Preliminary Results

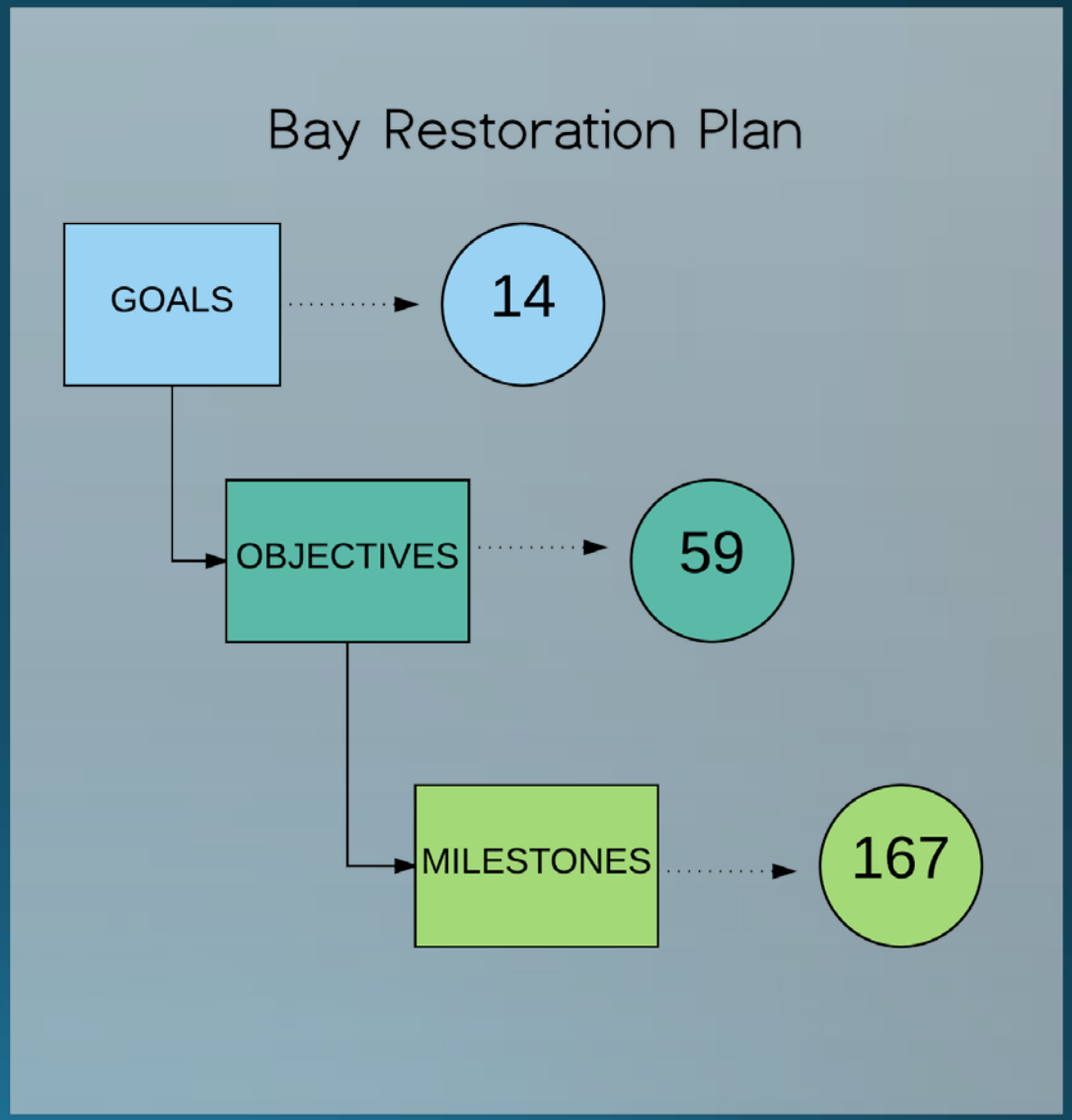
Bay Restoration Plan
Climate Change Vulnerability Analysis

CCVA Overarching Goal → "Climate Ready BRP"

- Develop a tool (framework) that can be used to evaluate the current BRP, in the context of future action planning.
    - Risks
    - Vulnerability assessment

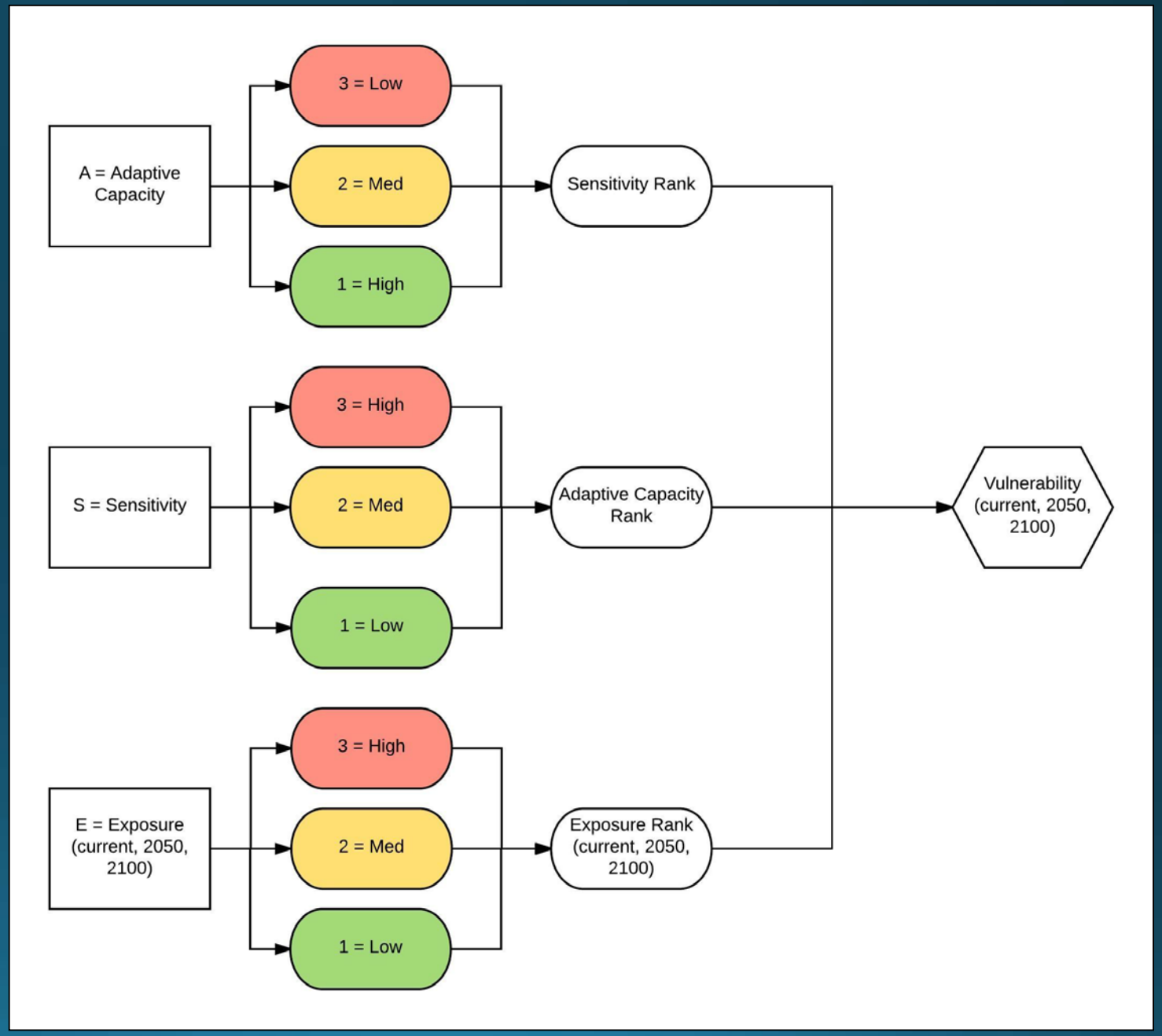
Framework

- Assess on the objective level
- Collaborative staff input + expert review
- Quantitative ranking to determine climate change vulnerability
- Vulnerability based on:
  - Adaptive capacity
  - Sensitivity
  - Exposure (current, year 2050, year 2100)
- Vulnerability assessment results in 3 different vulnerability scores associated with current, 2050, and 2100 conditions.

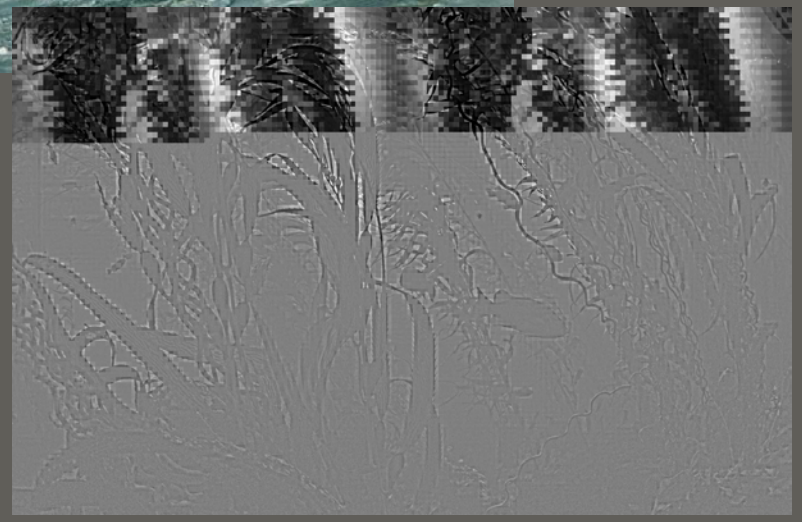


Framework

- The most vulnerable objectives are those that:
  - Experience the most exposure to perturbations or stresses,
  - Are the most sensitive to perturbations or stresses,
  - And, have the weakest capacity to respond and ability to recover.



Adaptive Capacity



- Adaptive capacity: refers to the potential, capability, or ability of a system to adapt to a specific climate change stressor. Additionally, can be defined as the degree to which adjustments are possible in practices, processes, or structures of systems to projected or actual changes of climate. Can be spontaneous or planned, and can be carried out in response to or in anticipation of changes.

i.e. BRP objective 9.1 – restore kelp forests – a value of 2 has been assigned to the increasing storminess stressor as kelp forests can occasionally adapt to increasing storminess, depending on the location, intensity and nature of storms, or density of a particular kelp bed. Adjustments to future kelp restoration site locations may be possible, strategically restoring kelp beds in sheltered areas.

Sensitivity

- Sensitivity refers to the degree to which a system will respond to a change in climatic conditions.

i.e. BRP objective 9.1 – restore kelp forests – a value of 2 has been assigned to the ocean acidification stressor because while increased pH can affect calcifying organisms in the kelp forest area, kelp has also shown an ability to combat ocean acidification by absorbing carbon dioxide and lowering pH.

i.e. – BRP objective 9.1 – restore kelp forests – a value of 3 has been assigned to the warmer water stressor as kelp forest habitats are highly sensitive to warmer water. Major shifts in response to warmer water have been observed and can be expected in the future.

Exposure

- Exposure is a combination of the impact and extent of a climate change stressor in the context of a particular objective. Considers the size of the area and/or system affected and the magnitude of the stressor. All objective exposure rankings are assumed to increase over time. For example, Sea Level Rise will be greater in 2050 than currently, and even greater by 2100.

media credit: McClatchy-Tribune News Service

i.e – BRP objective 8.2 – Protect and manage sandy beach habitats – a value of 1 (low) has been assigned to current exposure (E1). As sea level begins to rise impact and extent to sandy beaches will become greater; therefore, exposure in 2050 has been assigned a value of 2 (medium) and exposure in 2100 has been assigned a value of 3 (high).

Los Angeles Times
L.A. Now
California: This just in

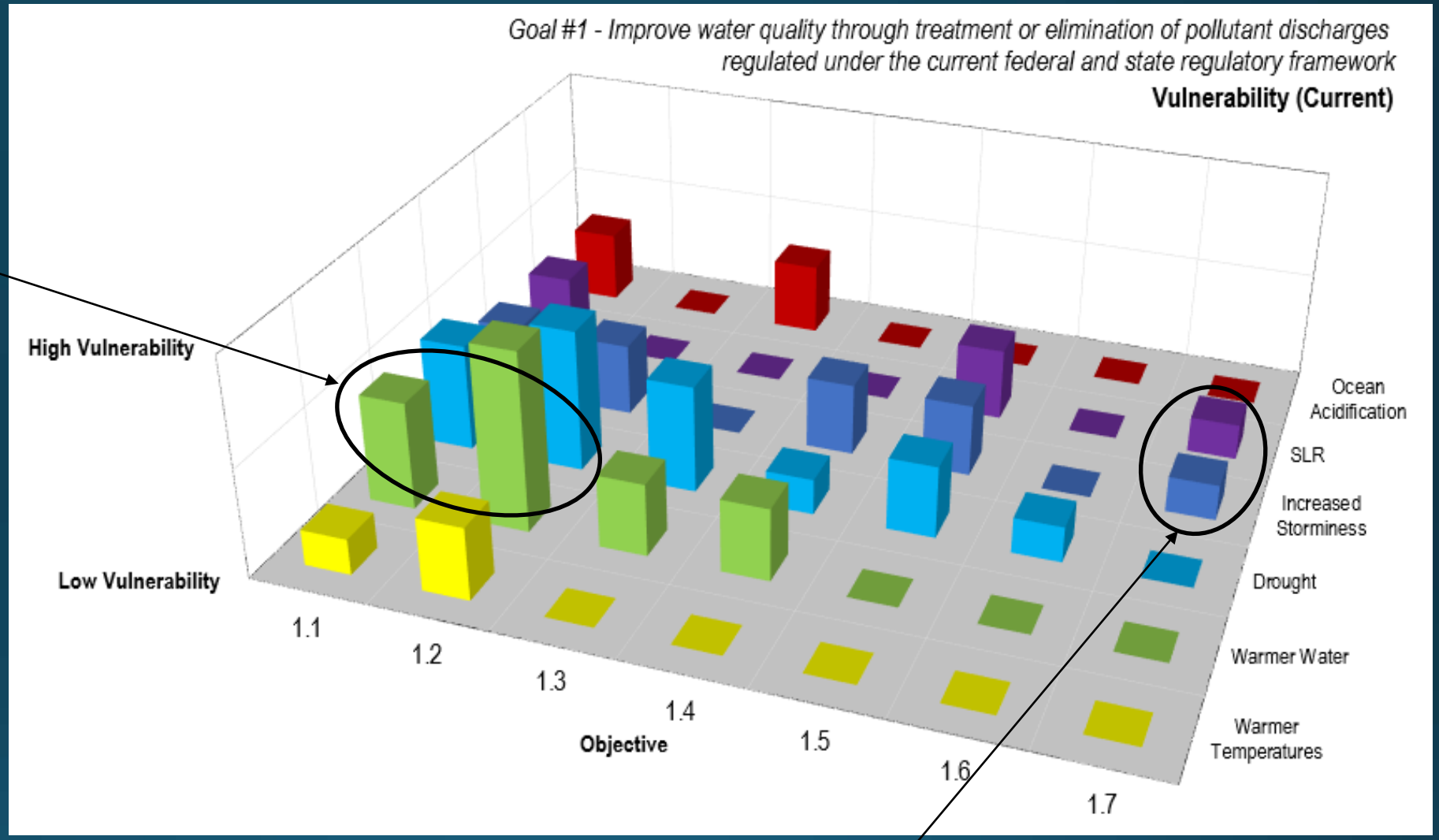
LOCAL / L.A. Now

Column A dangerous confluence on the California coast: beach erosion and sea level rise

1.1 – Attain water quality goals in TMDLs adopted for 303(d) listed waterbodies in the SMB Watershed

1.2 Eliminate and prevent water and sediment quality impairments from both point and nonpoint sources for waterbodies in the Malibu Creek watershed

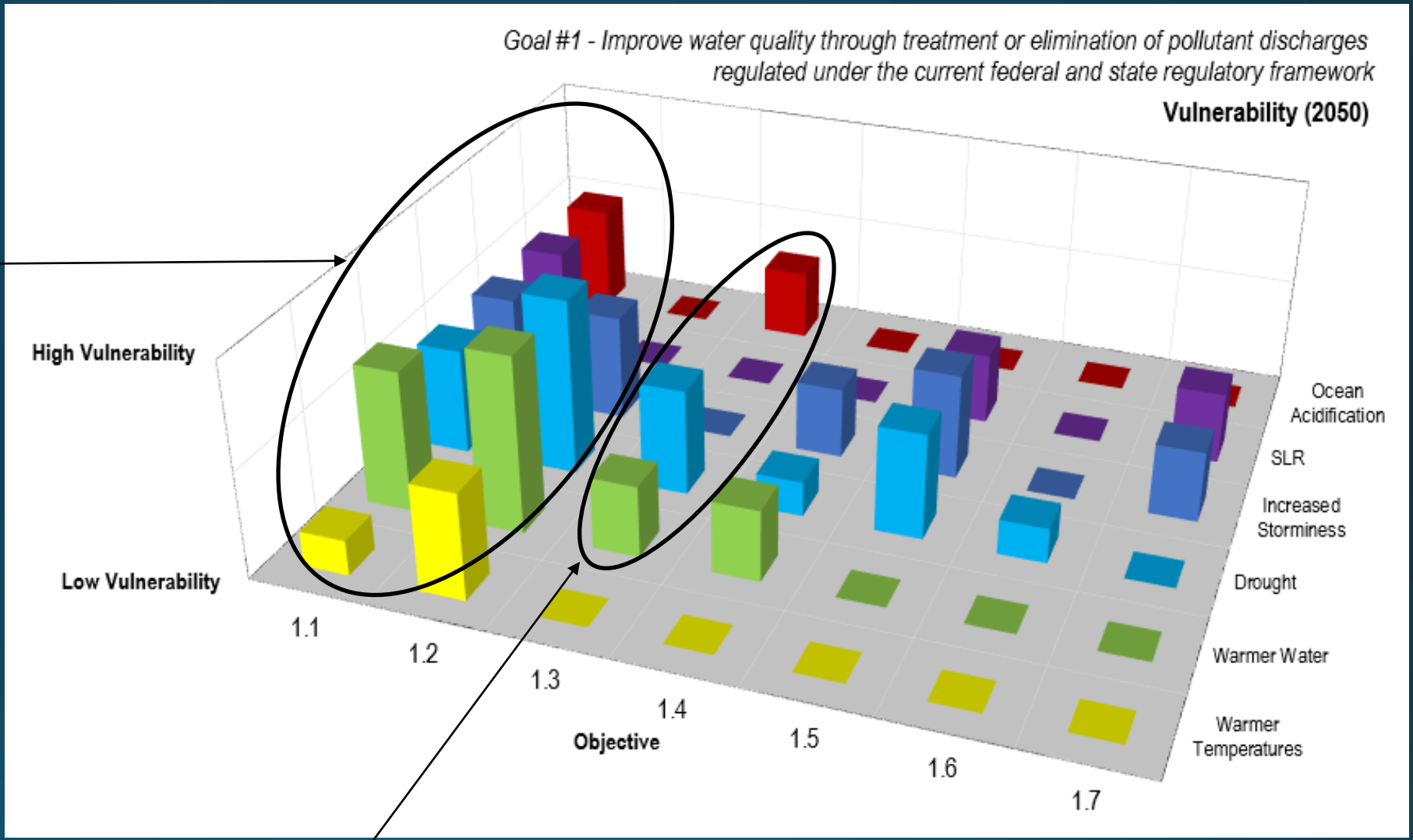
Warmer water will exasperate eutrophication + bacteria loading + may have impacts on toxic TMDLs



1.7 Eliminate non-point pollution from on-site wastewater disposal systems (OWDSs)

Increased storminess and SLR may cause more septic failure

Generally, vulnerability scores rise with increased exposure of climate change stressors into the future…

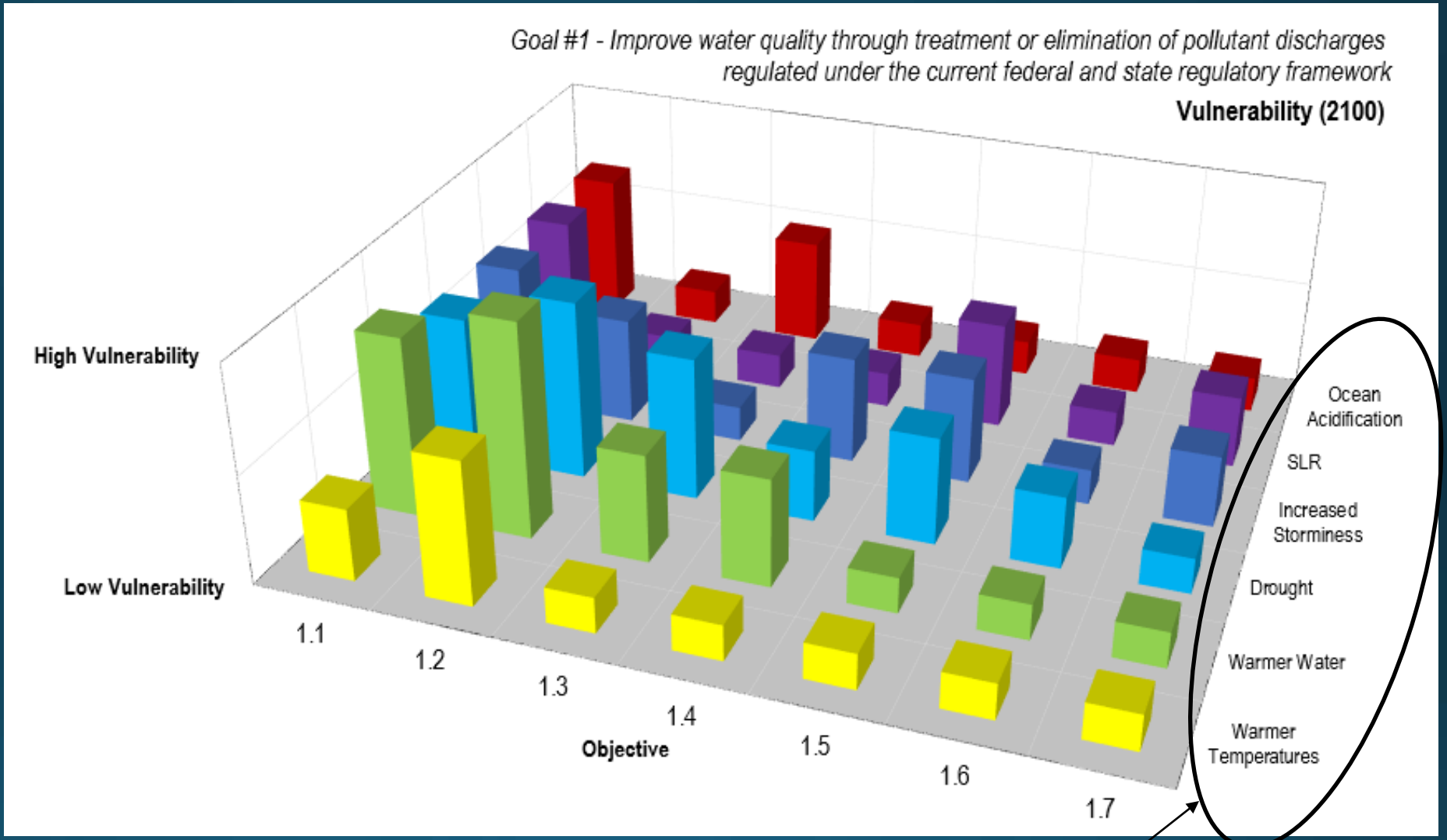


1.3 Eliminate biological impacts of water intake and discharge from coastal power and desalination plants

Warmer water makes cooling more problematic, severe drought may increase demand for desalination, ocean acidification may increase affect of brine discharge

Exposure continues to rise for many climate change stressors…

Even currently low vulnerability scores begin to rise by 2100.



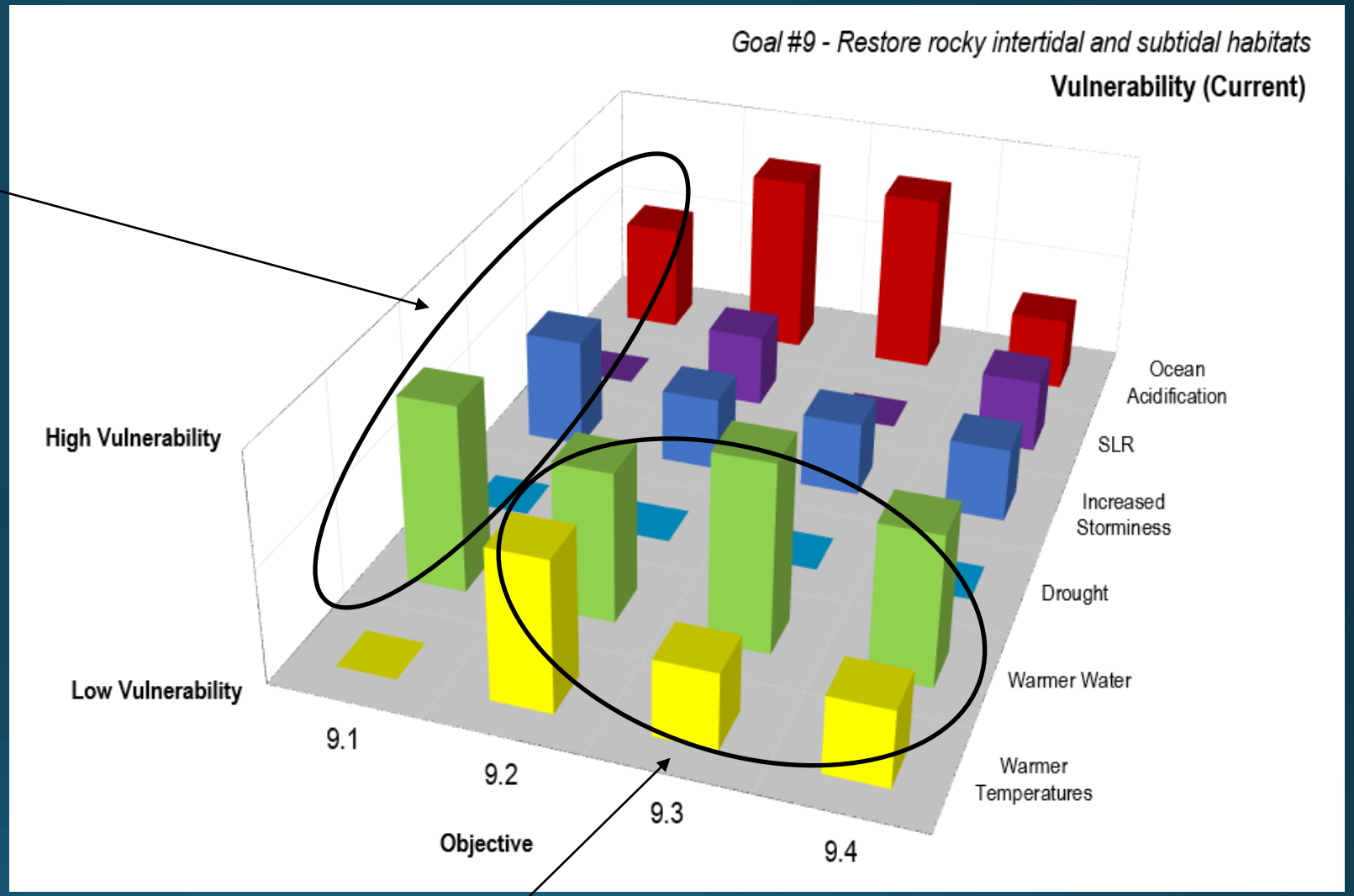
Assumption that many climate change stressors will begin to interact and have cascading effects

Identified possible risks associated with each stressor for all objectives

Organizational Objective	Climate stressor						Risk	Risk (R) or Opportunity (O)
	1 – warmer temperatures	2 – warmer water	3 – increasing drought	4 – increasing storminess	5 – sea level rise	6 – ocean acidification		
1.2 Eliminate and prevent water and sediment quality impairments from both point and nonpoint sources for waterbodies in the Malibu Creek watershed	x	x	x	x		x	Impacts and changes to benthic community	R
		x					May increase bacteria loading	R
		x					May decrease bacteria loading	
		x	x				Increased eutrophication potential	R
			x	x			Increased erosion and or sediment deposition	R
			x				Species may have different tolerance regimes	R
				x			Increase in turbidity / re-suspended sediment / stratification / decrease in water clarity	R
					x		Greater coastal wetland loss may occur	R
	x	x	x	x	x		Change in lagoon flora and fauna composition	R
						x	Impacts to shellfish and plankton communities; larval fish life stages may be adversely impacted	R
	x	x				x	Invasion of non-native species and/or changes in species composition	R

9.1 Restore and monitor sixty acres of kelp forest

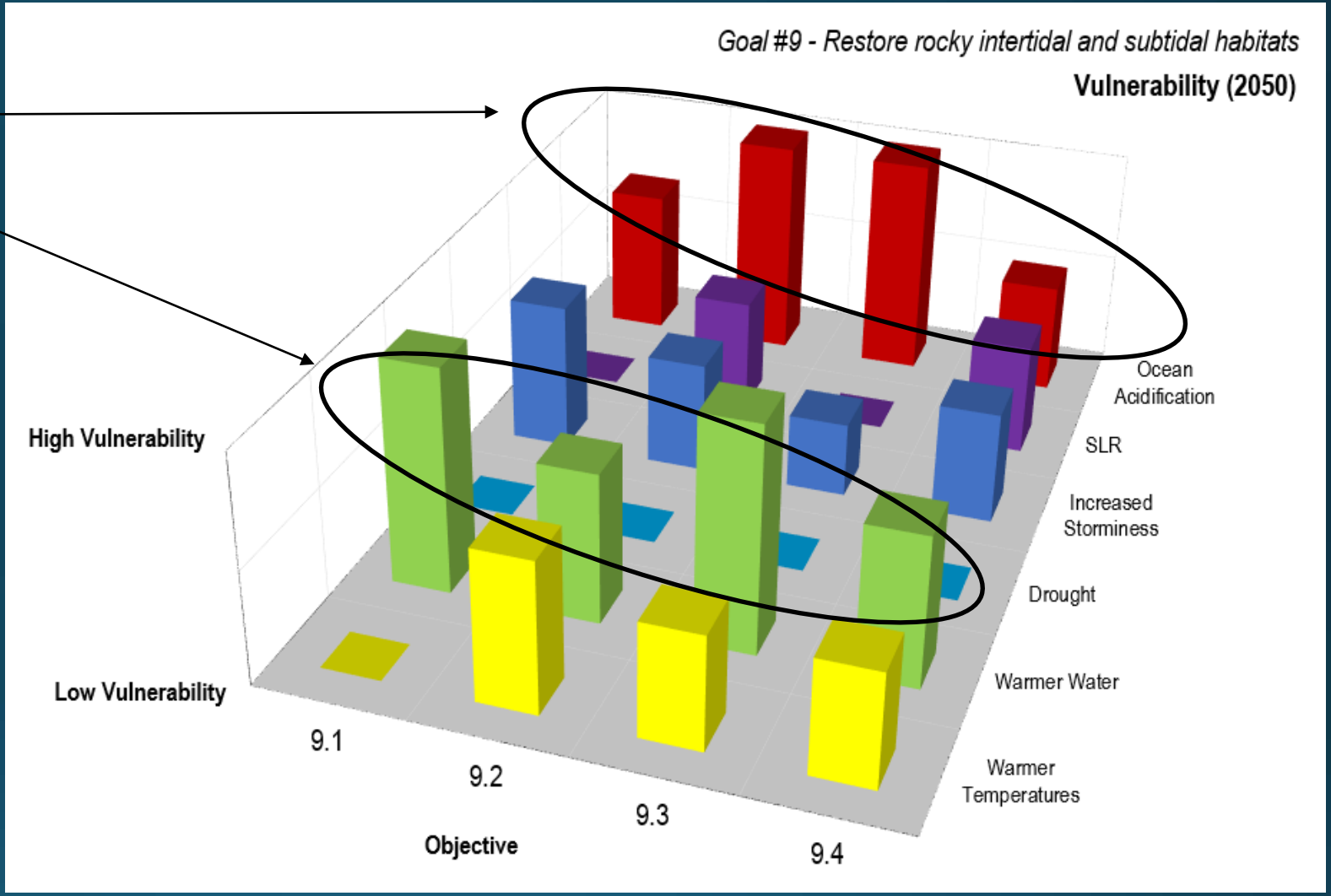
Warmer water + storminess currently effecting kelp restoration sites.
OA signs present.



9.2 Protect and manage rocky intertidal habitat
9.3 Re-introduce and restore abalone population
9.4 Assess and protect seagrass habitats

Intertidal species will be affected.
Warmer water and temperature not independent of each other, effects can be compounding, especially for intertidal habitats

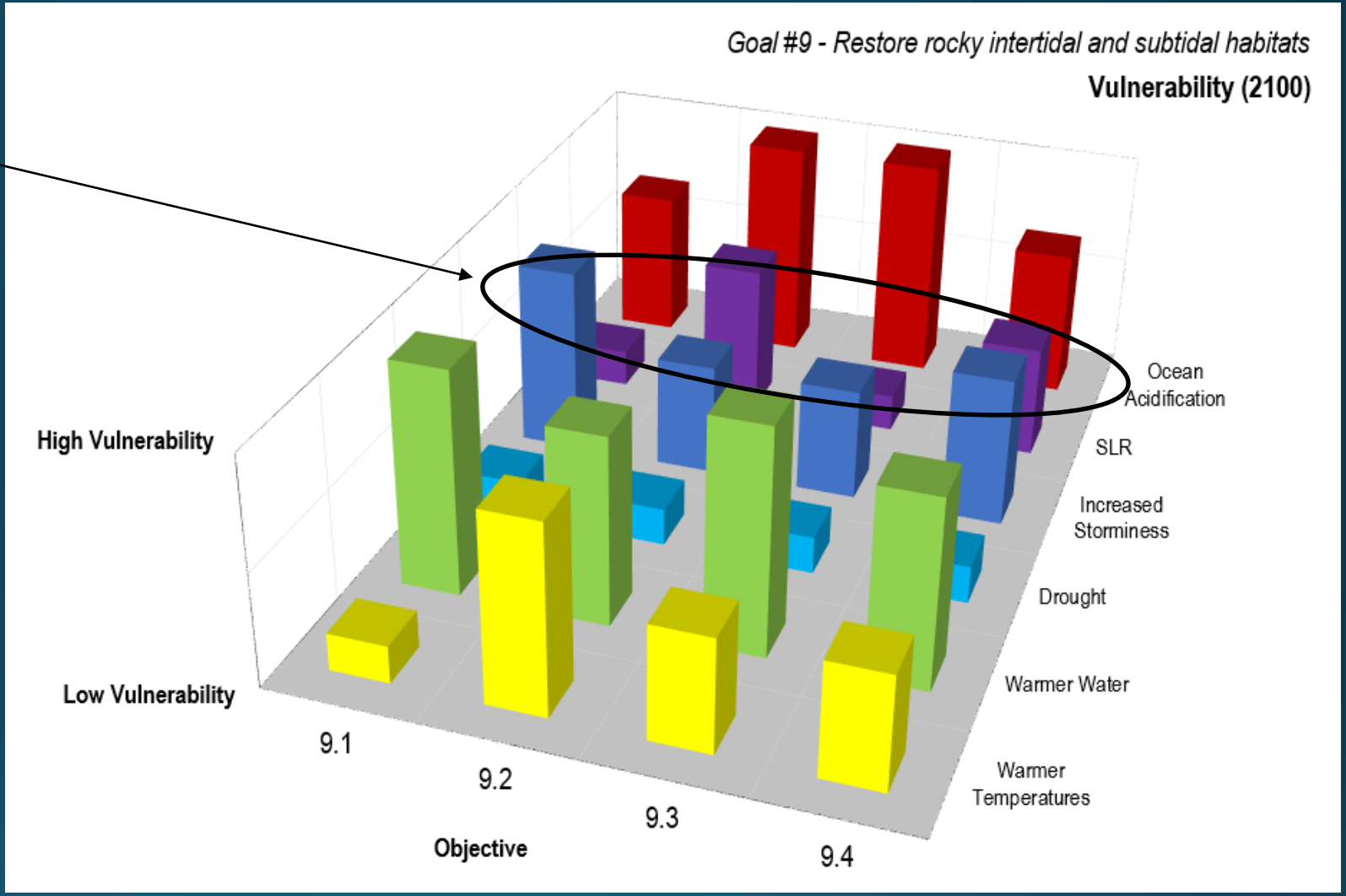
Vulnerability to warmer water + OA rises for all objectives



Trends begin to appear – intertidal habitats more vulnerable to SLR compared to subtidal habitats

OA and Warmer Water drive vulnerability scores high

Drought shows low vulnerability even into 2100



Risks identified for objective 9.1 – Restore and monitor 60 acres of kelp

Organizational Objective	Climate stressor						Risk	Risk (R) or Opportunity (O)
	1 – warmer temperatures	2 – warmer water	3 – increasing drought	4 – increasing storminess	5 – sea level rise	6 – ocean acidification		
9.1 Restore and monitor sixty acres of kelp forest		x					Kelp becomes stressed due to warmer water reducing reproduction and slowing restoration response	R
				x			Large storm events may rip out kelp, slowing restoration response	R
				x			Increased urban runoff from storms may increase contaminants, slowing kelp growth	R
				x			Increased sediment flow from storms may prevent kelp from seeding onto the reef	R
					x		Sea level rise may shift distribution of kelp dependent on depth	R
						x	Ocean acidification will affect urchins, a calcifying species, which may change the abundance of urchins in kelp forests	R
				x			Increased wave action may impact reefs	R
	x	x					New invasive species may occur	R
		x		x		x	Impacts to fish reproduction	R
		x		x	x	x	Changes in coastal phytoplankton community and food web	R
	x	x	x	x	x	x	Impacts to or alterations of monitoring priorities and planning efforts	R
	x	x					Increase in disease	R
	x	x	x	x	x	x	Incorporate climate change planning into dam removal and positioning of material	O

Scalable to Goal Level

Goal 7 – Restore wetlands, streams, and riparian zones

Overall higher vulnerability to climate change compared to other goals

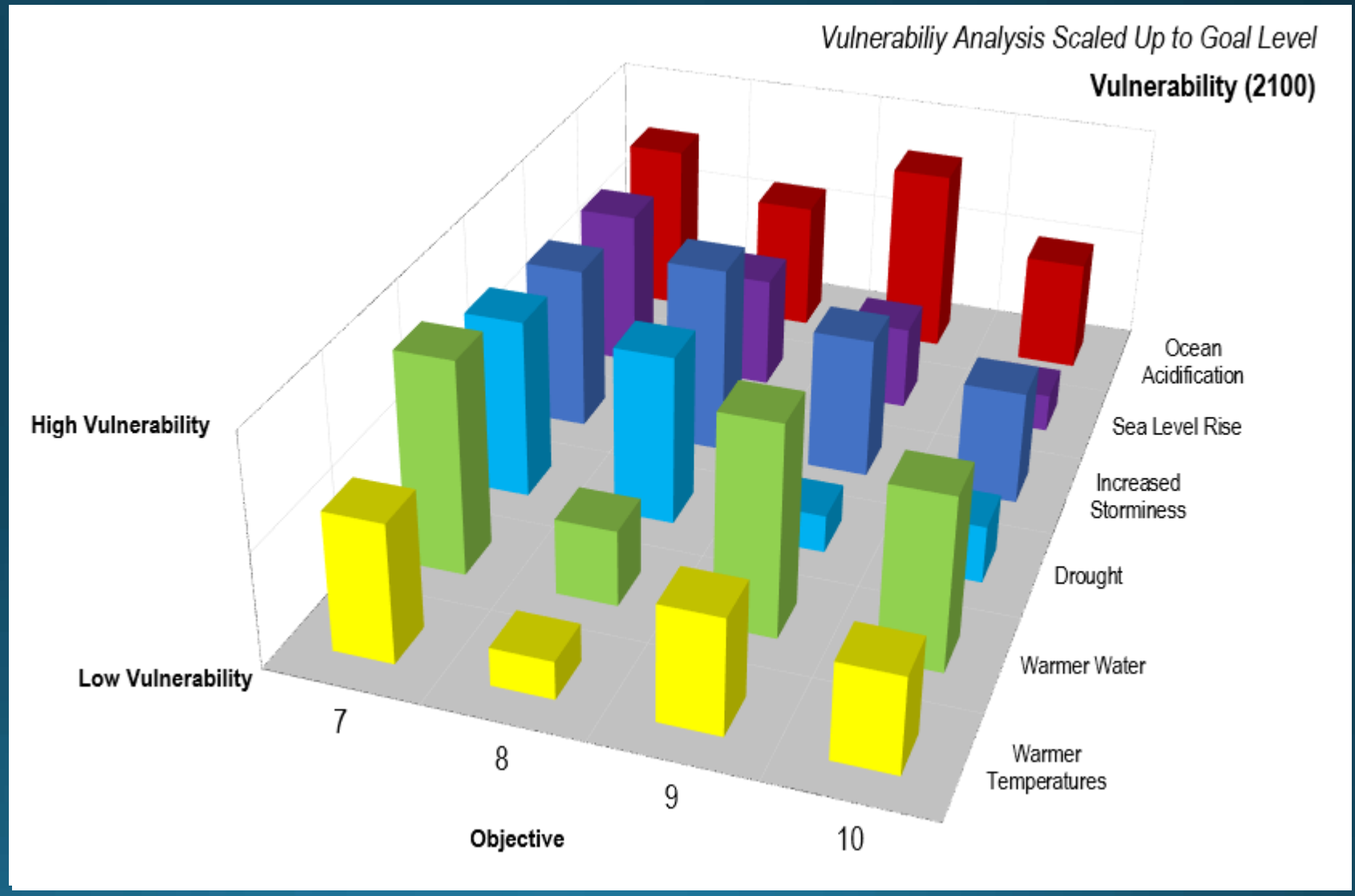
Goal 8 – Restore coastal bluffs, dunes, and sandy beaches

Higher vulnerability to drought, increased storminess, SLR, and OA

Goal 9 – Restore rocky intertidal and subtidal habitats

Goal 10 – Protect and restore open ocean and deep water habitats

Higher vulnerability to warmer water, increased storminess, and OA



Moving forward…

- Fine-tune to incorporate expert review at the goal-level
- Easily updated to incorporate current models and newly identified risks
- Combined with identified risks – vulnerability assessment becomes a powerful planning tool
- Can be used to identify those BRP objectives that are most vulnerable to climate change
  - Will be used for action based planning to update the BRP (2018)

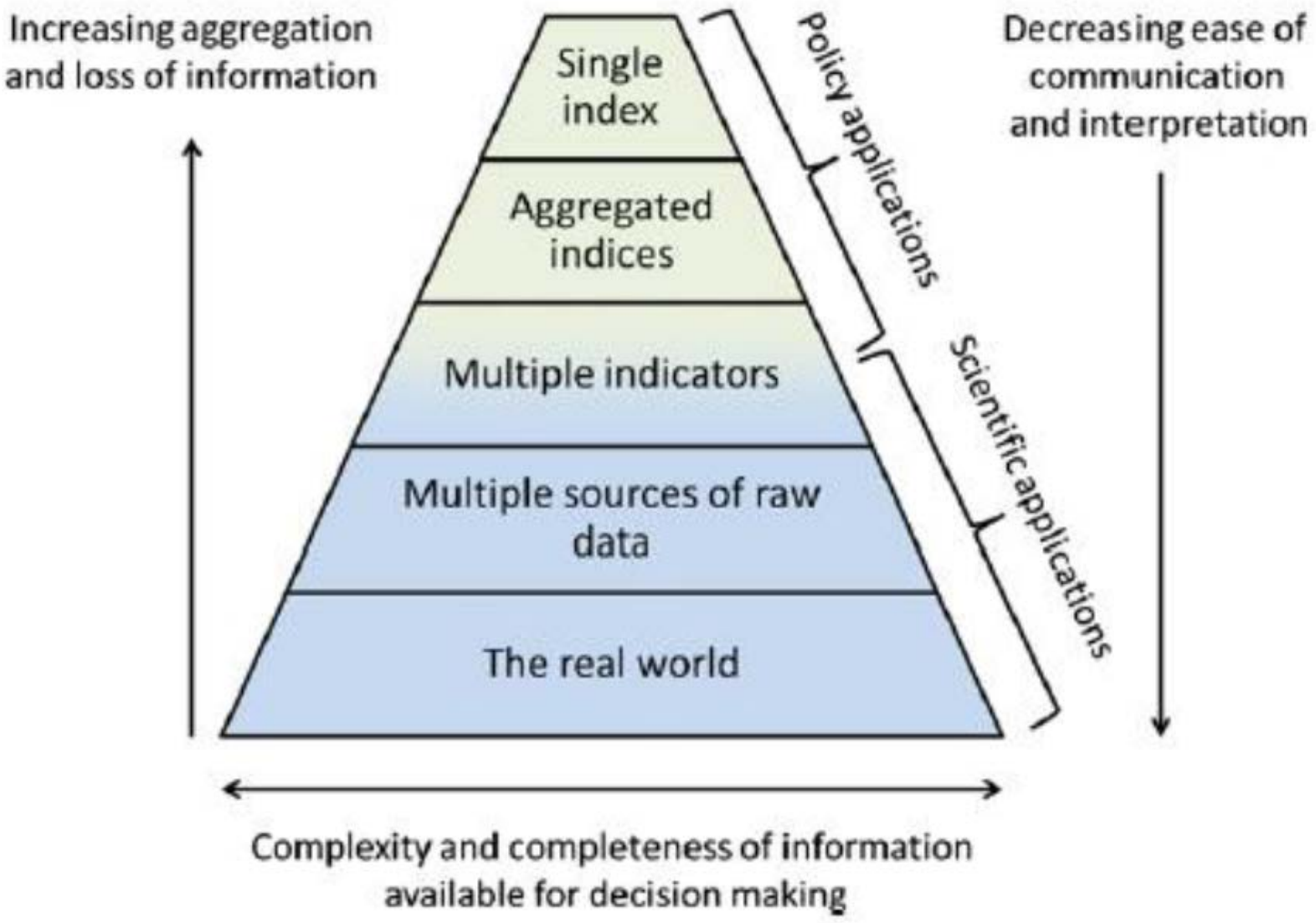
Questions for TAC

- We see the trends… how can we apply this tool to planning efforts?
  - How do next steps translate to action-based planning?
  - Which BRP objectives need modification?
  - Feasibility of objectives or goals? Threshold? Costs? Focus areas?
  - New / revised objectives? Factor in more adaptation?
- Visualizations?
- Scalability?
  - Goal-level average?
  - Error?
- Other feedback?

Sign up to review draft CCVA results

Goal	
1 – Improve water quality through treatment or elimination of pollutant discharges regulated under the current federal and state regulatory framework (7 objectives)	Water Quality
2 – Improve water quality through pollution prevention and source control (7 objectives)	
3 – Address potential impacts of emerging contaminants (2 objective)	
4 – Create/support policies and programs to protect natural resources (7 objectives)	Natural Resources
5 – Acquire land for preservation of habitat and ecological services (2 objectives)	
6 – Manage invasive species (5 objective)	
7 – Restore wetlands, streams, and riparian zones (8 objectives)	
8 – Restore coastal bluffs, dunes, and sandy beaches (2 objectives)	
9 – Restore rocky intertidal and subtidal habitats (4 objectives)	
10 – Protect and restore open ocean and deep water habitats (2 objectives)	
11 – Protect public health (5 objectives)	Benefits and Values to Humans
12 – Maintain/increase natural flood protection through ecologically functioning floodplains and wetlands (2 objectives)	
13 – Increase public access to beaches and open space (4 objectives)	
14 – Conserve water and increase local water supply (3 objectives)	

FIGURE 5. TRADE-OFFS BETWEEN COMMUNICABILITY AND INFORMATION RICHNESS



Abson et al (2012)