RESON

Regional Ecosystem Services Observation Network

A summary report of RESONs summer workshop: *Ecosystem unknowns and societal monitoring needs* June 28-29, 2021

This project is funded by the National Science Foundation's Coastlines and People Program and led by the University of California Santa Barbara

Executive Summary

The RCN's (Research Coordination Network) goal is to conceptualize and design a framework to guide the establishment of a biological monitoring network along the central and southern California coast. This Regional Ecosystem Services Observation Network (RESON) will monitor coastal ecosystems and ecophysiological stressors to understand the changing condition of our coastal ocean and the services it provides. Through a workshop series, the RCN will work with marine scientists, modelers, and engineers from academia and industry in collaboration with stakeholders and managers to design RESON. These workshops will identify and prioritize ecosystem indicator variables, identify knowledge gaps, and ways to close those gaps with novel technology.

RESON hosted their first virtual workshop on June 28 and 29, 2021 to determine from various coastal groups what their ecosystem monitoring needs are and to help articulate the societal need for RESON. Approximately 50 participants joined from academic, federal, state, local, NGO, and tribal groups.

Overall, participants want a better baseline of biological data such as species abundance and distribution, which can be established through higher spatial and temporal scale monitoring that spans various oceanographic systems. There is an urgent need to determine how organisms are responding to environmental stressors to understand the impact on ecosystem health and services. The most acute stressors that were of concern to the group were ocean warming, climate change, habitat loss, diseases, ocean acidification, hypoxia, and unsustainable use of resources. Suggestions to understand these stressors and their effect on the ecosystem included monitoring key species that can act as early warning systems for the rest of the ecosystem. This could provide indicators for overall ecosystem health and potentially show environmental tipping points.

There was also a strong emphasis on connecting ecological processes to social indicators and understanding how changing ecosystems will alter human use of the coast and environmental services. Other priorities were to include indigenous and local fishermen's knowledge into monitoring data, provide opportunities for community science, standardized data collection, and connect current biological datasets. People expressed that by gathering real-time biological data, RESON could establish risk assessments of species and ecosystems to support community needs and management decisions.

Contents

Overview

Coastal ecosystems are changing because of climate change, pollution, and overfishing. California's fisheries, coastal tourism and recreation, and overall community health depend on the wellbeing of marine ecosystems. While changes in our environment are readily measured through physical data, such as temperature, salinity, and oxygen, there is not a comprehensive network to understand how marine life is responding to these changes. Urgently needed are cheaper, faster, and high-quality ways to collect time-series data with broad spatial coverage that captures changes in marine ecosystems from plankton to whales.

Obtaining adequate spatial and temporal data is necessary to reveal regional and global shifts in marine communities. By creating a comprehensive monitoring network and standardizing ecological measurements, new biophysical links, dynamics, and emergent stressors could be detected. These new insights will help build and validate models to forecast future ecosystem change, which will improve our capacity for science-based decision-making for resource management and mitigation efforts.

The RCN (Research Coordination Network) will develop a plan for an integrated multiscale sensor and observation system to dramatically expand our ability to assess coastal change. This Regional Ecosystem Services Observation Network (RESON) will enhance coastal monitoring and provide a better understanding of ecosystem services and health. We will build a scientific, management, and education network across southern and central California that coordinates available expertise, prioritizes new techniques and infrastructure, and integrates these components into a cohesive implementation blueprint that will significantly advance our knowledge and understanding of the patterns and drivers of change in coastal systems.

The RCN will work with a diverse network of people, including researchers, practitioners, community members, recreational enthusiasts, commercial fishers, and tribal members to help guide and inform the RESON framework and its outcomes. Through a workshop series, the RCN will 1) identify and prioritize ecosystem indicator variables, 2) identify knowledge gaps, and ways to close those gaps with novel technological approaches, and 3) plan a multiscale sensor and measurement network to support ecosystem-based management.

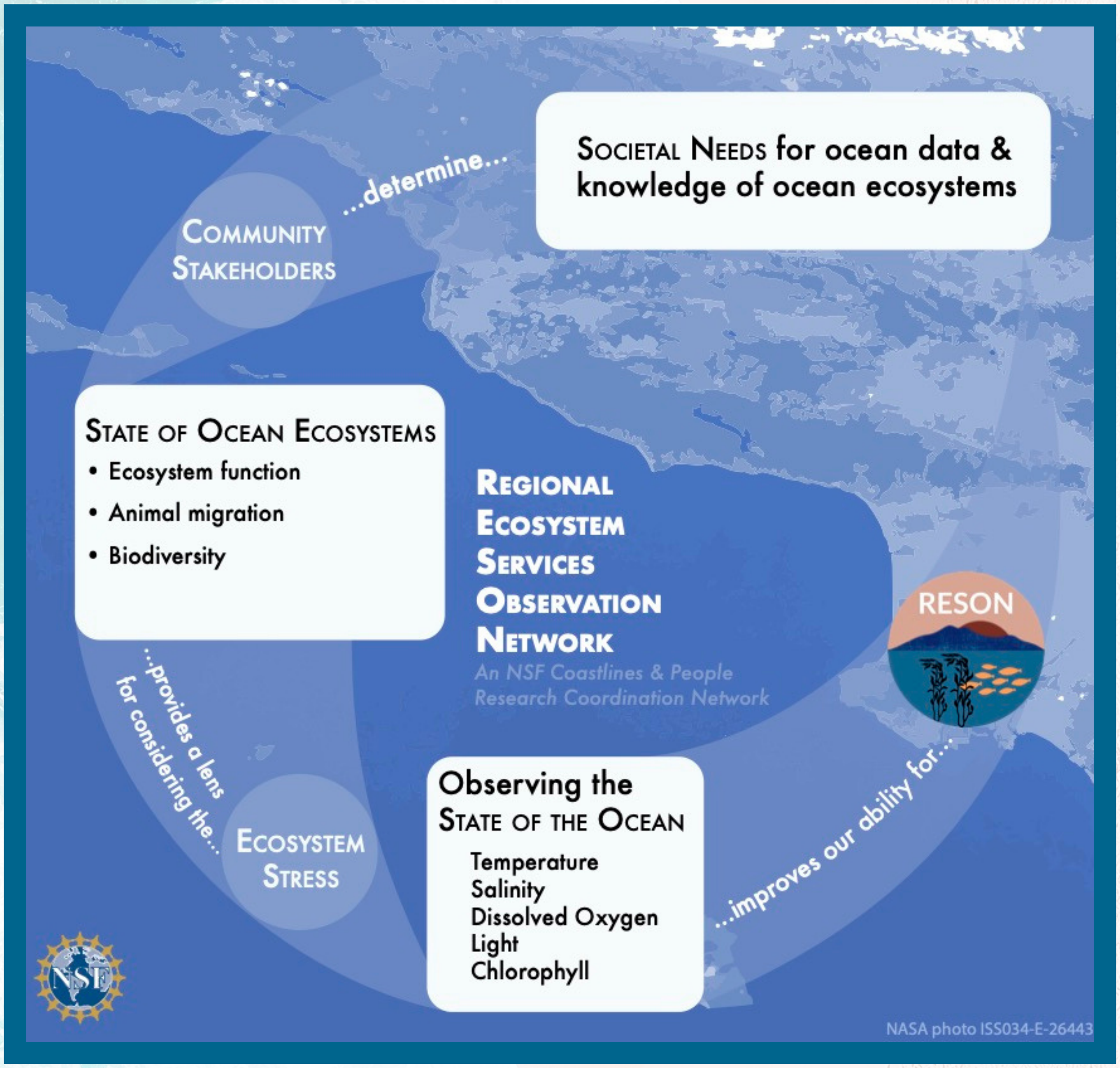


Figure 1: RESONs transfer framework of knowledge

Guiding the workshops is a knowledge transfer framework (Figure 1). Stressors on the environment, such as marine heatwaves or nutrient runoff, affect the state of ocean ecosystems. In particular, RESON will look at how stressors will impact ecosystem function, animal migration, and biodiversity. The health of these systems, which is critical to communities and industry, influences the need for certain ocean data and knowledge about ocean ecosystems. Working with communities to understand their societal needs will shape RESON, who seeks to enhance the ability to observe the state of the ocean. By developing a deeper understanding of ecosystem health and processes, ocean use and management can be improved. This first workshop prioritized working with various coastal groups to explore the societal needs aspect of the framework.

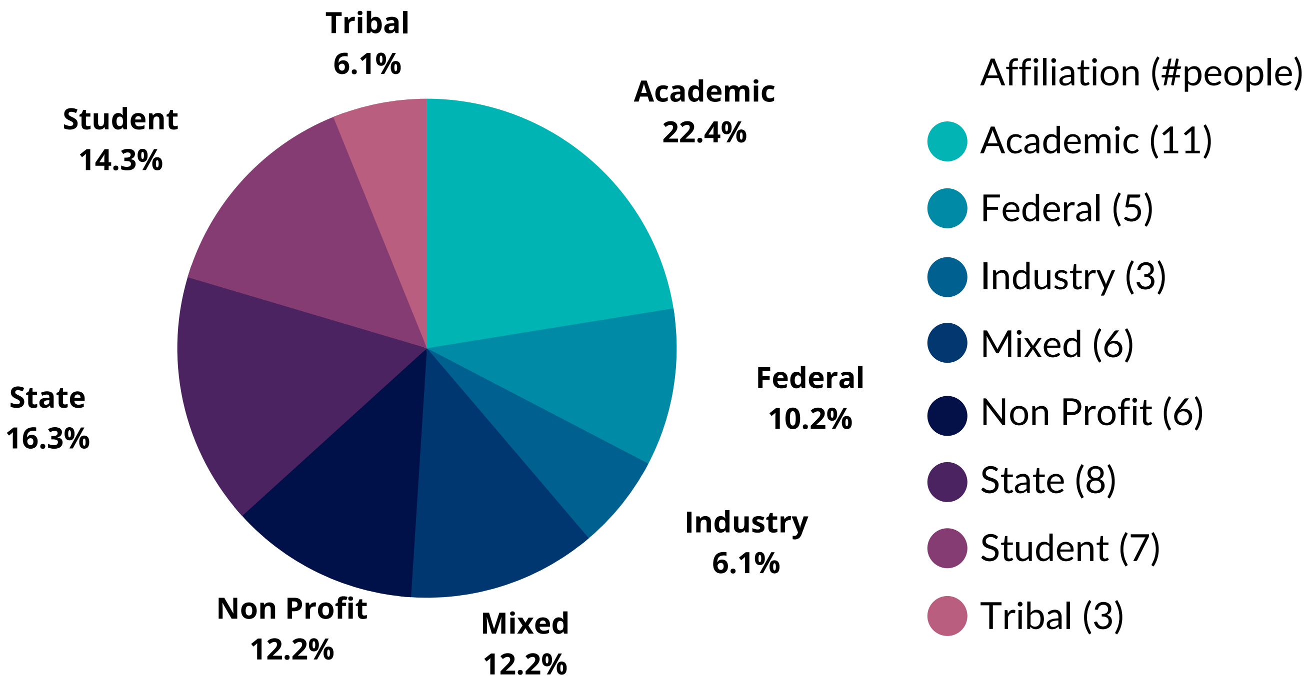
Stakeholder Workshop

On June 28-29 2021, RESON hosted their first virtual workshop, gathering a diverse network of people to help articulate the societal need for RESON.

Day 1 of the workshop prioritized understanding the most pressing marine ecosystem issues and unknowns for people and how that affects their livelihoods, while day 2 focused on how RESON could address those issues. Both days consisted of breakout groups to foster collaboration and more in-depth discussions. Prior to the workshop, 35 participants filled out an online questionnaire to understand their ocean priorities. These responses helped shape the workshop format. An overview of survey responses can be found in Appendix 1A.

49 participants joined on day 1 and 40 joined on day 2. The full list of participants with associated affiliation and areas of expertise can be found in Appendix 1B.

Figure 2: Affiliation of participants on Day 1



Day 1

Participants explored a series of questions in breakout groups to understand what ecosystem stressors are impacting individuals' livelihoods and how, and where ocean data is lacking. On day 1 in addition to answering 5 questions, groups were asked to provide 3-5 topics that were the most important to them surrounding these questions.

Question 1: What are the unknowns in the ecosystem that concern you?

Question 2: What do you need to know about the ocean ecosystem to improve your livelihood and support your community?

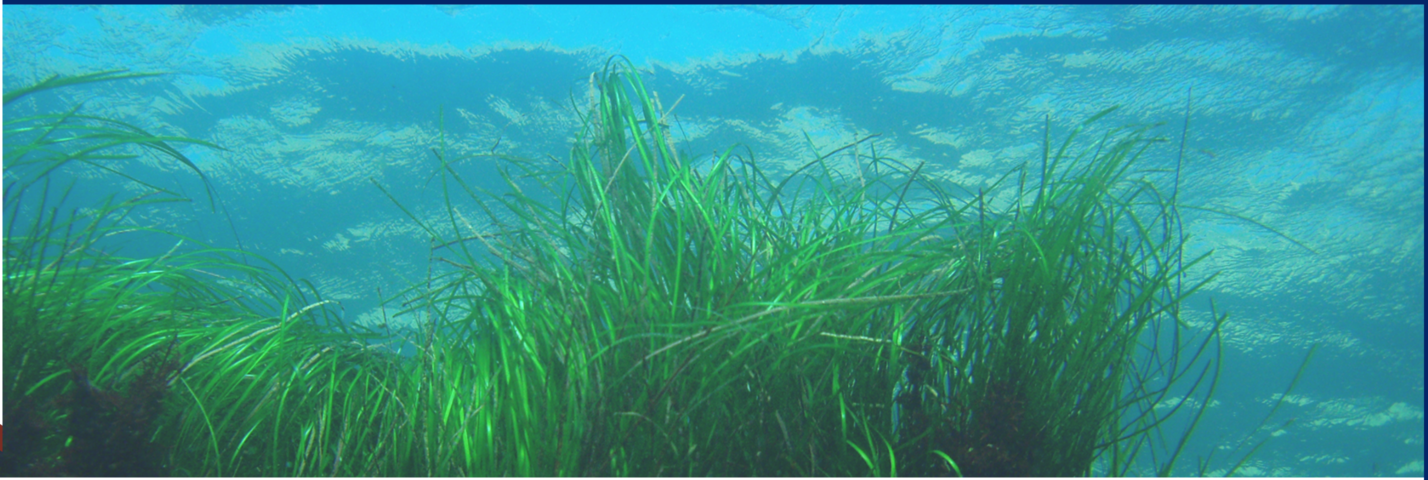
Question 3: What ongoing or potential changes and impacts in the ecosystem most concern your community?

Question 4: What information is lacking when trying to determine what type of day it is in the ocean?

Question 5: What are the negative consequences due to a lack of information about ocean life?

*For a full list of discussion notes for each question, see Appendix 2A.

Overall, groups are concerned about how environmental stressors are affecting the ocean ecosystem now and in the future, and how this will alter human use and activity. To understand the effects of these stressors on organisms and ecosystems, participants expressed the most interest in RESON exploring new ways to obtain higher temporal and spatial real-time biological data to establish better baselines.



By gathering higher resolution biological data, groups suggested RESON could inform on ecosystem tipping points, create health assessments, and connect data with social indicators to understand vulnerabilities. Connecting the human dimension to ecological monitoring has been lacking, and the group felt an acute need for this gap to be filled. This includes answering questions such as understanding how livelihoods could change as ecosystems shift, if we can rely on currently harvested species in the future, and how management can be improved based on better observations. The group highly valued including tribal and local fishermen knowledge into RESON and providing continuous opportunities for community science.

There are several networks that conduct biological monitoring, but there is a disconnect linking current data. Participants expressed the need to standardize monitoring, connect current datasets, and provide easy access to data that the public and managers can easily use. By providing dashboards or other products, the public could understand how actions are linked back to the ecosystem, and managers could address issues more effectively with real-time data. At the end of the day, each breakout group presented their leading topics and everyone voted on their top 3. (All group report out answers can be found in Appendix 2B.) 4 major themes emerged that the group prioritized to discuss in more detail on day 2.

Top Stressors

Climate change

Ocean warming

Diseases & pathogens

Unsustainable use

Habitat degradation & loss

Ocean acidification & hypoxia

Figure 3: The environmental stressors mentioned the most by participants

1) Community Engagement and Access
2) Ecosystem Baselines and Assessment Frameworks
3) Ecosystem Change from Human Use
4) Connecting Ecological Health with Social Needs

Day 2

For each theme determined on day 1, new questions were developed that participants explored in breakout groups. Detailed discussion notes for each question can be found in the appendix section 3A.

Theme 1: Community Engagement and Access

1. What local and traditional knowledge should be incorporated into understanding shifting ecosystem baselines?

2. What information would be most impactful for management for a healthy ocean?

Theme 2: Ecosystem Baselines and Assessment Frameworks

1. For observing the state of the ocean, what biological parameters are needed and at what scale?

2. How can we better connect physical data with effects on marine life?

Theme 3: Community Engagement and Access

1. What are the most urgent impacts that should be addressed?

2. What data is needed to inform us of their importance?

Theme 4: Connecting Ecological Health with Social Needs

1. What aspects of the ecosystem impact human activity?

2. How do communities across CA value the ocean differently?

Day 2

Community Engagement and Access

Engaging with diverse stakeholders and the broader community is a key goal of RESON. This aspect resonated with participants, especially collaborating with underrepresented communities who have normally been left out of conversations. Discussion groups suggested to engage early and often with indigenous, local, and fishing communities and conduct surveys and interviews to gather their knowledge on coastal systems. This could cover species spatial information, past histories of ecosystem health including species ranges and abundances, and gaining a better understanding of cultural uses of marine systems. It was noted with high importance for RESON to understand how to include Traditional Ecological Knowledge into the RESON framework. Further suggestions included conducting community surveys to understand access, use, and understanding of coastal habitats. Understanding local priorities and what people value about the ecosystem, will help guide RESONs data collection. Also, by working with these local communities and providing opportunities for collaboration and community science projects RESON would have closer ties with coastal communities to prioritize their needs and share information.

With regards to informing coastal management, groups proposed real-time monitoring, which is severely lacking especially for biological processes. Having data that could also be quality assured and controlled in real-time would provide relevant information for managers needing to make day-to-day decisions. Also, by monitoring sentinel species and understanding their thresholds and metrics, they can provide a baseline status for how the ecosystem is functioning. This data collection would support the expansion of baselines, providing deeper knowledge on ecosystem health trends and informing management practices. Participants suggested that providing standardized data collection techniques and connecting data through a centralized database could allow for higher quality products, such as assessment frameworks, to characterize ecosystem health and change. Participants were also highly interested in guiding management decisions by understanding the human perception of the ocean and how and why people are using the coast.

Day 2

Ecosystem Baselines and Assessment Frameworks

There was a large focus on obtaining higher spatial and temporal resolution data on critical species that can act as early warning systems for the ecosystem, such as monitoring pteropod shells for ocean acidification. Participants suggested using rugged technology that can be shared and used across users, providing long-term information spanning across various ecosystems. Obtaining data at the appropriate scales, however, is necessary to understand thresholds, tipping points, and provide accurate inputs for future ecosystem predictability models. Further, understanding what scales are necessary for enhancing management practices and connecting biological, physical, and human well-being scales were of interest to the group. Potentially creating a nested design of scales, including coarser-resolution of off-shore data with increasingly finer resolution data closer in-shore, could provide more relevant data. Below is an example of different monitoring scales and their relevant data streams, where participants remarked that the 1km - 1m scale is under-observed and needed the most.

100km Scale

- Species-habitat relationships
- Population trends and changes in ranges
- Trophic dynamics
- Nutrients and zooplankton foundation species

10km Scale

- Species-habitat relationships
- Abundance surveys
- Recruitment surveys

1km - 1m Scale

- Species-habitat relationships
- Larval survival

Day 2

Ecosystem Baselines and Assessment Frameworks

Connecting physical and biological data is necessary to understand how environmental stressors are affecting ecosystems, like marine heatwaves on phytoplankton. To do this, participants again put a heavy emphasis on co-locating physical, biological, and chemical observations through routes such as sentinel sites. For current monitoring, groups suggested combining various data sources with in-situ physical measurements such as finding ways to mesh remote sensing with biological datasets. It was acknowledged, however, that combining or merging existing datasets would be difficult due to the lack of standardization between data.

Critical Species

Abalone	Phytoplankton
Anchovy	Pismo clams
Bluefin tuna	Seabirds
Crabs	Seagrass
Deep sea coral	Sea stars
Grouper	Sharks
Kelp	Snails
Krill	Sponges
Marsh	Squid
Microbes	Steelhead trout
Olivella	Urchins
Oysters	Wetland

Figure 4: The critical species that participants were most interested in for RESON to monitor

Not only does data need to be combined, but there are very few long-term data sets that are at a high temporal and spatial scale. By exploring ways to automate technology such as time-lapse cameras, aerial surveys, and eDNA, RESON could provide the long-term monitoring data that is necessary to model habitats and species distributions. Automated technology could also provide data at multiple scales and facilitate linkages between data streams. This data could be integrated into risk assessments, which would provide visualizations for communicating risk to managers and the public. Determining which species or communities to monitor is a key goal for RESON and the important species that were mentioned for monitoring during the breakout groups are listed in Figure 4.

Ecosystem Change from Human Use

One of RESONs goals is understanding how environmental stressors are going to change ecosystems, which is critical to understand how environmental services are going to change in the future. The table below describes the stressors that participants are most concerned about. Several were prioritized, which are listed in the first column.

Participants suggested using numerous low-cost rugged sensors to monitor key species, including harvested species. Long-term data on population, habitat and migration ranges, and understanding individual species stress would provide insight into how these environmental stressors affect organisms and their habitat.

Climate change	Sea level rise	Food insecurity
Ocean warming	Plastics	Emerging contaminants
Diseases & pathogens	Invasive species	Harmful Algal Blooms
Unsustainable use	Anthropogenic noise	Transportation development
Habitat degradation & loss	Contamination & pollution	Renewable energy development
Ocean acidification	Coastal armoring	Debris flow from fire
Hypoxia	Coastal resilience projects	Fire retardants

Day 2

Connecting Ecological Health with Social Needs

A major theme that dominated conversations is the lack of connection between ecological processes and human use of the environment. Understanding human perception of the coast and how this influences activity along the coast may provide insights into how we can make monitoring efforts more impactful. Participants said human use of the coast is linked to various aspects, the top ones being a sense of place and well-being within the coastal environment which impacts tourism, recreation, and jobs. How people use the coast was also linked to resource availability and ease of access to the coast. How the ecosystem looks and behaves was also an aspect impacting human activity. This included physical properties such as water temperature, clarity, shore cleanliness, intact habitats, and interactions such as changing species distribution and migration patterns. Participants were also concerned about communities' apparent lack of connection to the ocean and want to determine why this is.

Understanding how and why people use the coast is also heavily tied to specific communities. Recognizing the impact of geographic location, cultural and socioeconomic statuses, and differences in education are important aspects the group wants RESON to consider, especially with community science and education endeavors. By understanding human coastal activity, RESON can help assess the most pressing ecosystem issues and their association with human usage of coastal areas.

Next Steps

Overall, the workshop conducted by RESON provided a valuable space to bring together multidisciplinary groups to understand their concerns and needs in the California coastal ecosystem.

We are excited about the opportunities that RESON can play in expanding and connecting biological monitoring. Creating a network of researchers, practitioners, community members, commercial fishers, and tribal members will provide a robust connection between our coastal ecosystem and human use of the ocean.

Now, with a better understanding of the societal needs of RESON, we want to understand the technical possibilities to enhance biological monitoring. Our next workshop will explore what new or underused technology could provide higher spatial and temporal sampling of data.

Thank you to those who took time to provide input through the workshop or online questionnaire. We are grateful for the insight each of you provided to help shape and provide direction for RESON. We look forward to continuing the dialogue for RESONs role in the California ecosystem to provide quality ecosystem monitoring as we look towards a healthier ecosystem.

We want to continue to hear from you, so please reach out to us with any questions or comments.

Contact: Ali Burgos, RESON Project Coordinator
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For updates, join our newsletter found on RESON.msi.ucsb.edu
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Appendix

1A: Stakeholder Survey and Response

Prior to the workshop, the project PI and coordinator met one on one with previously identified stakeholders and tribal members. People to reach out to were determined by their research, program goals and priorities, work in management or policy, or use of the coastal environment.

We asked each group to fill out a brief survey pre-workshop. Not every participant filled out the survey, nor did every respondent attend the workshop. These questions included:

1. What are your priorities with regards to the ocean (including estuaries)?
2. What information (i.e. data, tools, expert knowledge) is most important to you now in meeting your priorities?
3. What additional information could improve your ability to meet your priorities?
4. Do you feel you have enough access to experts to help you?
5. Is your expert access coming internally or externally?
6. Is there critical expertise missing to help you meet your priorities? If so, what?
7. What are the ecosystem, ocean, or physiological stressors that you consider important to your target audience?
8. What do you hope to get out of this project?

A full list of responses can be found here

Appendix

1A: Stakeholder Survey and Response

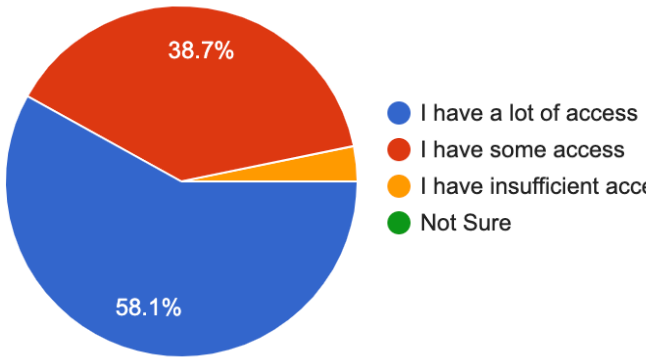
Across the survey, several responses were repeated and came to the forefront.

1. Priorities: Long term monitoring, ocean management, understanding climate change effects, understanding human use, understanding ecological dynamics, and network collaboration

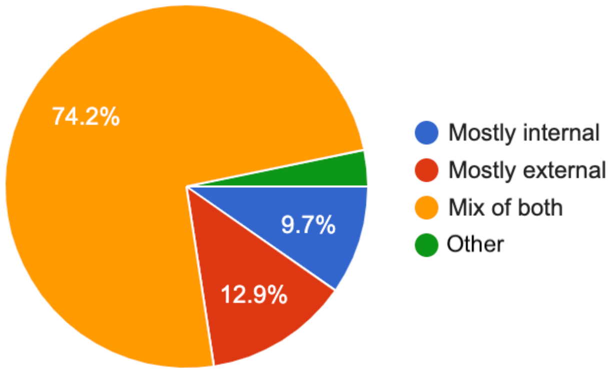
2. Important Information: Suite of ocean data, human use data, visualization and mapping tools, and data integration

3. Additional Information: Long term regional monitoring, data integration, human use data

4. Access to experts



5. Internal or external experts



6. Missing Expertise: Ecosystem dynamics, human dimension, data integration, new technology for monitoring

7. Important stressors: Temperature and heatwaves, ocean dynamics, natural variability, hypoxia, dissolved oxygen, nutrients, sea level rise, harmful algal blooms, species abundance and distribution

8. Project hopes: Build new partnerships, prioritize ecosystem indicators, use efficient technology, human dimension integration

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B

Appendix

1B: Workshop Participants

Name	Affiliation	Area of Expertise
Alex Harper	CeNCOOS	Ocean Obs + Chemical Oceanography
Ali Burgos	UCSB	RESON project coordinator
Amber McEldowney	UCSB	Student
Amelia Ritger	UCSB	Student
Andrea Mills	Island Packers	Science educator
Andres Aguilar	CSULA	Conservation biology
Andrew Thompson	SWFSC/ CalCOFI	Fisheries + larval fishes
Annie Lovell	UCSB	Student
Barbara Block	Stanford	Tuna and shark tagging
Bill Standley	Bureau of Land Management	Natural Resource Specialist
Bob Miller	UCSB	Coastal marine ecology
Camille Pagniello	Scripps	PhD Candidate
Chandra Krintz	UCSB	Computer science
Chris Caldow	NOAA CINMS	Marine spatial planning + reef ecology
Clarissa Anderson	SCCOOS	Ecological forecasting + HABs
Corey Garza	CSU Monterey Bay	Landscape ecology
David Gillet	SCCWRP	Ecologist
David Kushner	CINP	Kelp forest ecosystems
Duncan Mactavish	SOFAR Ocean technologies	Coastal oceanography
Ed Parnell	Scripps	Coastal Shelf ecologist
Emanuele Di Lorenzo	GA Tech	Ocean dynamics + modeling
Emily Parker	Heal the Bay	Coastal + marine scientist
Erin Satterthwaite	CalCOFI/ CA SG	Marine ecology + ocean obs
Francisco Chavez	MBARI	Biological oceanography
Halley McVeigh	UCSB	Student

1B

Appendix

1B: Workshop Participants

Name	Affiliation	Area of Expertise
Hayley Carter	Ocean Science Trust	Senior Climate Science Officer
Jenny Selgrath	NOAA CINMS	Ecology-social science
Jeremy Jun Ming Rubin	Stanford	Student
Julia Coates	CDFW	Fisheries modeling
Karen McLaughlin	SCCWRP	Biogeochemistry + human impacts
Karin Lin	TNC	Programs associate
Kerri Dobson	NOAA OAP	OA + coral physiology
Lena Capece	UCSB	Student
Lindsay Bonito	Ocean Protection Council	MPA Program Manager
Marisa Nixon	WCOA	Marine planning
Mariza Sullivan	Coastal Band Chumash	Traditional indigenous knowledge
Mark Reynolds	TNC	Marine Scientist
Megan Medina	SCCOOS	Biodiversity
Mia Lopez	Wishtoyo Fnd.	Traditional indigenous knowledge
Michael Quill	Los Angeles Waterkeeper	Ecopsychology
Molly Troup	SB Channelkeeper	Science and policy associate
Natalie Dornan	UCSB	Student
Nick Nidzieko	UCSB	Marine circulation + autonomous tech
Phyllis Grifman	USC Sea Grant Program	Social science + marine policy
Stephen Schroeter	CA Sea Urchin Commission	Ecology + Invertebrate Fisheries
Steve Weisberg	SCCWRP	Molecular technology
Teresa Romero	Santa Ynez Chumash Env. Office	Traditional indigenous knowledge
Tom Bell	WHOI	Remote Sensing + Ecology
Zack Johnson	SOFAR Ocean technologies	Remote sensing + citizen science

2
A

Appendix

2A: Day 1 Detailed Notes

* Notes are synthesized from all breakout groups

Question 1: What are the unknowns in the ecosystem that concern you?

- Want faster & higher resolution observations for these unknowns:
    - Population dynamic changes
    - Abundance
    - Settlement
    - Biodiversity
    - Management-relevant scales (and determining these scales)
    - Larval recruitment
    - Deeper waters/ pelagic zone
    - Water column data
    - Sand transport
    - Large predators
    - Fisheries
- Understanding local vs. global impacts
- Are fishery models working?
- How are fisheries impacting humans?
- Climate change stressors and their interaction with the ecosystem
    - How will social + ecosystem services change
    - What are the impacts on fished species + life dynamics
    - How will seafood market dynamics change
    - What are the impacts on biodiversity
    - How will transportation change
- How organisms/ecosystems respond to environmental conditions
    - How and when?
    - Climate change impacts
    - Contamination impacts
    - Sea level rise impacts
    - Habitat alteration impacts
- Relationship between physical features and animal distributions
- Biological tipping points; What are the tolerance thresholds?
- Lack of baseline data
    - Should incorporate indigenous knowledge
    - What is natural vs. human impact
- How do we link integrated effects and data?
    - Integrate methods
    - Linking physical, biological, and human wellbeing - how are they connected
- Not knowing what sensors are important for stakeholders
- MPA's
    - Lacking data on species spillover
    - Is management more beneficial with intervention or without?
- Are existing management tools enough?
- Changes in benthic magafauna

Appendix

2A: Day 1 Detailed Notes

* Notes are synthesized from all breakout groups

- Ocean uses, impacts, marine spatial planning
  - Platforms
  - Oil rig decommissioning
  - Offshore wind impacts
  - Aquaculture impacts
  - Human impact
  - Agricultural inputs
  - Fishing permits
- Stressors - lacking monitoring; what are the effects? Are changes oscillating, linear, or cumulative?
  - Ocean Acidification
  - Hypoxia
  - Microplastics/ marine debris/ pollution
    - Sorption, digestion, translocation
    - Standardized methods
  - Ocean warming
  - Disease/ pathogens
  - Invasive species
  - Changing chemistry - What happens when oxygen minimum zone increases?

<u>Question 2: What do you need to know about the ocean ecosystem to improve your livelihood and support your community?</u>

- Effectiveness of fisheries management - need baselines
  - How do species respond?
  - Create assessment framework
  - What are the relevant conditions in the next 2-4 days?
  - How will aquaculture development impact near and off-shore resources?
  - Adapt permits in response to stock status
- Connect all data collection sources
- Link lab experiments with coastal observations
- OA observations in deeper water and intertidal zones
  - Species response to OA - use relevant indicators (temp, pH, O2, pCO2)
  - No permanent funding to long term monitor OA
- Link coastal ocean problems to land-based ones
- MPA's
  - How do we protect the target species and promote resilience?
  - How do we restore and/ or improve them?
- Threshold and assessment frameworks to interpret observed data
- Knowledge of the impact of local inputs
- Would land-based management slow ecosystem changes?
- Knowledge of extreme weather risk
- What are mitigation strategies for kelp or seagrass?
- More time for conversations to reach consensus and understand these places

2
A

Appendix

2A: Day 1 Detailed Notes

* Notes are synthesized from all breakout groups

- Harvesting
  - Can we rely on the same species to harvest in the future?
  - What is the sustainable harvest for all species?
  - Need higher resolution harvest data to link ecological changes with fisheries practices
  - What is safe to eat and when?
- Need incentives to help people take care of their resources
  - E.g. fishermen restoring at the same time they fish
- Using the community to get data
  - Develop protocols/ methodologies so data collection can be entry-level
- Human dimension monitoring
  - Defined for fisheries but not other ecosystems
  - Who is using the environment and why
  - Why do people care/don't care
- Where is safe to swim and when?
- How do we prepare young generations about future climate change
- Species status and trends that are important to communities/ agencies
- What resources/ species can we monitor that are indicators for the rest of the ecosystem
  - How do species respond to stressors, what makes them vulnerable?
  - What can be done to restore species/ mitigate impacts?
  -

<u>Question 3: What ongoing or potential changes/impacts in the ecosystem most concern your community?</u>

- Stressors:
  - Ocean warming
  - Climate change
  - pH changes
  - Acidification
  - Sea level rise
  - Biodiversity/ habitat loss
  - Anthropogenic noise on animals
  - Coastal discharges on offshore/ receiving water communities
  - Invasive species
  - Pathogens
  - Plastic
- Ecological surprises
- Abundance changes in harvested species
- Irreversible community composition changes
- Mis-match between the scale of data collection and policy/ management decisions
  - E.g. by the time results are published or policy decisions made, they are outdated with how quickly the environment changes
- Deploying new tech. must lineup with existing tech
- Lack of monitoring
- Tourist boat traffic impacts
- Lack of ocean access/ privatization of the ocean
- Change relative to historical data

Appendix

2A: Day 1 Detailed Notes

* Notes are synthesized from all breakout groups

- Lacking a rapid response team/ assessment for monitoring disturbances
  - What are the major things we would want to know about a particular disturbance and its impacts?
- How will livelihoods change as ecosystems shift
- How will we adapt to new energy facilities
- How do we determine areas best zoned for aquaculture and sustainable fishing?
- Can we conduct a survey of different communities and their concerns?

Question 4: What information is lacking when trying to determine what type of day it is in the ocean?

- Assessment frameworks for climate change impact & toolkits to communicate biological impacts to managers
  - Accessible health dashboards
- Satellite data for near-shore
- Easy access to data + data portals
- Connecting social scientists and communicators
- Methods standardization
- Knowing what ecosystems/ species are most vulnerable to certain environmental stressors and their response
- Light meters - to understand visibility
- Ecosystem moorings with physical data
- Thresholds and context - baselines
- Electrochemistry
- Biodiversity trend data
- Real-time high-resolution data - HAB alerts, biodiversity, water quality, spills, turbidity
- Where and what human activities are taking place at the coast
- OA data
- Where animals are to reduce ship strikes/ gear entanglement

Question 5: What are the negative consequences due to a lack of information about ocean life?

- Limiting fishing
- Not accurately determining what will be used by people + what will be protected for wildlife
- Lack of sensible management decisions/ lack of action
- Continuing preventable impacts that will be hard to reverse
- Lack of public awareness/ understanding of how actions are connected to ocean life
- Overusing the ocean
- Missed opportunities to connect with oceans and other stakeholders
- No data to inform human activities
- Inability to predict change
- Don't know what we're changing in the environment
- Addressing incorrect stressors
- Improper allocation of funds
- Reactive vs. proactive management strategies

2
B

Appendix

2B: Day 1 Group Report

Group 1

1. We need more observations at relevant spatial and temporal scales
2. We need better information on how organisms respond to stressors and what are the mechanisms/ indicators of those responses
3. We need assessment frameworks- thresholds, tipping points, shifting baselines, seasonal/annual forecasts
4. We need more equitable access to science and technology - better linking those in need of data, democratizing access

Group 2

1. Baselines across multiple scales (time and space)
2. Community engagement, collaboration (including sharing data) & education, particulary overlooked/excluded/marginalized groups
3. Connecting ecological & social indicators to understand vulnerabilities

Group 3

1. Societal impacts of these stressors/ indicators unknown:
    a. OA and hypoxia
    b. Disease and pathogens
    c. Microplastics
    d. Sea level rise
    e. Impacts on megafauna (benthic)
2. Data Limitation
    a. Real-time high-frequency data collection and low frequency large spatial scale data collection
    b. Need to think critically about what data we want and the timescale associated with that
3. Interpretational limitation
    a. Connectivity between ecosystems
    b. Tipping points and thresholds
    c. Underutilized synthetic products that span scale
    d. Ensuring communication and dissemination of data to managers/policymakers (end-user stakeholders) avoiding misinformation

Appendix

2B: Day 1 Group Report

Group 4

1. Cascading ecosystems: How will climate change affect entire ecosystems (acidification, oxygen, temperature)
2. Can human communities and industries adapt to changing climates" Water quality, coastal habitats, sea level rise, food safety
3. What are potential changes due to human use? Need to predict regions of importance (aquaculture, energy, recreation)
4. Communication: We need to communicate the importance of ocean health to the right people in the right way
5. Data needed: We do not have baselines, deep ocean, biological vs. physical

Group 5

1. Temperature impacts
2. Understanding societal benefits of the ocean
3. Access to information/ data
4. Understanding how changes in biodiversity affect the interests in different communities
5. Changes in public access to ocean resources (e.g. overfishing, energy development)

Group 6

1. Understanding the spatial diversity of what communities are concerned with along the coast and what decisions need to be made in this regard, specifically, what decisions or questions will the monitoring network help these communities with
2. Who is the audience community of RESON (e.g. scientists, people, managers, policymakers)? What value will they get out of the project?
3. What core baseline biotic and abiotic data do we need to understand variability and social-ecological-climate impacts (e.g. historical, setting new baselines, state variables vs. function indicators, biodiversity, human metrics)

3A

Appendix

3A: Day 2 Detailed Notes

* Notes are synthesized from all breakout groups

Session 1: Community Engagement & Access

1. What local and traditional knowledge should be incorporated into understanding shifting ecosystem baselines?

- Need to define our baseline
    - Use today's situations as a baseline moving forward
    - Use TEK to expand baseline knowledge
    - New ways to define baselines beyond quantitative
    - How do we tell the story? Ingigenous > colonizers > hunters/fishers > industrial > present
    - Geologic history, how far back should RESON go?
- Engage indigenous, local, and fishing communities (also underserved/unheard - subsistence anglers, tidepool collectors)
    - Engage early and often
    - Community surveys + individual oral interviews - they decide what to contribute
        - Gather spatial info (historic ranges/populations/abundances), maps of harvesting areas, fisheries, MPAs, local fishing
        - Put histories into a database (interview oldest ocean users)
        - Use TEK to characterize climate forcings (ENSO)
        - Understand cultural uses of marine ecosystems
    - Ask them to help with data collection (fishers feel excluded)
        - Can offer stories, trends, collaborations
        - Species compositions, catch, effort, gear types, environmental conditions
    - Create a searchable database for ecosystem trends
- Allow for community users to input data or interact with it
        - Create a centralized database for longer-term monitoring
    - Use the info to inform/ direct monitoring efforts and ecological research programs
    - Community surveys and assessments about access, use, and understanding of coastal habitats
        - Ensure results are shared back with the community
        - What are local priorities? What do they value about their ecosystem?
        - What end products/ deliverables are the most impactful?
    - Important to frame questions and use correct language
    - Better understanding of culturally, spiritually, and aesthetic benefits about coastal/ocean regions
    - Let them decide what needs to be prioritized
- Look at BC and PNW for how scientists are working with communities
        - Philippines - fisheries app for data collection and citizen involvement
        - Co-monitoring and management
- Think about the transition of data <--> information <--> story
    - Need to tell the story to make data relevant to communities
- Incorporate historical documents - photos, maps, newspaper articles
- Match historical accounts of impactful ecological events with climate data
- Create a map of stakeholders for each area/ecosystem (contact community organizers such as PCFFA, MPA Collaborative, Climate Collaboratives etc.)
- Use policy drivers to inform data collection
- Survey beachgoers at MPAs to know what languages are needed to translate
- More collaboration with social scientists

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3A: Day 2 Detailed Notes

* Notes are synthesized from all breakout groups

2. What information would be most impactful for management of a healthy ocean?

- Sentinel taxa - know their thresholds and metrics, know indicator species and status of their baseline
- Information on mechanisms of impact for factors like temperature + pollution
- Long-time series to see changes
  - Using current datasets to their fullest extent, but 50 yrs is not long enough
  - Need to be careful with 'long' sets like PISCO starting in 2000
  - Use recent paleontological data + combine it with long-term datasets
- Understand/ analyze which active management interventions have been effective
  - Restoration, MPAs, artificial reefs, species enhancements/ removals, assisted migrations
- Need more locations with paired biological + chemical/physical monitoring
  - Create sentinel sites to track ecosystem tipping points
- Data on pathogens - useful for fisheries
  - Pelagic monitoring, larval sampling, molecular
  - Know what key species it is affecting
- Real-time QA/QC data
- Assessment frameworks for characterizing ecosystem health and change
- More spatially distributed monitoring data - what communities are changing from Mexico to Monterey?
- Human monitoring - Understanding how people use and understand the ocean - what are the attitudes, perceptions, + attachments?
  - Who is using coastal resources? Who isn't?
  - Why are they using them? Why aren't they? And how?
  - What information do they have that we don't?
  - Compare how people impact the ocean with their use
- What are policies that are working to improve ocean health worldwide?
  - Can they be strengthened/ repeated?
- How are communities planning for climate change
  - What are they concerned about with regards to climate impacts
  - What should they be concerned about?
- Data consistency and longevity
- Smaller spatial and temporal scales
  - Link to communities in the end
  - Think about management outcomes and policies it can inform
- How biological, physical, and chemical changes interact with each other
- What will cumulative climate change impacts do?
- Species distribution and abundance on relevant time/ space scales
- Where/ how resources are being extracted
- Heal the Bay Beach Report Card - good example of data and use
- How do we define a healthy ocean? (clean, abundant fish etc.)
- Disseminate information to end-users meaningfully
  - How to communicate info to underserved/ minority populations?
- Educate people at a young age
- Is management based on useful long-term baseline data or not?
- Documenting collapses and recoveries
- Information important for spatial planning (wind farm, aquaculture, desalination plants)

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3A: Day 2 Detailed Notes

* Notes are synthesized from all breakout groups

Session 2: Ecosystem Baseline & Assessment Frameworks

1. For observing the state of the ocean, what biological parameters are needed and at what scale?

- Biodiversity
  - Species abundance, biomass, recruitment, species type variance, growth & distribution data
- What are the best indicators/ metrics to observe things like OA?
- Use the condition of key indicator species as early warning systems
  - E.g. Pteropod shell condition for OA
- Size/ demographic data on important species (sea stars, urchins, kelp, abalone)
- Indicator species - pick ones that are of interest in themselves
  - Data on year 1 size classes
  - Changes in fishery/ managed species catch data
  - Track range shifts statewide - avoiding or clustering? why?
  - Track disease/pathogen outbreaks of selected species
- How are different datasets comparable - to track baselines
- Temporally consistent data
- What are the gaps and where is the need?
- What are the needed scales for management (30x30?)
- What are the scales needed inside vs. outside MPAs or restored vs. non-restored areas?
- Seagrass, kelp, marsh, wetland data
- Species that indicate overall health of an area (grouper/ snappers)
- Create protocols/ technology that's cheap and accessible to share with everyone
  - Prioritize quality over quantity
- Overall goal = predictability of ecosystems and species
- Measure in-situ physical environment so we know why species abundance is changing
- Sensors on/near animals - animals as oceanographers
  - Concerns with impacts, change in behavior or survivorship
- Scale down ROMS model to biologically relevant scales
- Resident vs. transient species
  - Ecological vs. biological connections between species to determine cascade effects on community/ ecosystem scale
- Each location is unique - standard monitoring might not work
- Regular check-ins (~3 months) with locals to get input on area status
- Be proactive (not reactive) in how we do research and timing of measuring these variables
- Need more than 1 scale
  - Monitoring studies over various 'boxes' 1km, 5km, 100km w/ census data
  - 100km Scale:
    - Species-habitat relationships (are we managing at scales important for species)?
    - population trends & changes in ranges
    - trophic dynamics (sea birds, prey)
    - Nutrients and zooplankton foundation species
  - 10km Scale:
    - Species-habitat relationships
    - Abundance surveys
    - recruitment surveys

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    - 1km - 1m Scale (under observed and needed):
        - Species-habitat relationships
        - Larval survival (1m) - eDNA and glider data
- How data is synthesized and interpreted and the rate at which it's done is important for thresholds and tipping points
    - Nested design with higher resolutions closer to shore
- Balance of micro and macro parameters on specific environment
- Seabirds, microbes to magafauna, deep sea coral, sponges

<u>2. How can we better connect physical data with effects on marine life?</u>

- Outfit existing biological sites with sensors
    - Prioritize these 'flagship' sites where there are high-quality long-term physical + chemical observations
- Monitor species distribution with depth across the shelf
- Compare the 4 ~40+ yr biological data sets in SoCal Bight along with physical data available to answer this question
- Model habitat and species distributions in current and future conditions
    - Time series of species as functions of physical variables
- Connecting/ validating models and other data with in situ physical data
- Risk assessment of species, ecosystems, and habitats
- Combine remote sensing and biological monitoring (ground data or physical)
- In-situ data on the physiology of diverse species (sessile + mobile)
    - Lab + field experiments to identify mechanisms affecting physiology, survival, etc.
    - Time lapse cameras co-located with physical data (DO, temperature, salinity)
    - Remote cameras hand collected - community science projects
    - Aerial surveys for grass/kelp coverage with in-situ physical parameters
- Merge existing datasets
- Create better visualizations, synthesis products + communication material for communicating data + impacts to public
- Climate modeling
    - Determine how climate impacts marine life
    - Connect historical physical data with future predictions
    - E.g. determine the ideal temperature of a fish to predict changes in range or predict habitat loss to inform conservation
- Model time series of species as functions of physical variables
- Marine program (UCSC) connected with Audubon to connect black oystercatcher abundance and behavior/health and intertidal parameters
- Map and characterize deep sea communities
- Increase physical monitoring programs, autonomous tech to rove for deep sea creatures
- Fish counts - population and migration patterns
- Connect chemical + ecological studies
- Have physical data across depth to match actual habitats
- Connect physical data to observational/ anecdotal data
- Basic science to test how physical data impacts captive animals

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3A: Day 2 Detailed Notes

* Notes are synthesized from all breakout groups

- Determine the mechanisms that control population dynamics
- Connect environment with survival at small scales
- Employ new technologies (autonomous systems and eDNA) to facilitate linkages between biological and physical data at multiple-scales
- Empirical Dynamical Models and AI to forecast & hindcast marine populations from physical data

Session 3: Ecosystem Change from Human Use

1. What are the most urgent impacts that should be addressed?

- Harmful algal blooms
- Marine disease / pathogens
- Anthropogenic sound
- Direct consumption of resources
- Pollution
- Freshwater discharge
- Water quality
- Climate change
- Ocean acidification
- Hypoxia
- Ocean Warming
- Sediment supply to the coast
- Coastal armoring
- Invasive species
- Sea level rise
- Extreme weather events
- Assessing lack of knowledge
- Wind/ energy development
- Estuary impacts from transportation
- Ecological impacts from resilience projects
- Biodiversity and habitat loss
- Plastics
- Oil spill risk
- Unsustainable use
- Nutrient runoff
- Fisheries changes
- Overfishing
- Deep sea mining
- Aquaculture
- Fire influence on ocean ecosystems (fire retardants, nutrients in ash, debris flow)
- Improper management
  - Fisheries
  - Street (trash)
  - Nutrient run-off
  - Boats introducing pollutants

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3A: Day 2 Detailed Notes

* Notes are synthesized from all breakout groups

- Food insecurity
- Overharvesting
- Shifting species ranges
- Fixed gear in water - entanglements
- Tipping points
- People deadened to ocean related issues
- Tide pool collection
- Food web changes
- Knowledge on how MPAs work
- Demand for protein production

<u>2. What data is needed to inform us of their importance?</u>

- Low cost options for data collection
- Early warning systems
- Species population and range data
- Use AI
- Community observations
- Tagging harvested species to get spatially explicit data
- Timescales of impacts
- Short term vs. long term (physical and biological data)
- Human use detection systems
- Acoustic tracking of recreational boats in/around MPA’s
- Understand impacts of human activities
- Long-term climate data
- Individual organism stress
- What indicators can be early warning systems?
- “Canary” species - pteropods, oysters, crabs, krill, anchovy, sardine, snail
- Physical, biological, and human use information
- Climate change impact data
- Links between nearshore and offshore systems
- Pollution life cycles
- Microplastics sources and fate - how do we quantify?
- Water quality
- Terrestrial inputs/ impacts data
- Metal contamination
- How can we convey ecosystem value that doesn’t have a dollar value?
- Does the general community value the same data as the scientific community?
- How do we make a case for sustained funding for monitoring?
- Need strong baseline data for areas proposed for offshore development - continue monitoring after development
- How many species/ ecosystems are impacted and in what way
- Nearshore habitat mapping
- Natural vs. human induced variation
- Who and how are people violating the ocean resources
- What controls fish populations?
- Marine spatial planning
- Impacts on early life history stages
- Enforcement response and NGO/community response data

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* Notes are synthesized from all breakout groups

Session 4: Connecting Ecological Health with Social Needs

1. What aspects of the ecosystem impact human activity?

- Having a sense of place & well being
  - Ability to go swimming, fishing, surfing, scuba diving
- Lack of connection to the ocean
  - Lack of easy to harvest shellfish
  - Strong export economy, limits ties to own coastal community needs
- Ecosystem health
  - Impacts to tourism and activities
  - Impacts fisheries
- Ease of access to ocean and resources
- Shellfish disease
- HABs
- Coastal resilience
- Resource availability/ accessibility
  - Abundance of consumable resources
  - Abundance of charismatic megafauna
- Visible ecosystem destruction
- Pollution
- Extreme weather impacts (transportation/boating/fisheries)
- Sense of Californication - whales, kelp, sea otters, garibaldi
- Physical properties - how pristine is the environment?
  - Water temperature
    - Change species distribution and migration patterns - impacts human interactions (whale watching, fishing, management structures)
  - Clarity
  - Kelp forests
  - Fisheries
  - Water quality
  - Cleanliness of shores
  - Sharks
  - Waves
  - Sandy beaches
  - Smell
- Location of development (wind, seafloor mining)
- Ecosystem shifts - climate change and changing human response
- Response to wildfires

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3A: Day 2 Detailed Notes

* Notes are synthesized from all breakout groups

2. How do communities across CA value the ocean differently?

- Tied to geographic location, cultural and socioeconomic status
- How do these influence the value of the ocean to people?
- Perception of the ocean
- Strong regionalism
- Media’s portrayal of the ocean
- Accessibility and Equity
-
- Difference in education curriculums
- People value coastal aesthetics differently
- Various conceptions of the coast/ ocean
- Community perception
  - Subsistence vs. economic
  - Age
  - Racial / ethinic differences
- Ecosystem services
  - Cultural importance
- Ocean for climate solutions (green energy)
- Make ocean related environmental issues relatable to everyone
- Use of permanent structures for monitoring/ science
- Ocean use
  - Fishing
  - Cultural
  - Recreation
  - Livelihood
  - Tourism
  - Regional identity
- Surveys on how people value the ocean

RESON

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