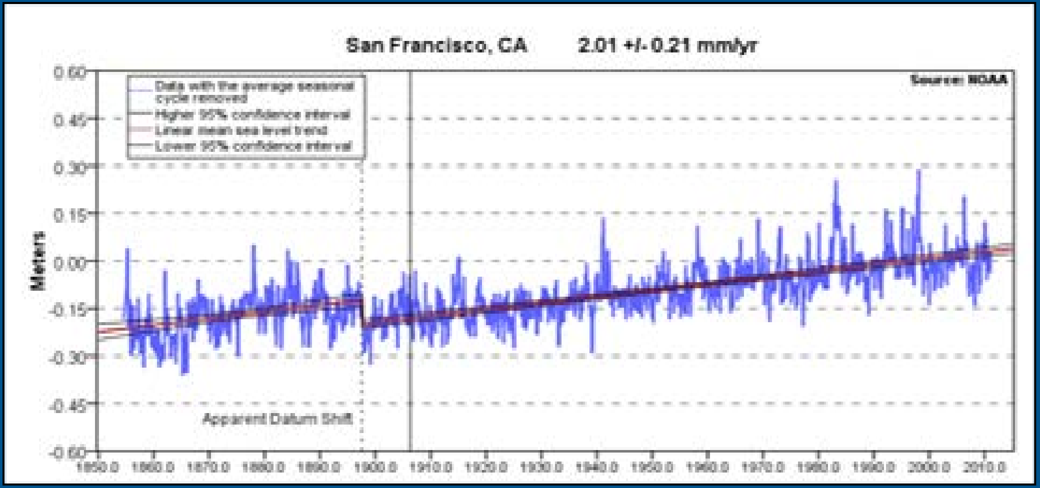
The extent to which a species, habitat or ecosystem service is susceptible to harm from climate change impacts

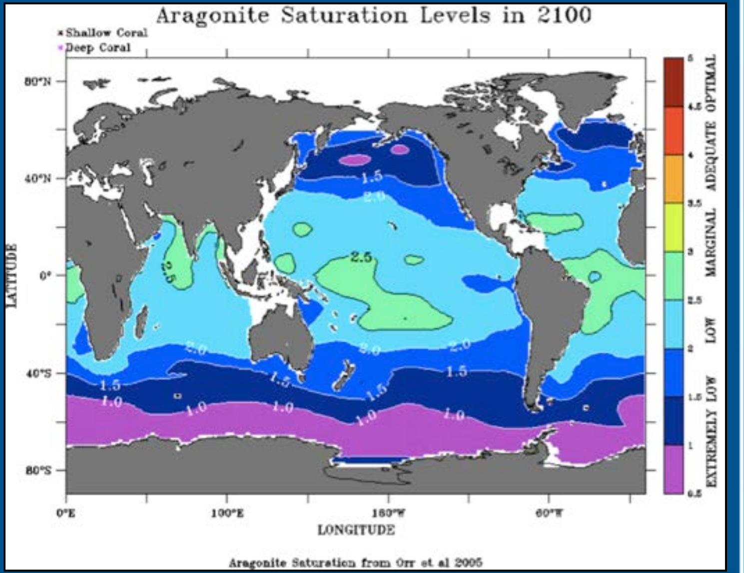


$$V = \frac{E*S}{AC}$$

Defining Vulnerability

<u>Exposure</u>: Measure of how much of a change in climate or other environmental factor a resource is likely to experience.





Defining Vulnerability

Sensitivity: Measure of whether and how a resource is likely to be affected by a given change in climate.

Factors to consider:

- ALL climate-related stressors
- Non-climate stressors
- Dependencies
- Life history

Defining Vulnerability

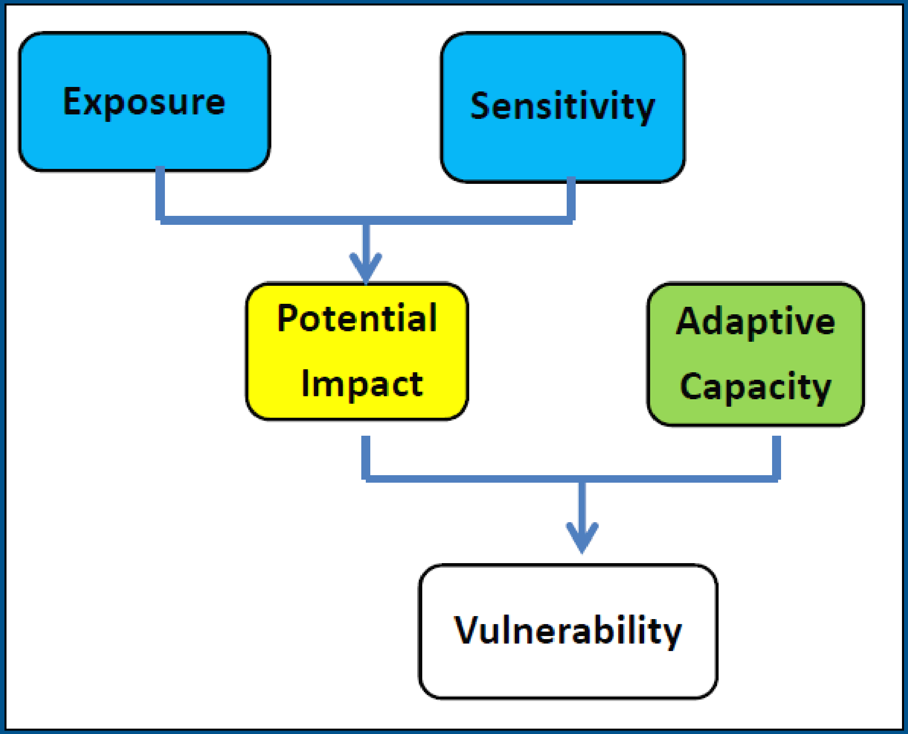
Adaptive Capacity: Ability to accommodate or cope with climate change impacts with minimal disruption.

Factors to consider:

- Extent, status, dispersal ability
- Population connectivity
- Diversity
- Value of resource
- Management potential

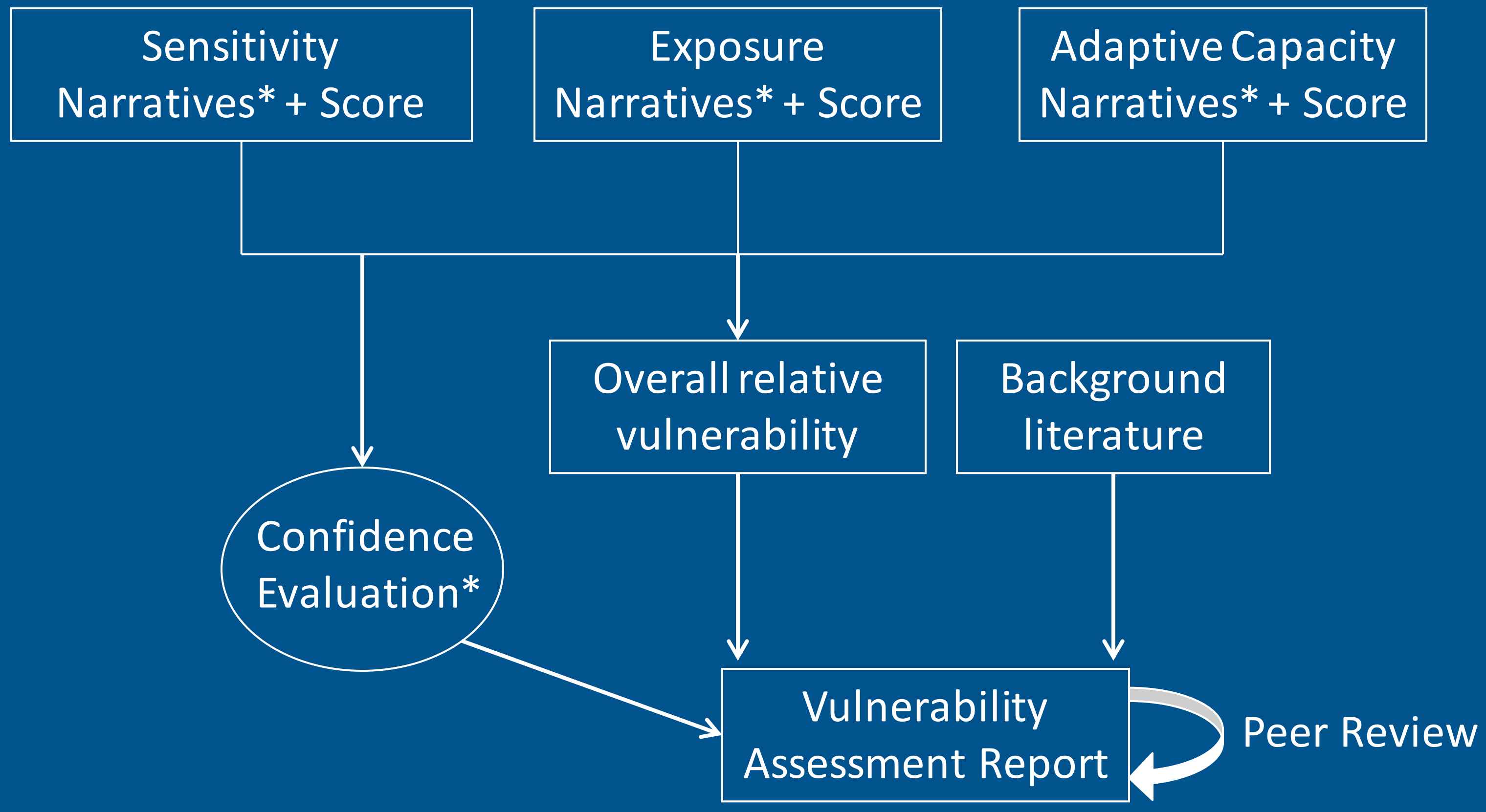
Defining Vulnerability

The extent to which a species, habitat or ecosystem service is susceptible to harm from climate change impacts



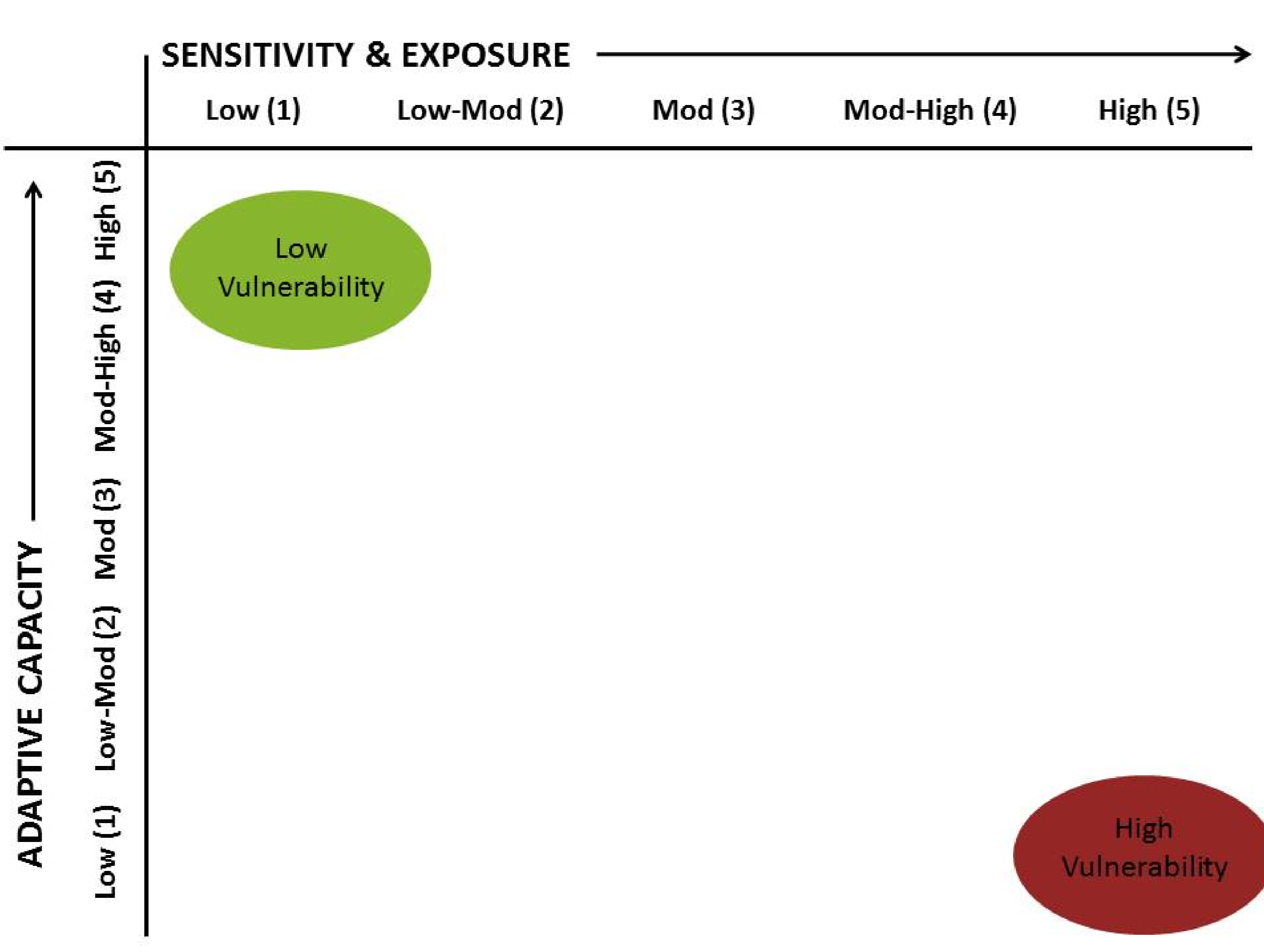
$$V = \frac{E*S}{AC}$$

Vulnerability Assessment Methods

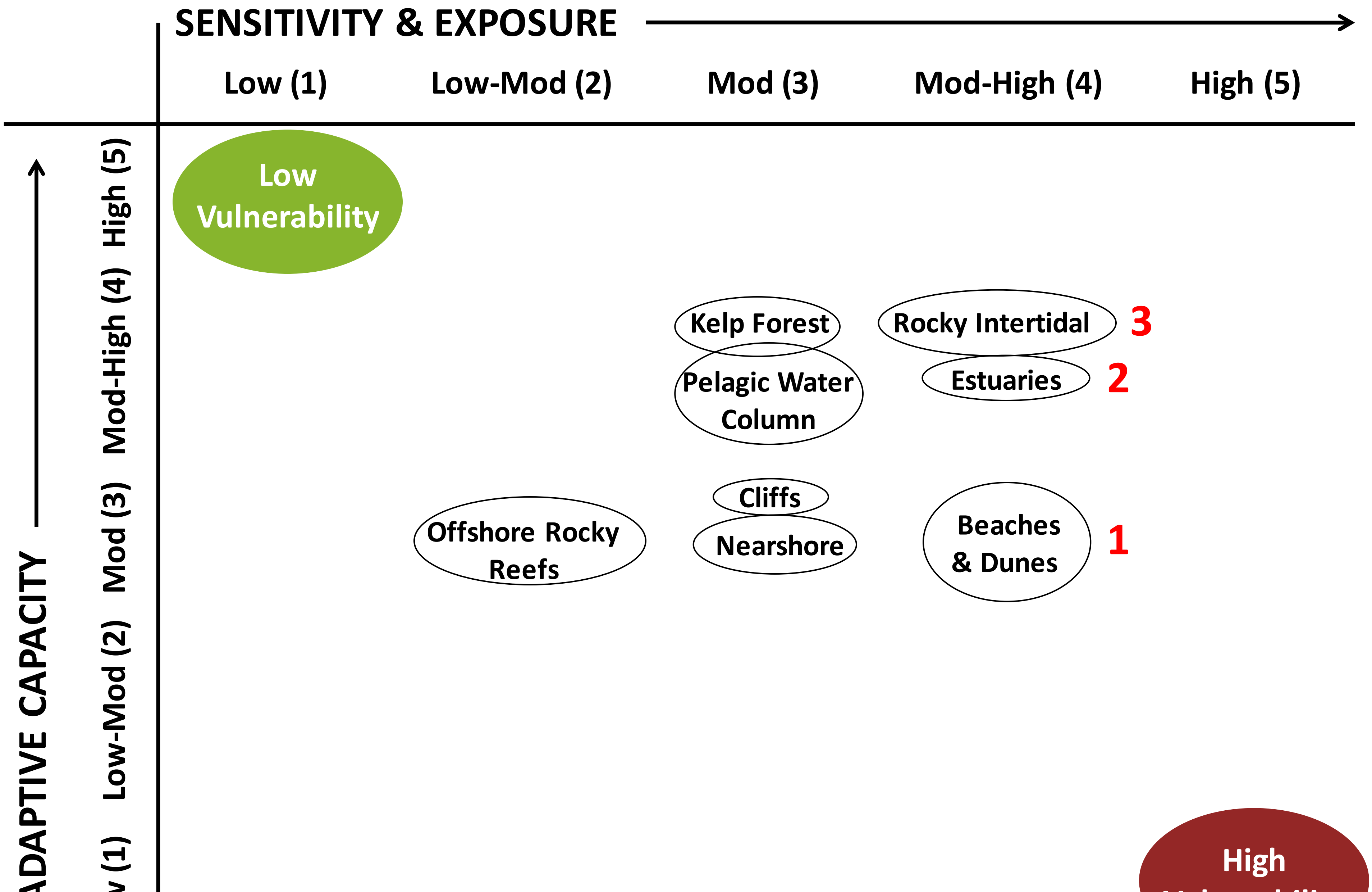


*documenting uncertainty

Relative Vulnerability

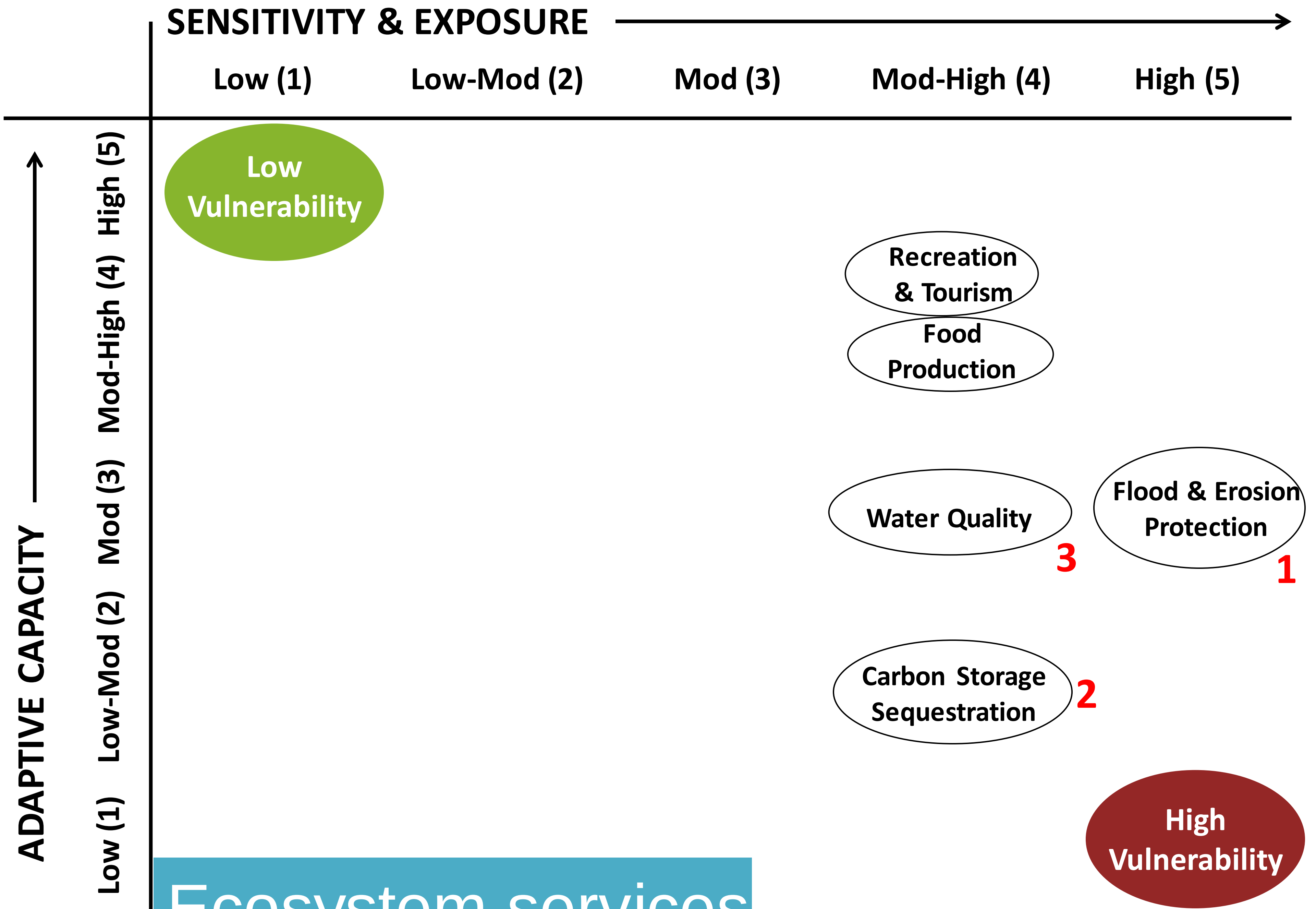


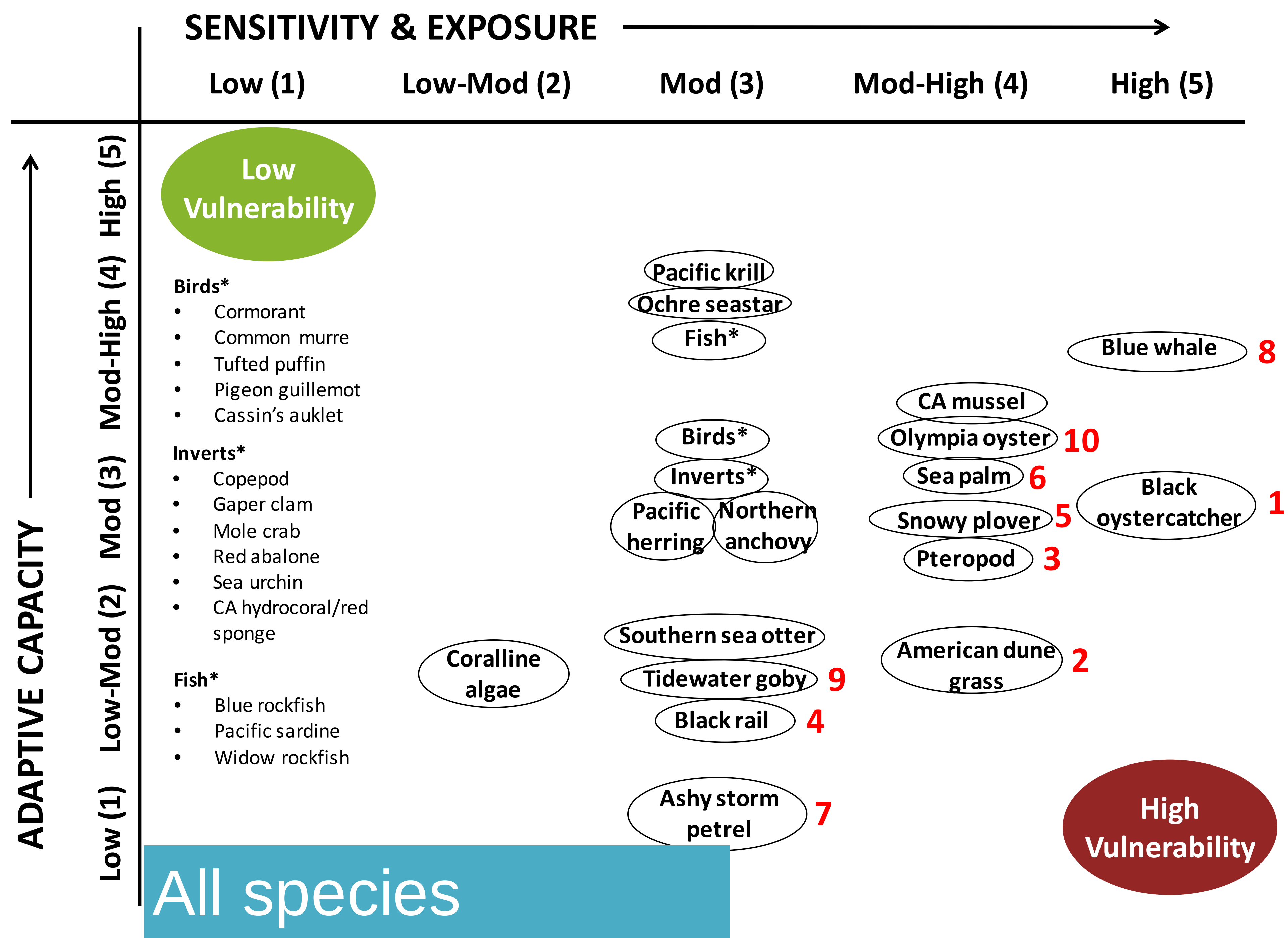
Habitats



SENSITIVITY & EXPOSURE
Low (1)
Low-Mod (2)
Mod (3)
Mod-High (4)
High (5)
ADAPTIVE CAPACITY
High (5)
Mod-High (4)
Mod (3)
Low-Mod (2)
Low (1)
Low Vulnerability
Kelp Forest
Rocky Intertidal
3
Pelagic Water Column
Estuaries
2
Cliffs
Offshore Rocky Reefs
Nearshore
Beaches & Dunes
1
High Vulnerability

Ecosystem services




SENSITIVITY & EXPOSURE
Low (1)
Low-Mod (2)
Mod (3)
Mod-High (4)
High (5)
ADAPTIVE CAPACITY
High (5)
Mod-High (4)
Mod (3)
Low-Mod (2)
Low (1)
Low Vulnerability
Birds*
• Cormorant
• Common murre
• Tufted puffin
• Pigeon guillemot
• Cassin's auklet
Inverts*
• Copepod
• Gaper clam
• Mole crab
• Red abalone
• Sea urchin
• CA hydrocoral/red sponge
Fish*
• Blue rockfish
• Pacific sardine
• Widow rockfish
Pacific krill
Ochre seastar
Fish*
Blue whale 8
CA mussel
Olympia oyster 10
Birds*
Inverts*
Sea palm 6
Black oystercatcher 1
Snowy plover 5
Pacific herring
Northern anchovy
Pteropod 3
Southern sea otter
American dune grass 2
Coralline algae
Tidewater goby 9
Black rail 4
Ashy storm petrel 7
High Vulnerability
All species

Climate-driven stressors

Most impactful (average sensitivity score):

1. Wave action
2. Coastal erosion
3. Salinity
4. pH
5. Dynamic ocean conditions (currents/mixing/stratification)

Most cited (# resources):

1. pH
2. Dynamic ocean conditions
3. Sea surface temperature

Non-climate stressors

Most impactful (average sensitivity score):

1. Roads/coastal armoring
2. Invasive/problematic species
3. Recreation
4. Pollution and poisons
5. Land use change

Most cited (# resources):

1. Pollution and poisons
2. Harvest
3. Invasive/problematic species

Marine Sanctuaries Conservation Series ONMS (succession number to be added by NMSP personnel)

Climate Change Vulnerability Assessment for the North-central California Coast and Ocean

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Ocean Service
Office of National Marine Sanctuaries

Insert Month Year

Blue Rockfish (*Sebastes mystinus*) [1]

Executive Summary

Blue Rockfish	Score	Confidence
Sensitivity	3 Moderate	3 High
Exposure	3 Moderate	3 High
Adaptive Capacity	4 Moderate-High	3 High
Vulnerability	3 Moderate	3 High

Blue rockfish is a medium-sized, midwater rockfish important in both the recreational and commercial catches in California, and is the most abundant rockfish in central California kelp forests (CDFG 2010). The species occurs from Alaska to Baja California, from surface waters to a maximum depth of 600 meters. Key climate sensitivities identified by workshop participants for the blue rockfish include dissolved oxygen, pH, salinity, and the Pacific Decadal Oscillation, and key non-climate sensitivities include harvest, energy production, and oil spills. Blue rockfish exhibit a transcontinental geographic extent and a stable, continuous population that is at abundant levels. The species has a relatively high dispersal capability for both the larval and adult stages, and exhibits relatively moderate-high diversity in life history strategies, genetics, and phenotypic/behavioral plasticity. The societal value for blue rockfish is moderate-high due to its value for harvest, recreational diving and tourism, but managers may have difficulty in managing this species due to the inability to control the impacts expected from climate change, which will likely outweigh any manageable impacts such as harvest and pollution.

Sensitivity

I. Sensitivity to climate and climate driven changes

Climate and climate-driven changes identified (score[2], confidence[3]): dissolved oxygen (DO) levels (5, high), ocean pH (4, low), salinity (4, moderate), Pacific Decadal Oscillation (PDO) (4, high), sea surface temperature (3, moderate), dynamic ocean conditions (currents/mixing/stratification) (2, moderate-high)

Climate and climate-driven changes that may benefit the species: sea surface temperature
Description of benefit: Increased sea surface temperatures may promote more jellyfish production, which are prey for blue rockfish, increasing food supplies. Increasing sea surface temperatures may also result in increased distribution of blue rockfish.

Overall species sensitivity to climate and climate-driven factors: Moderate-High

- Confidence of workshop participants: Moderate

Supporting literature

[1] Refer to the "Introduction to Assessment Summaries" section for an explanation of the format, layout and content of this summary report.
[2] For scoring methodology, see methods section. Factors were scored on a scale of 1-5, with 5 indicating high sensitivity and 1 indicating low sensitivity.
[3] Confidence level indicated by workshop participants.

including enhanced warming of surface waters, increased rainfall, erosion and r
reduced upwelling (Largier et al. 2010). Seabird diet studies have shown a decr
availability of juvenile rockfish during warm (positive) PDO periods (Miller and S
and reduced fecundity of female rockfish (as well as reduced growth rate) was c
changes in ocean circulation and temperature, likely a result of reduced food su
2005).

II. Sensitivity to disturbance regimes

Disturbance regimes identified: disease and storms

Overall species sensitivity to disturbance regimes: Moderate-High

- Confidence of workshop participants: High

Additional participant comments

Storms may cause loss of prime habitat (kelp forests) which will impact blue roc
recruitment and survival, and increase turbulence that exacerbates kelp dislodg
sedimentation that may reduce the recovery of storm-damaged forests.

Supporting literature

Disease

Disease is projected to increase with warming water temperatures, due to enha
development and survival, as well as host susceptibility (Harvell et al. 2002). Bl
no known diseases, but may be indirectly impacted by disease through their de
kelp forest habitat.

III. Dependencies

Species dependence on one or more sensitive habitat types: Moderate-High

- Confidence of workshop participants: High
- Sensitive habitats species is dependent upon: kelp forest and nearshore

Species dependence on specific prey or forage species: Low-Moderate

- Confidence of workshop participants: High

Other critical dependencies: oceanographic conditions

- Degree of dependence: Low-Moderate
- Confidence of workshop participants: High

Spectrum of species (1=generalist; 5=specialist): 3

- Confidence of workshop participants: High

Additional participant comments

Blue rockfish are dependent on productive oceanographic conditions, including
cool surface waters for reproductive success. This species does not recruit well
upwelling and during El Niño events.

Blue Rockfish – Overview of Vulnerability Component Evaluations

Overall Vulnerability Ranking[1]: 3 Moderate **Overall Confidence[2]: 3 High**

SENSITIVITY

Sensitivity Factor	Sensitivity Evaluation	Confidence
Sensitivities to Climate & Climate-Driven Changes • Sea surface temperature • Salinity • Oxygen • pH • Dynamic ocean conditions (currents/mixing/stratification) • Other: Pacific Decadal Oscillation	**Overall: 4 Moderate-High** • **3 Moderate** • **4 Moderate-High** • **5 High** • **4 Moderate-High** • **2 Low-Moderate** • **4 Moderate-High**	**Overall: 2 Moderate** • **2 Moderate** • **2 Moderate** • **3 High** • **1 Low** • **2.5 Moderate** • **3 High**
Disturbance Regimes • Storms • Disease	**Overall: 4 Moderate-High**	**Overall: 3 High**

Dependencies
• Dependence on sensitive habitat types
  ○ Kelp forest
  ○ Nearshore
• Dependence on specific prey or forage species
• Other dependencies
  ○ Lack of successful reproduction in El Nino years
  ○ Lack of recruitment with poor upwelling
• Generalist or specialist?
	Overall: 3 Moderate
	
	• **4 Moderate-High**
	• **4 Moderate-High**
	• **2 Low-Moderate**
	
	• **2 Low-Moderate**
	• **2 Low-Moderate**
	• **3 (Both generalist and specialist characteristics)**
		Overall: 3 High
		
		• **3 High**
		• **3 High**
		
		• **3 High**
		• **3 High**
		• **3 High**
		• **3 High**

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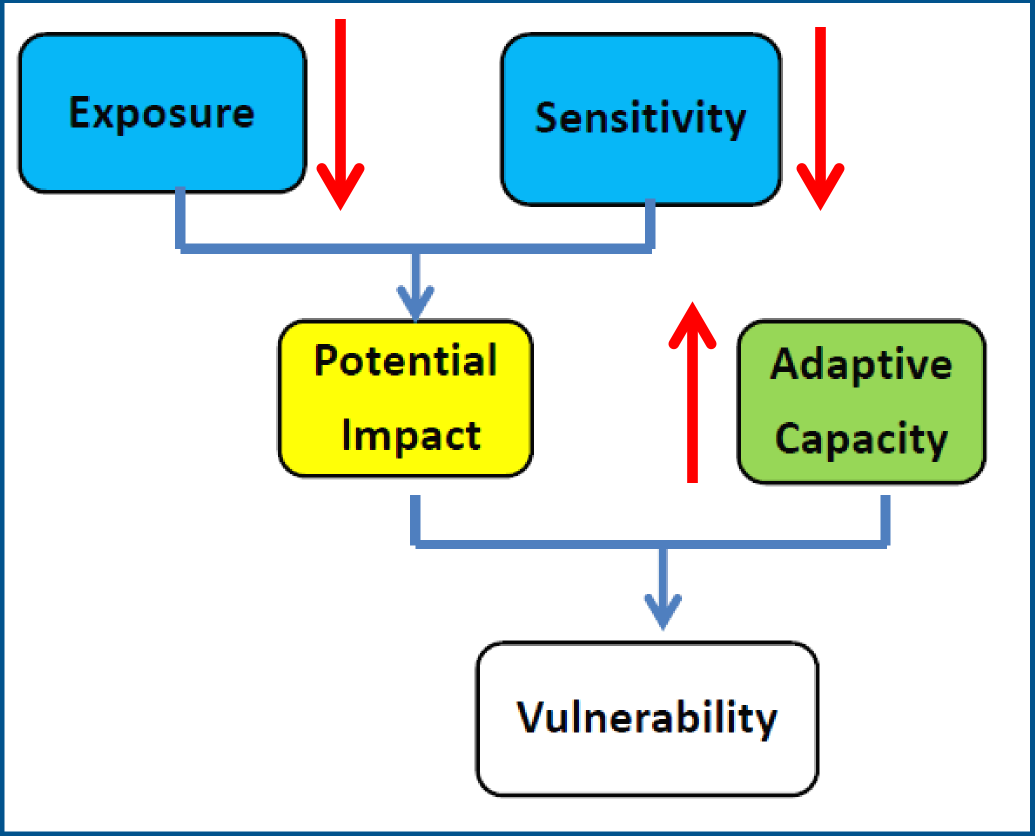
[1] Overall vulnerability is calculated according to the following formula: Vulnerability = Sensitivity * Exposure * (1/Adaptive Capacity).
[2] Overall confidence is an average of the overall averaged confidences for sensitivity, exposure, and adaptive capacity.

Phase 2: Adaptation Planning

Use assessment results to develop management strategies that will:



Climate-Smart Adaptation Working Group

Members:

Federal: USFWS, GFNMS, CA LCC, GGNRA, PRNS, NMFS, BLM, USGS

State: Coastal Commission, CalTrans, CDFW

Local: San Mateo and Marin Counties

NGOs: Point Blue, EcoAdapt, BAECCC

Academia: City College of SF, Bodega Marine Lab, Stanford University

Meetings:

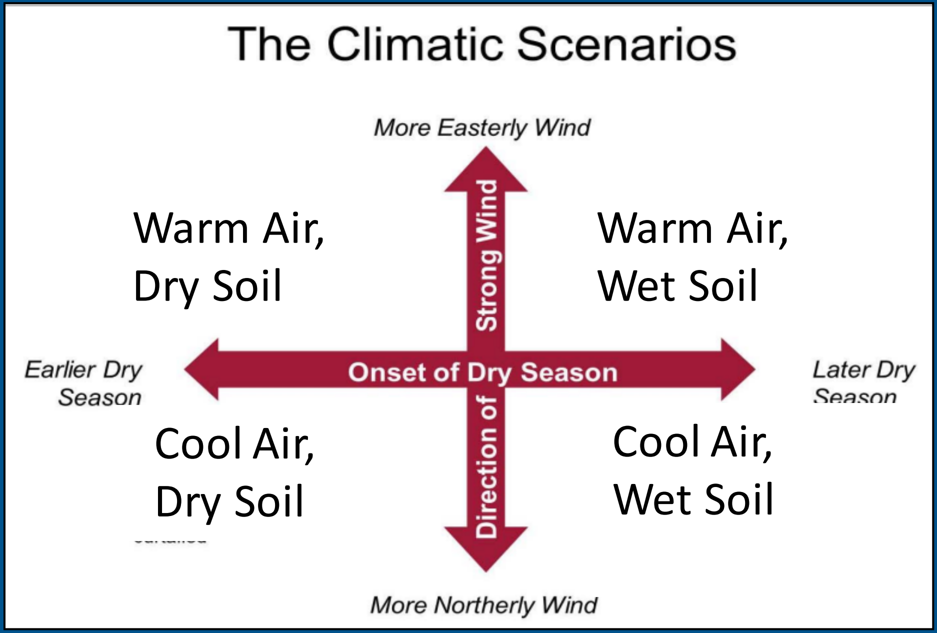
- April 22
- Likely 2-3 additional meetings before November

Climate-Smart Adaptation Working Group

Adaptation planning through the use of scenarios

Why scenario planning?

Process to identify most robust management actions in an uncertain future. Proposed actions that find overlap among divergent scenarios will rise to the top.



Futures of Wild Marin, Scenario Planning for Climate Change Adaptation

Climate-Smart Adaptation Working Group

Define distinct climate scenarios:

Multiple plausible futures based on most **uncertain** and most **impactful** drivers of change to serve as a framework for the development of adaptive management responses.

1) Select final drivers and define scenarios
2) Small groups develop their scenario:
   I. Build storyline
   II. Evaluate potential implications for study region
   III. Begin brainstorming adaptive management responses

Climate-Smart Adaptation Working Group

Provide Adaptation Recommendations:

Develop, evaluate and prioritize potential actions for each climate scenario based on vulnerability assessment results.

1) Brainstorm potential management responses for each scenario - evaluate how well each action will perform in each scenario, prioritize actions within each scenario.
2) Small groups rotate through scenarios.
3) Identify overlapping actions (those that were identified for multiple scenarios), prioritize actions and make final recommendations.

Phase 2: Adaptation Planning

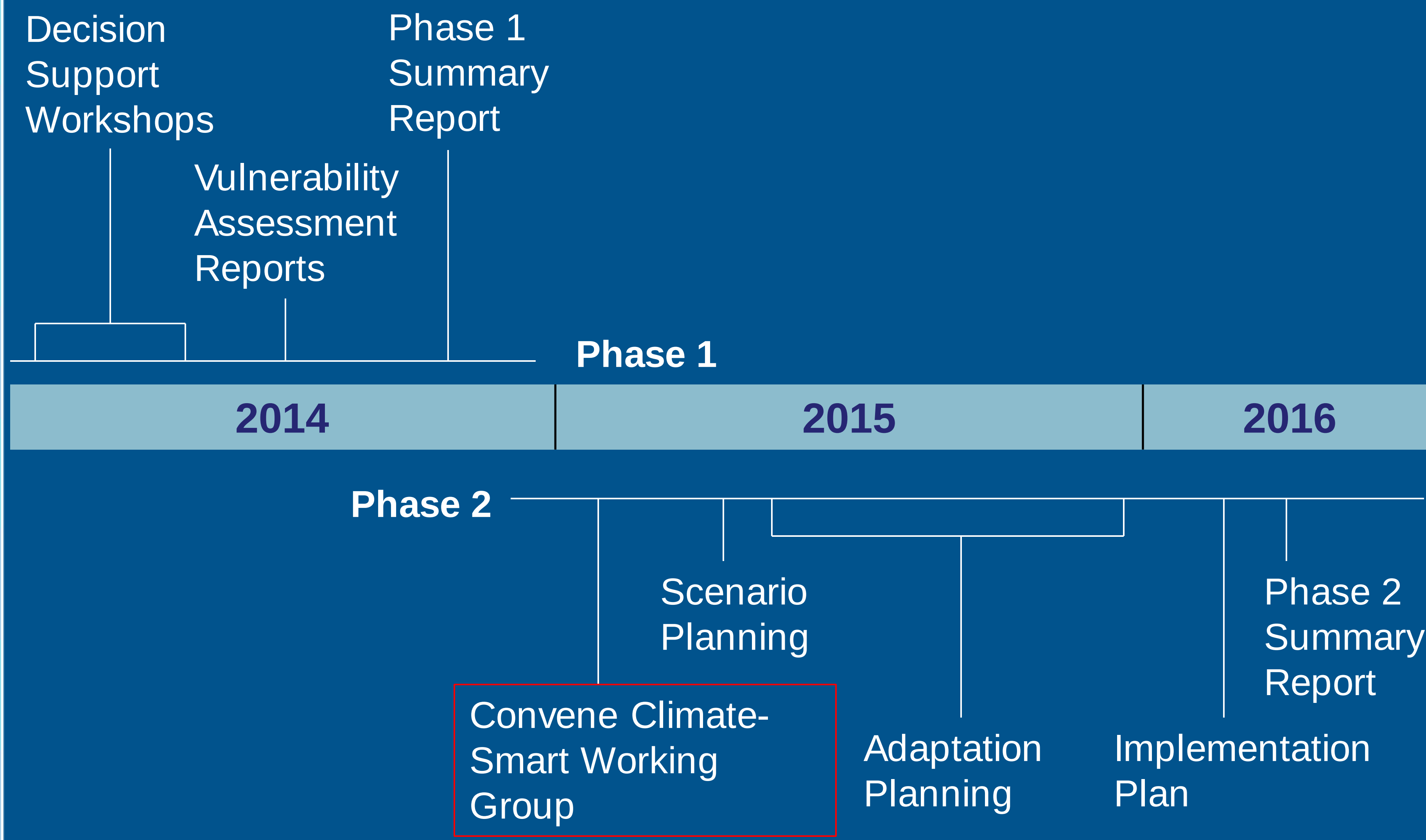
Approval of recommended actions

- Forwarded to Sanctuary Superintendent
- Made available to other management agencies

Sanctuary Implementation Plan

- Summary of approved and/or modified adaptation actions
- Implementation prioritization and schedule
- Estimated cost and potential funding sources
- Participating partners

Proposed Project Timeline



Thank you!

Contact:

Sara.Hutto@noaa.gov

415-970-5253

http://farallones.noaa.gov/manage/climate/welcome.html

Focal Resources Workshop

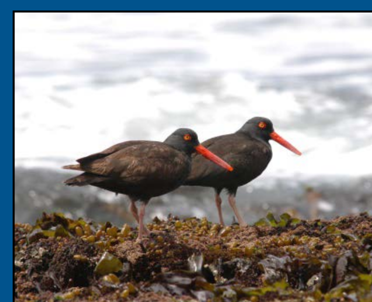
11 February 2014

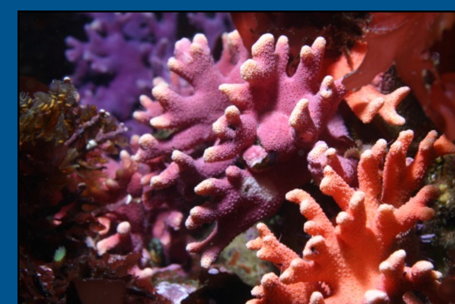
Workshop Goal:

Recommend North-central California coast and ocean focal resources (species, habitats and ecosystem services) for use in vulnerability assessments.

Recommendations produced in habitat break-out groups

- 53 species
- 9 services
- 10 habitats





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Recommendations produced in habitat break-out groups

- 53 species
- 9 services
- 10 habitats

Finalized by staff and planning committee

- 42 species
- 8 services
- 8 habitats

Vulnerability Assessment Workshop

10-11 June 2014

Workshop Goal:

Assess the vulnerability of selected focal resources to climate change impacts

Habitat break-out groups assessed resource

- Sensitivity
- Exposure
- Adaptive capacity

Vulnerability Assessment Workshop

10-11 June 2014

Workshop Goal:

Assess the vulnerability of selected focal resources to climate change impacts

Habitat break-out groups assessed resource

- Sensitivity
- Exposure
- Adaptive capacity

Resources assessed:

- 8 habitats
- 18 species, 10 post-workshop
- 6 ecosystem services