Climate-Smart Adaptation at Greater Farallones National Marine Sanctuary

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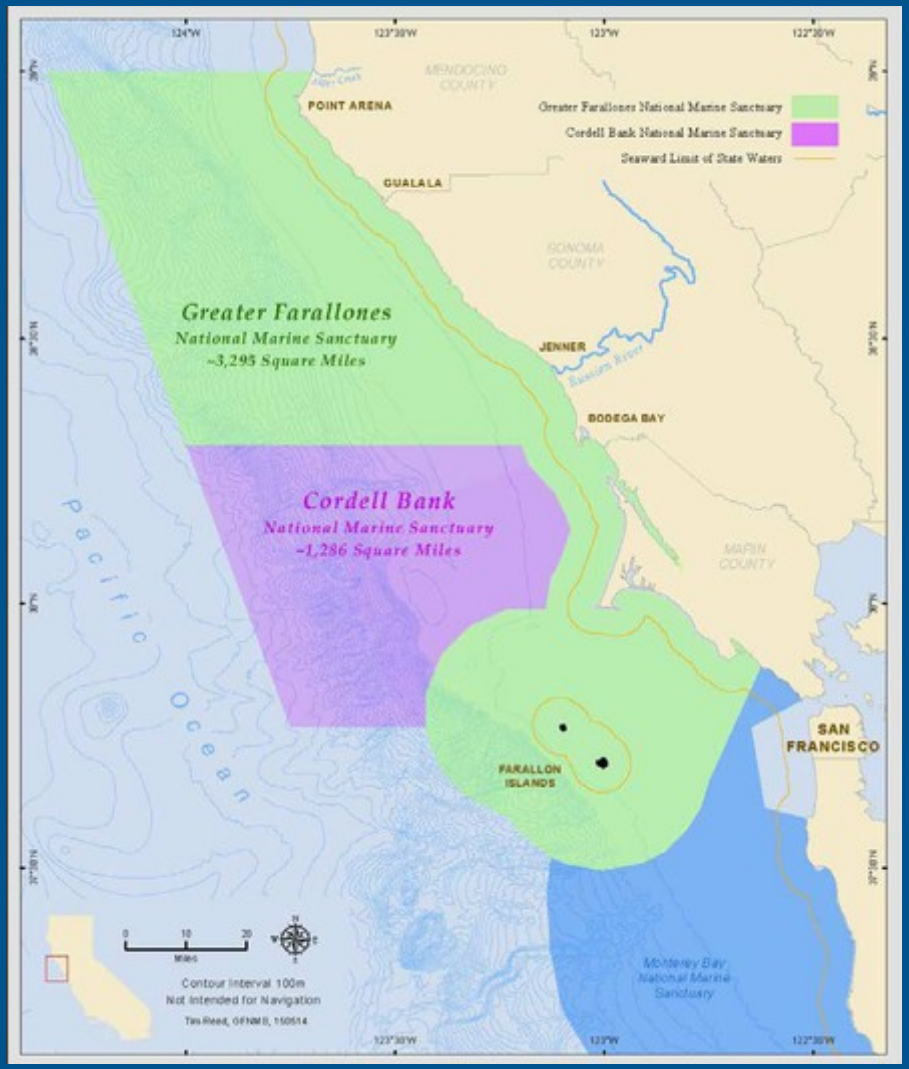
MBNMS Advisory Council
August 19, 2016

Greater Farallones National Marine Sanctuary



- Designated in 1981, recently expanded
- 3,295 square miles
- Open ocean, tidal flats, rocky intertidal, estuarine wetlands, subtidal reefs, and beaches
- Breeding/feeding grounds for:
  - 25 E&T species
  - 36 marine mammal species
  - > 1/4 million breeding seabirds
  - Significant white shark population

GFNMS Ocean Climate Program

Founded in 2008 as the Ocean Climate Initiative

Designated in 2015 as an ONMS Collaborative Center

Focal areas:

- Climate-Smart Conservation (program integration)
- National and Regional Partnerships
- International Leadership

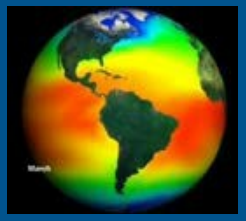
GFNMS Ocean Climate Program

GFNMS Climate-Smart Conservation

Integrating climate change….

mitigation

adaptation



science

communication

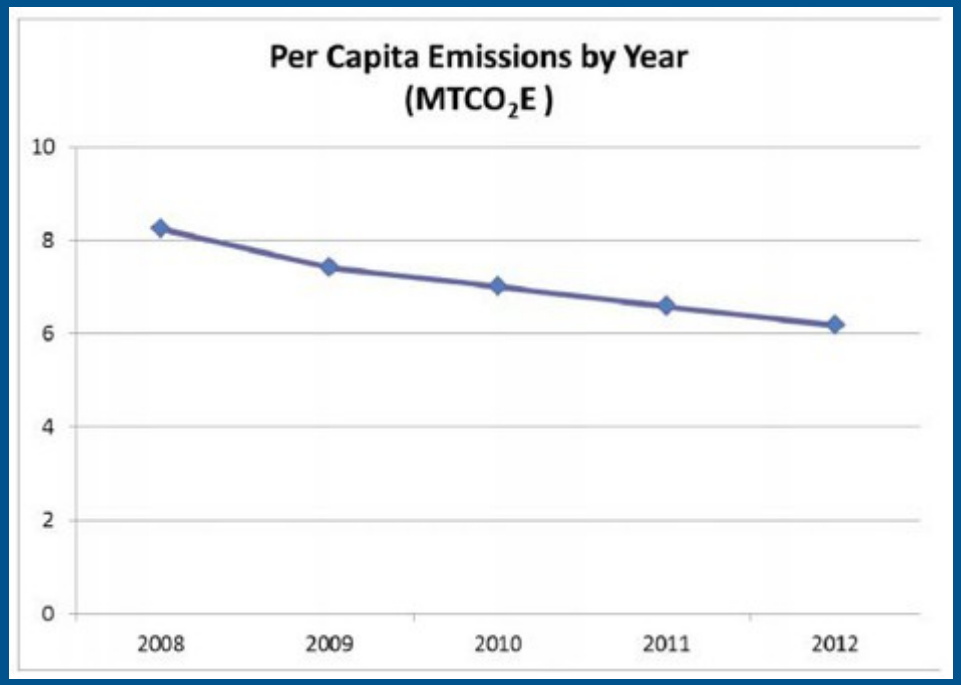
monitoring

….into sanctuary management

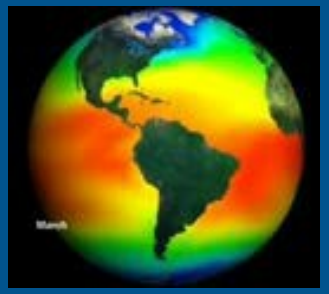
Mitigation

- ✓**Green Operations: Reducing Our Carbon Footprint**

  Working group developed over 130 strategies to reduce sanctuary's carbon footprint.



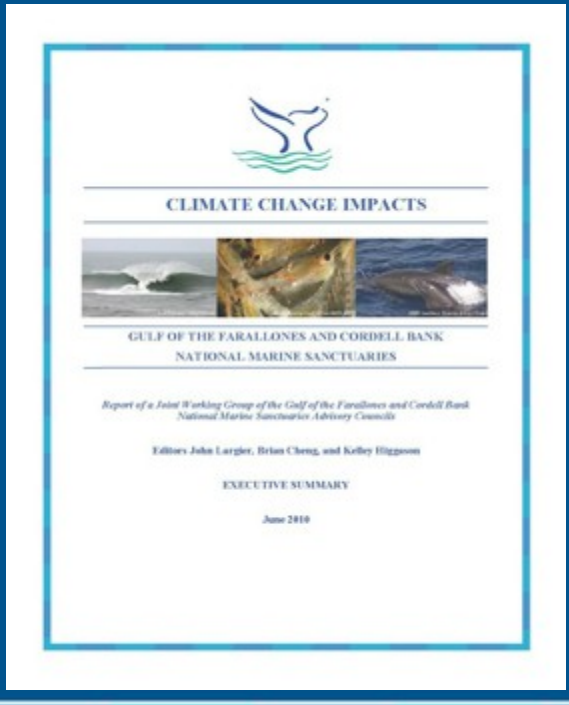
Science



✓**Climate Change Impacts Report**

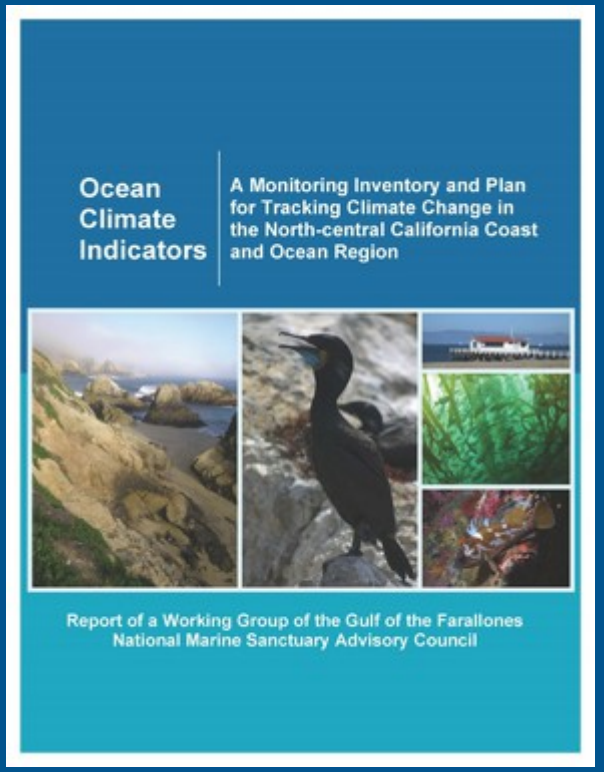
Working group identified observed and predicted climate change impacts and provided recommendations for future action.

- Educate the community
- Put ecosystems in context – link emissions with ecosystem health
- Mitigate impacts by reducing manageable stressors
- Anticipate and adapt to change through flexible policies
- Obtain best available info on changing and future conditions



Monitoring

✓**Ocean Climate Indicators Monitoring Plan**
Working group developed comprehensive monitoring inventory and plan for physical and biological indicators.



- Continued/expanded funding for long-term monitoring
- Expanded/new indictor monitoring
- Synthesis of existing regional climate change research
- Increased communication with regional and local government agencies
- Understanding of indicator species vulnerability.

GFNMS Ocean Climate Program

Integrating climate change….

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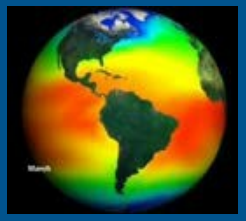
adaptation



science

communication

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….into sanctuary management

Climate-Smart Adaptation

promotes nature-based solutions to:

- Reduce greenhouse gas emissions and enhance carbon sinks
- Reduce climate change impacts on wildlife and people and enhance resilience
- Sustain vibrant, diverse ecosystems

Hydrocoral. *Credit: Steve Lonhart, MBNMS*

Pacifica. *Credit: Jack Sutton*

Taylor's Sea Hare. *Credit: Jennifer Stock, CBNMS*

Climate-Smart Adaptation Project

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.

Geographic Scope

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

MANY Project Partners

Two Big Questions…

1) How vulnerable to climate change are the resources that we manage?

2) What can we do to limit or reduce vulnerability?

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Assess Climate Vulnerabilities

Two Decision-Support Workshops:

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



Focal Resources Workshop

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

Workshop Goal:

Assess the vulnerability of selected focal resources to climate change impacts

Habitat break-out groups assessed resource

- Sensitivity
- Exposure
- Adaptive capacity

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Habitat break-out groups assessed resource

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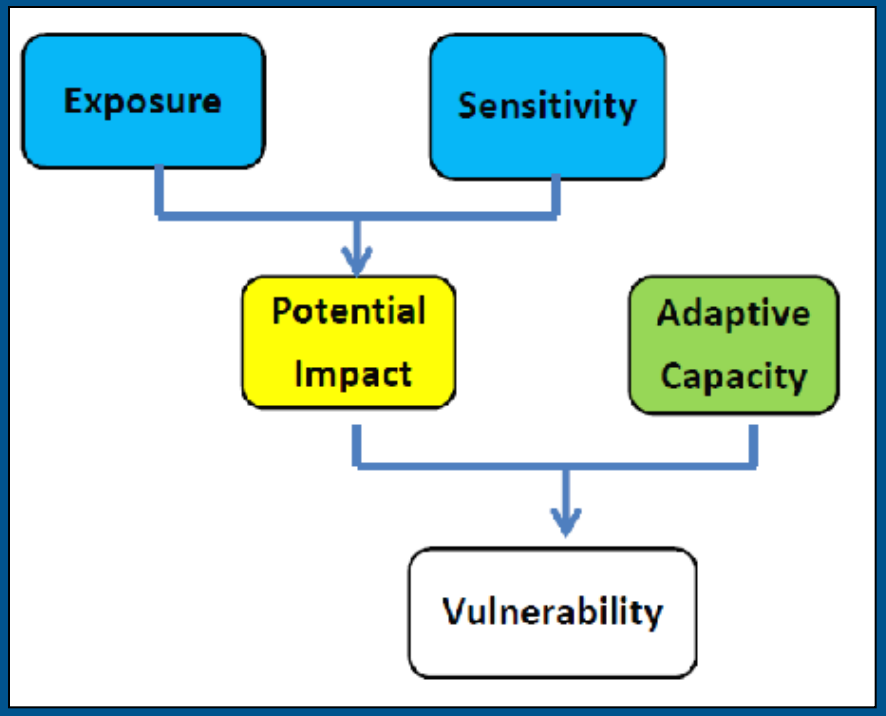
- Exposure
- Adaptive capacity

Resources assessed:

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

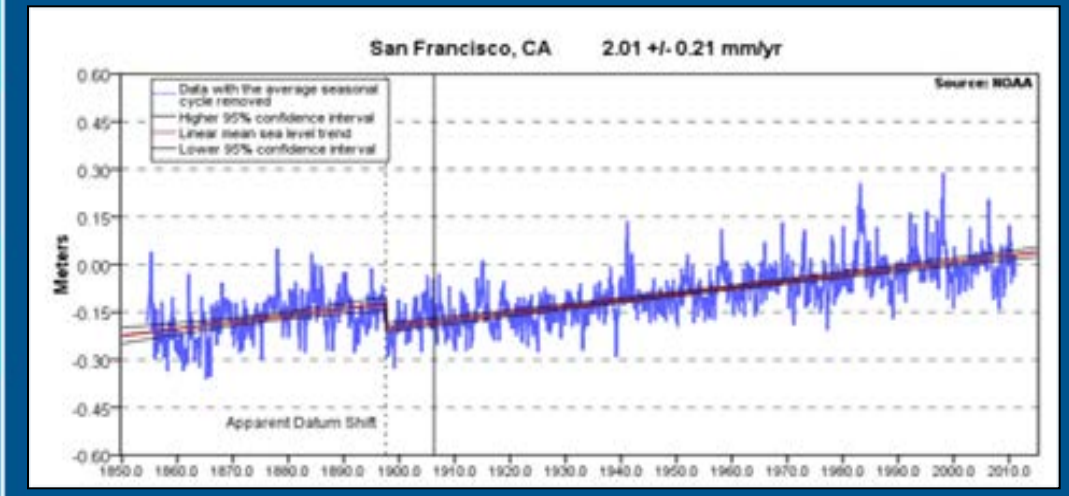
Defining Vulnerability

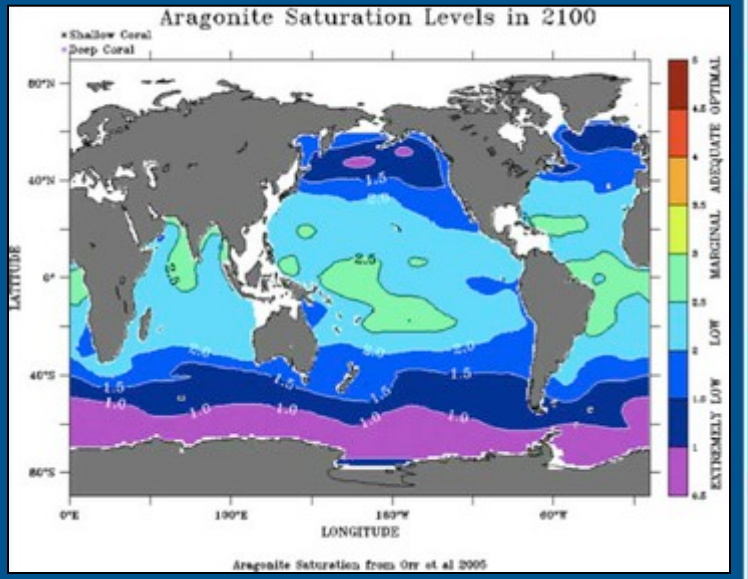
*A function of the **sensitivity** of a particular resource to climate changes, its **exposure** to those changes, and its **capacity to adapt** to those changes* (IPCC 2007)



Defining Vulnerability

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





Workshop participants provided degree of exposure (1 low -5 high) for a list of climate factors for each focal resource.

Defining Vulnerability

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

Workshop participants considered:

- *Sensitivity to climate factors (1 low – 5 high)*
- *Sensitivity to non-climate stressors (1 low – 5 high)*
- *Dependencies (specific habitat or prey, generalist or specialist?)*

Defining Vulnerability

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

Workshop participants considered:

- *Extent, status, dispersal ability*
- *Population connectivity*
- *Diversity (genetic, life history strategies)*
- *Plasticity (behavioral, morphological)*
- *Value of resource*
- *Management potential*

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
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

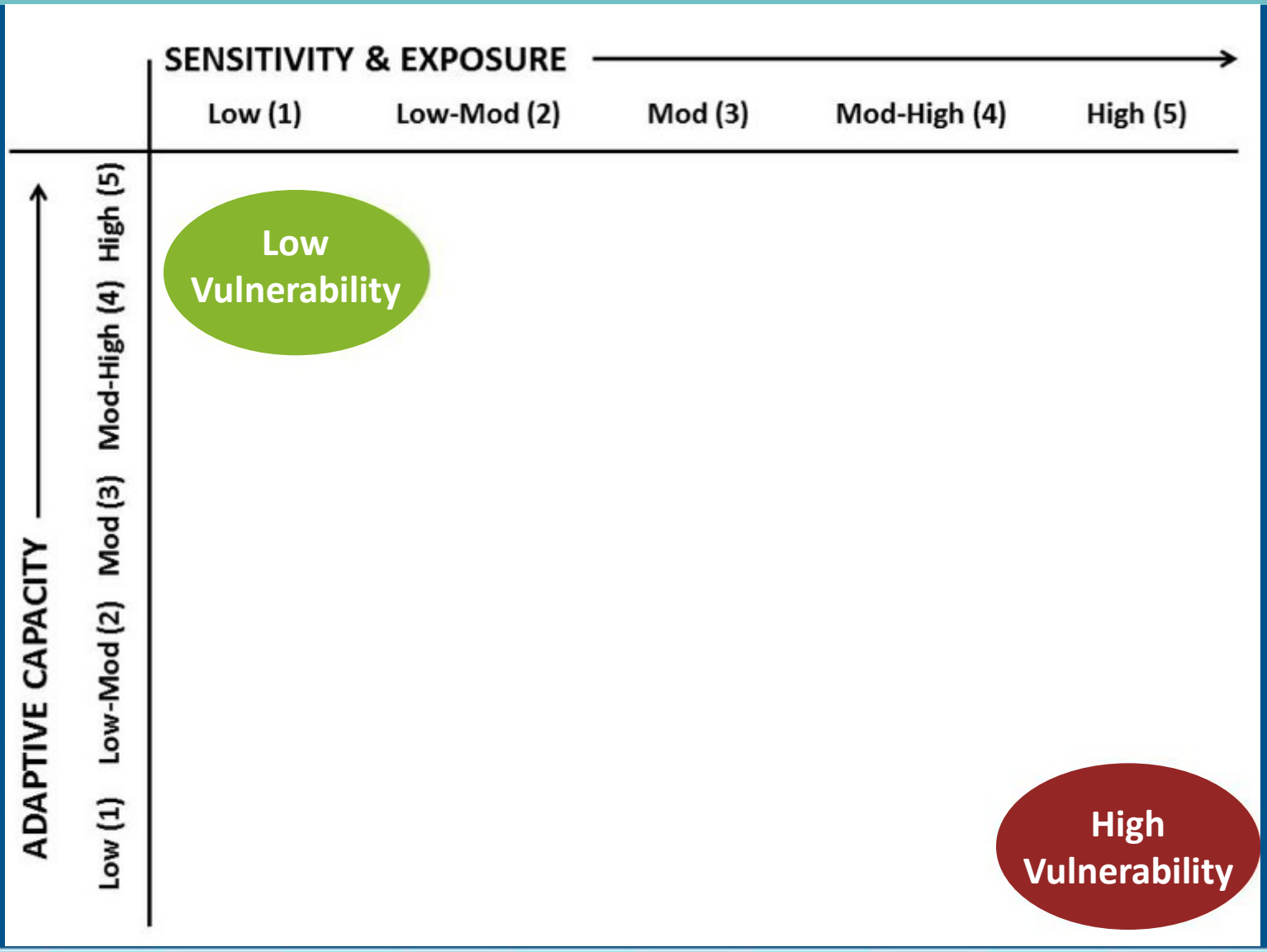
Spectrum of species (1=generalist; 5=specialist): 3

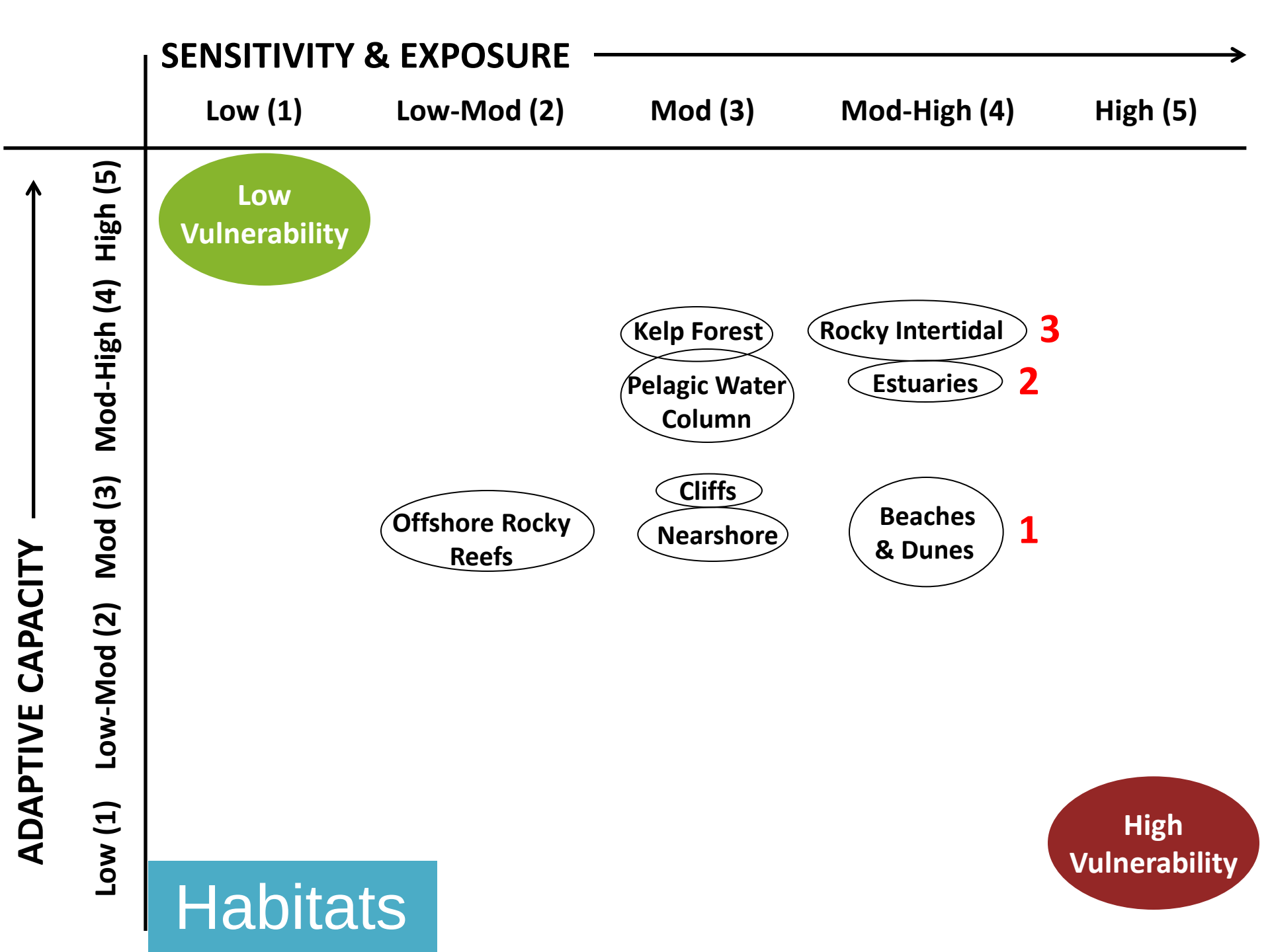
- Confidence of workshop participants: High

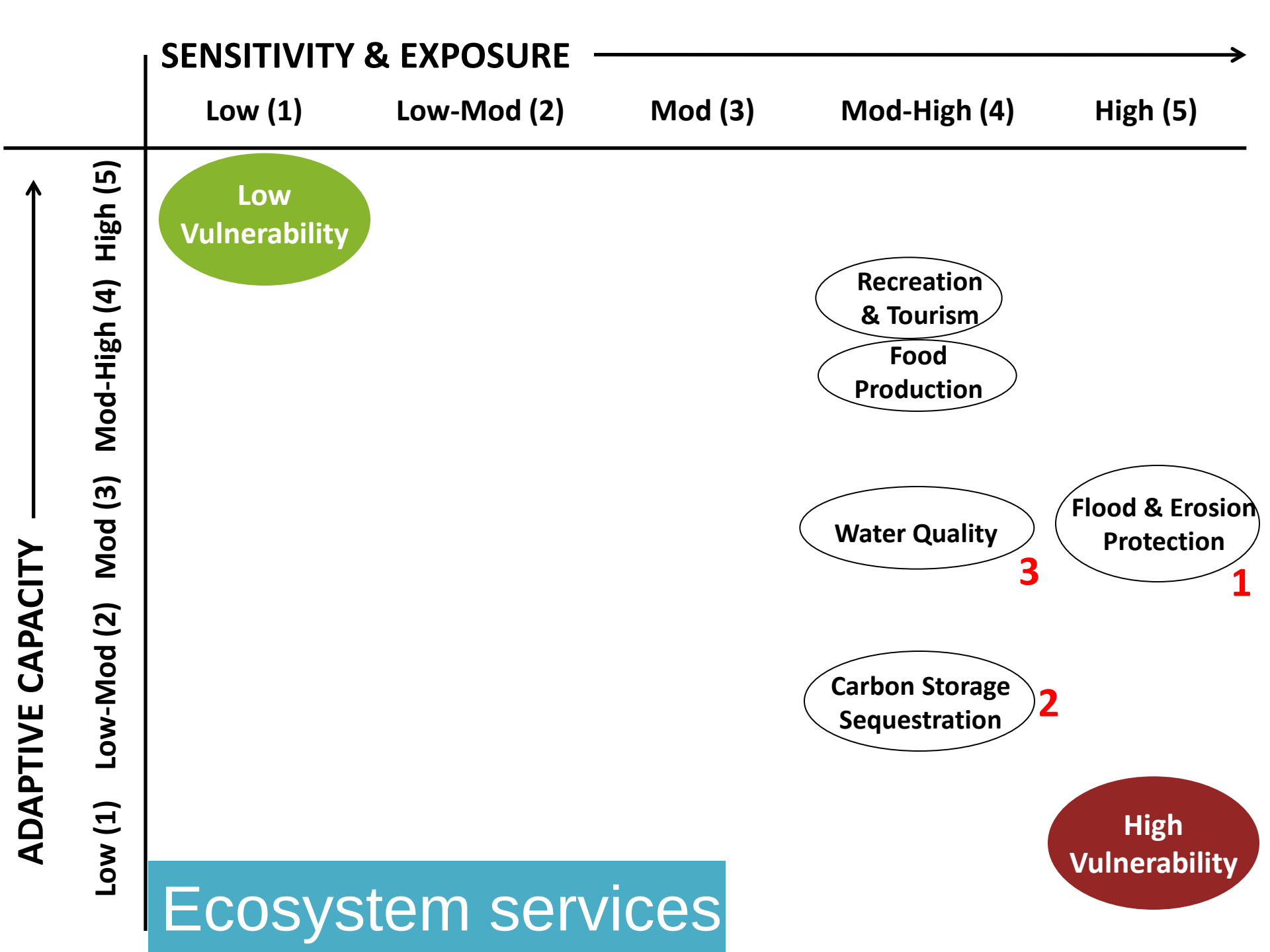
Additional participant comments

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.

Relative Vulnerability




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
Pelagic Water Column
Rocky Intertidal
Estuaries
3
2
Offshore Rocky Reefs
Cliffs
Nearshore
Beaches & Dunes
1
High Vulnerability
Habitats


SENSITIVITY & EXPOSURE
Low (1)
Low-Mod (2)
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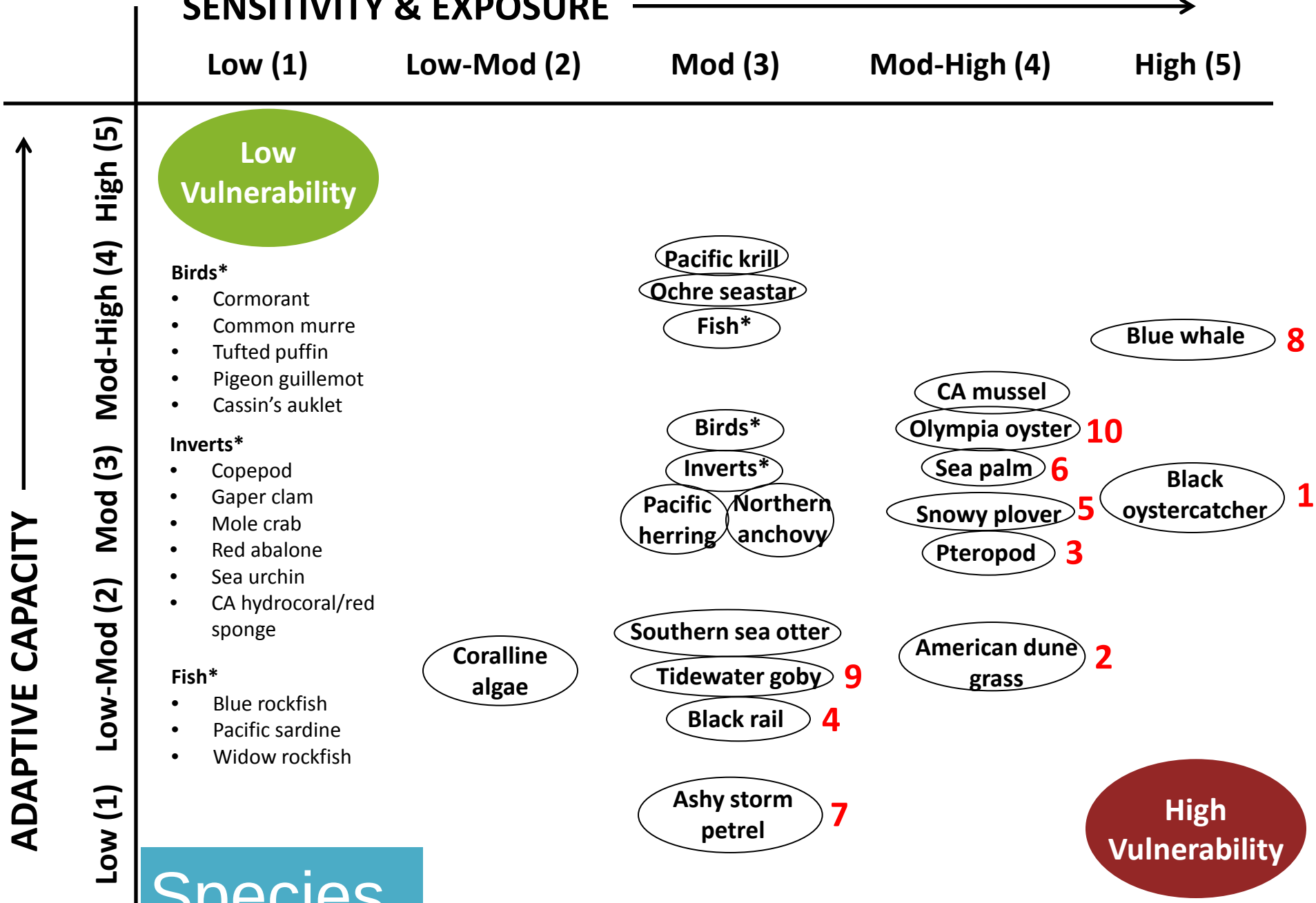
High (5)
ADAPTIVE CAPACITY
Low (1)
Low-Mod (2)
Mod (3)
Mod-High (4)
High (5)
Low Vulnerability
Recreation & Tourism
Food Production
Water Quality
3
Flood & Erosion Protection
1
Carbon Storage Sequestration
2
High Vulnerability
Ecosystem services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Low (1)
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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
Species
Pacific krill
Ochre seastar
Fish*
Birds*
Inverts*
Pacific herring
Northern anchovy
Coralline algae
Southern sea otter
Tidewater goby
9
Black rail
4
Ashy storm petrel
7
Blue whale
8
CA mussel
Olympia oyster
10
Sea palm
6
Black oystercatcher
1
Snowy plover
5
Pteropod
3
American dune grass
2
High Vulnerability

Key climate-driven stressors

1. Wave action
2. Coastal erosion
3. Sea level rise

Key non-climate stressors

1. Roads/coastal armoring
2. Invasive/problematic species
3. Land use change

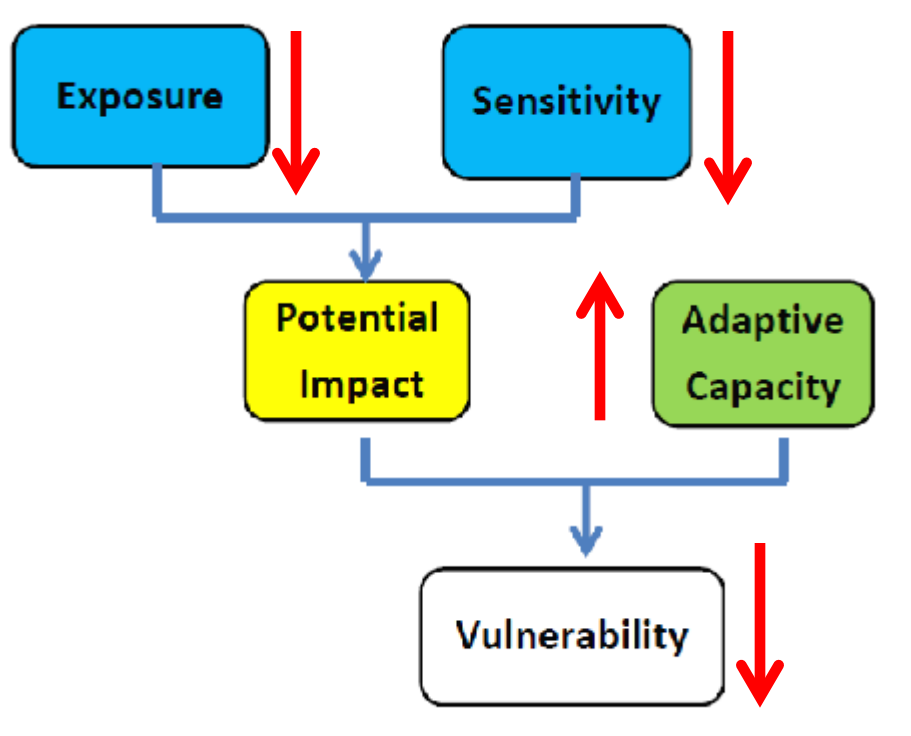
Back to the Questions

1) How vulnerable to climate change are the resources that we manage?

2) What can we do to limit or reduce vulnerability?

Identify Adaptation Options

Use assessment results to develop management strategies that will…



…in a variety of plausible future climate scenarios

Climate-Smart Adaptation Working Group

Federal: USFWS, CA LCC, National Park Service, GGNRA, NMFS, BLM, USGS

State: Coastal Commission, State Parks, State Coastal Conservancy, CDFW

Local: San Mateo and Marin Counties

NGOs: Point Blue, BAECCC, Greater Farallones Association

Academia: Bodega Marine Lab, Stanford University

Working Group Outcomes

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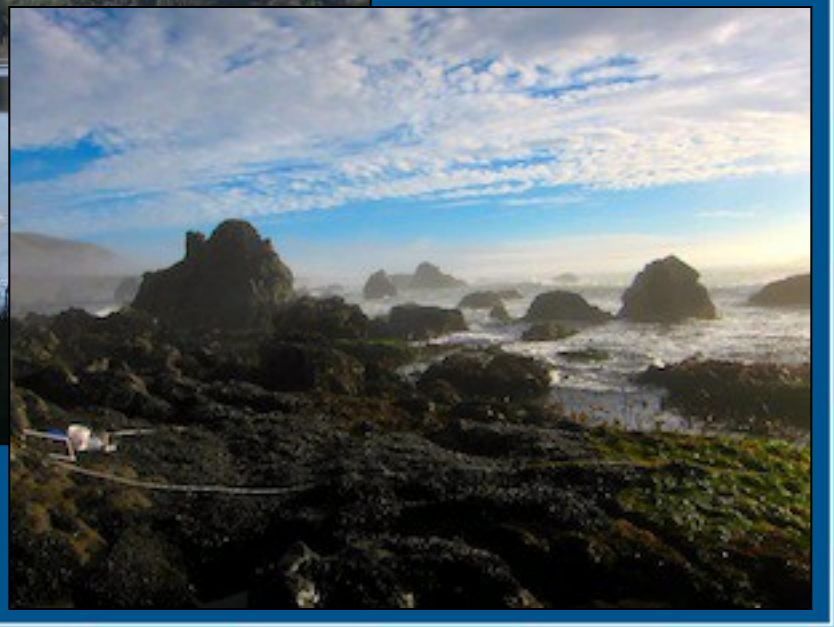
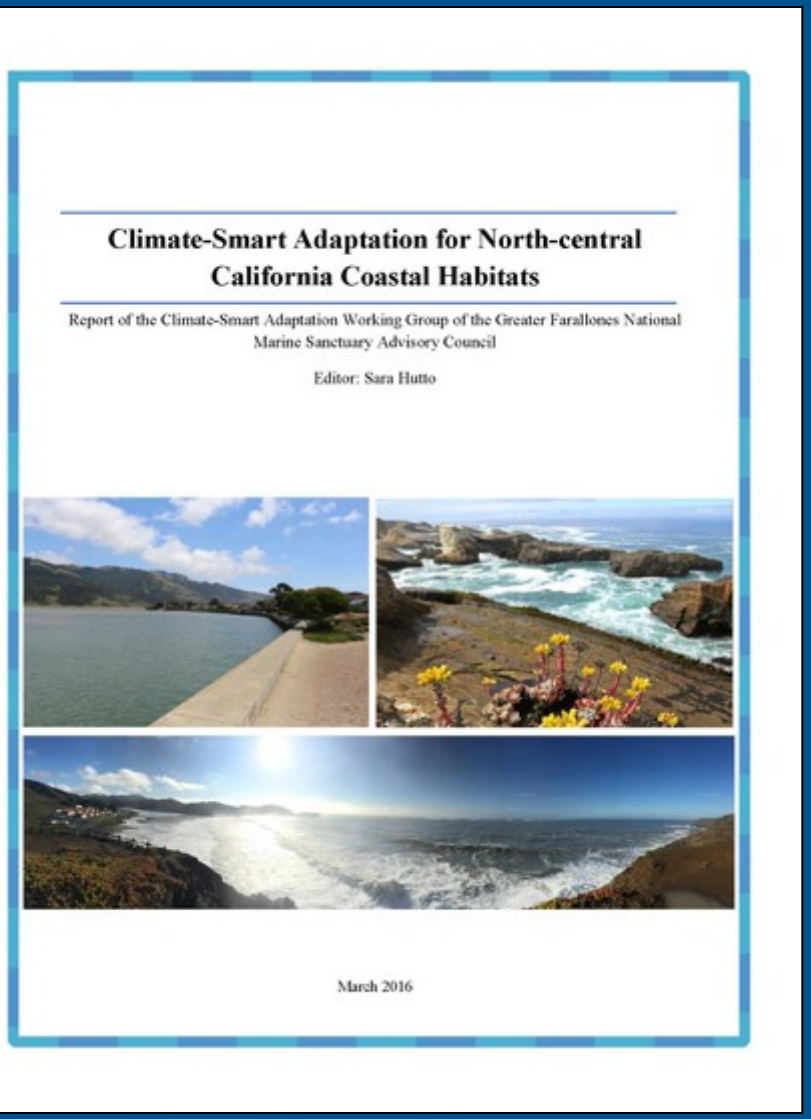


Climate-Smart Adaptation Report



Some examples…

Remove/redesign roads to allow for coastal habitats to migrate inland in response to sea level rise

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Restore living shorelines (kelp beds, seagrass beds, beaches/dunes) to buffer from storms

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Manage invasive species – keep track of species range shifts

Enhance tidepool and marsh education and interpretation

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Restore living shorelines (kelp beds, seagrass beds, beaches/dunes) to buffer from storms

Manage invasive species – keep track of species range shifts

Enhance tidepool and marsh education and interpretation

Investigate the use of vegetation to locally mitigate ocean acidification

Remove sediment supply inhibitors and structures that cause erosion (jetties)

What is next?

Report distributed to management agencies in the region

GFNMS Climate Action Plan

- Modified selection of adaptation strategies
- Implementation details: timeline, cost, resources, participating partners
- Currently seeking funding to begin conceptual plans

Thank you!

Contact:

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