FINAL REPORT

A scientific analysis and decision framework to support the standardization of citizen science ecological monitoring methods for community-based fishing areas

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Prepared by:
Conservation International
Hawaii Program | Center for Oceans
3555 Harding Avenue, Suite 200
Honolulu, Hawaiʻi 96818

Conservation International Hawaiʻi (CI Hawaiʻi) is pleased to provide this final report on the cumulative activities September 2018 – December 2019 and outcomes implemented under the project *A scientific analysis and decision framework to support the standardization of citizen science ecological monitoring methods for community-based fishing area*. We would like to acknowledge our key collaborators in this project including the Department of Land & Natural Resources – Division of Aquatic Resources, the University of Hawaiʻi, The Nature Conservancy Hawaiʻi, Kuaʻāina Ulu ʻAuamo, Kalanihale Foundation, KUPA-Friends of Hoʻokena Beach Park, Hui Mālama O Moʻomomi, NOAA, Hui Makaʻainana O Makana, Nā Maka/Nā Kilo ʻĀina, and numerous other community members and organizations.

Project Summary

The objective of this project is to analyze existing ecological monitoring methods and develop a decision framework to support the standardization of citizen science ecological monitoring protocols for the Community-Based Fishing Areas. To accomplish this, we have performed scientific analysis of common community-based monitoring methods used across Hawaii. The scientific analysis included a comprehensive review of the current community monitoring methods in use across Hawaii with a power analysis to review the monitoring intensity (# of surveys and # of survey years) needed to detect a measurable change for each method. This scientific analysis was used to inform discussions between community members, scientists, and Division of Aquatic Resource (DAR) staff and biologists and to develop a decision framework, which included an evaluation of what each method would accomplish in relation to management targets, cost to implement (include tradeoffs in time, financial burden, skills needed to implement), and power to detect change. This decision framework was developed with the input of communities, scientists, and DAR. To support this work moving forward, we have created a group to support the standardization, review, and uptake of community-based marine monitoring methods called the Community-based Marine Monitoring Network. With the help of the network, we have developed a community-based marine monitoring survey to gather feedback from community monitoring participants on methods used, frequency, consistency of use, cost, and benefits of monitoring. The survey results were shared back with community members, scientists, and DAR through a variety of presentations, meetings, email, and in-person correspondence.

Introduction

Communities are uniquely poised to be significant participants and leaders in gathering marine resource data through monitoring efforts. These efforts empower communities to observe the health and status of key marine resources and play a decision-making role in stewardship efforts. A wealth of information to support marine resource management is possible, with appropriate community-based monitoring methods that emphasize and incorporate local and indigenous knowledge and practices. These can include methods that community members use to record information from activities that they already do (i.e. subsistence harvesting) or can do with minimal investment (time, money, resources/gear). Working with communities to better understand their monitoring and fishing practices can support tailoring community-based monitoring methods that are feasible for community participants and can support long term monitoring efforts needed for tracking trends in resources over time.

There are many monitoring methods implemented in Hawaiʻi that are organized and conducted by community members. Numerous methods were idenitified through a community feedback process that included gathering community input at various workshops, focus group discussions, and through a community-based marine monitoring survey that was distributed to community members through partner networks such as The Nature Conservancy, the University of Hawaiʻi (UH), The Department of Land and Natural Resources Division of Aquatic Resources, and Kua ʻĀina Ulu Auamo. The purpose of the community input was to solicit information on the use and frequency of community-based marine monitoring methods across Hawaiʻi and understand the costs and benefits of each method to community participants.

The other approach that was undertaken was to look at the scientific power of each community-based monitoring method to understand trends in the resources over time. A trend analysis was done that examined the ability of each method to detect a 20% change in the resource indicator (abundance, biomass, mean fish size, catch per unit effort (CPUE)) at an 80% power level with an alpha or p-value of 0.05.

The results from this research were shared with DAR to inform community-based monitoring guidelines and incorporated into a draft community-based monitoring methods guidebook that provides information on appropriate monitoring methods to address various management needs. The guidebook methods are adaptable and include resources for implementation and support.

Project Objectives

The specific objectives of this project are to: 1) work with partnering communities and NGOs to review community ecological monitoring methods used throughout the state of Hawaii; 2) collaborate with the Department of Land and Natural Resources (DLNR) Division of Aquatic Resources (DAR) to review monitoring objectives and the scientific power analyses for each identified citizen science monitoring method; and 3) combine the monitoring objectives and power analysis for each method into a decision framework for use by communities and/or DLNR-DAR, when selecting ecological monitoring methods that fit state and local capacity and management needs. In response to DAR and partner feedback, the final objective was revised to focus on the development of a decision-supporting guidebook (mentioned in the previous section) for use by community members and resource managers.

Table 1. Revised timeline with No Cost Extension.

Tasks	2018				2019											
	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Meet with collaborators	x	x	x			x	x	x	x	x	x					
Task 1. Review citizen science methods and variability in design	x	x	x													
Task 2. Scientific power analysis				x	x	x	x	x	x							
Task 3. Work with DAR to determine monitoring objectives for post designated CBSFAs.									x							
Task 4. Translate the findings of scientific analysis and DAR monitoring objectives into a decision framework										x	x	x	x	x	x	
Scientific report and outreach document preparation										x	x	x	x	x	x	
Task 5. Communicate the results of the monitoring methods									x	x	x	x	x	x	x	x

Proposed Task 1. Under this task, project staff will review the utilized citizen science monitoring methods used in marine managed areas and communities that are interested in seeking local management through Community-Based Fishing Areas (CBFA) in Hawaii to compile a list of most commonly utilized community marine resource monitoring methods, review objective of each monitoring method for communities and community partners, and document the variability in the protocols for each method among community monitoring locations. This will be achieved through meetings and collaborations with scientific experts (UH researchers, NGO partners (including The Nature Conservancy)) and communities that are actively monitoring. We will attend meetings with community organizations, which are actively monitoring, to review their monitoring activities and discuss how this project will aid in the use of collected monitoring information for increased stewardship and management. Communities that we have identified that are consistently monitoring their marine resources through citizen science methods include Miloliʻi (Hawaii Island), Polanui (Maui), Moʻomomi (Molokai), and Haʻena (Kauai). These communities will be contacted to provide feedback on the monitoring process (costs and benefits to their community) and may decide to share data for incorporation into the project to be analyzed and used in the project to look at method variability, covariance, response rates, and power to detect changes in marine resources (response variables). For project success, it is not required that all communities share their monitoring data as Conservation International, our partner organization The Division of Aquatic Resources, and our collaborator

The Nature Conservancy, have community monitoring data and scientific monitoring data for a range of citizen monitoring methods including fish and benthic snorkel surveys, intertidal marine resource surveys, and fishing effort and catch (CREEL) surveys. These methods that are utilized in communities across Hawai'i. These methods are also integrated into other place-based practices that yield additional data sets for community members and managers. Finally, managers and community members and practitioners also utilize indigenous science methodologies based on local and indigenous knowledge, practices, and customs. One of the outreach objectives is to discuss the value, uniqueness, and in some cases variability in these survey methods and acknowledge the appropriateness of this variability in survey design. An additional community outreach objective is to discuss the cost and benefits (e.g. financial expenses, time commitments, social value, and use of the data within the community) of each monitoring method with communities to support the development of a decision-supporting guidebook. Lastly, a final outreach objective is to support awareness of this project and various monitoring methods with communities across Hawai'i to encourage and support community marine stewardship.

Task 1 Accomplishments:
With NOAA support, project staff created the Community-Based Marine Monitoring Network (Community Monitoring Hui, or the Hui), a collaborative group with members representing communities, The Nature Conservancy, Kuaʻāina Ulu ʻAuamo (a non-profit that supports a network of marine stewardship community groups), The Department of Land and Natural Resources Division of Aquatic Resources, and the National Atmospheric and Oceanic Administration. This network's purpose is to share information on community-based marine monitoring methods and support the communication and dissemination of information to communities. A community-based monitoring survey (Appendix 1) was developed to assess the monitoring methods used in communities and the costs and benefits of each method. The collaborative group provided feedback on this survey and supported the distribution and collection of community participant responses. This approach allowed us to reach additional communities across Hawaii.

We visited the community of Miloliʻi to share the project's purpose and gather information on monitoring methods, in October 2018. We contacted Moʻomomi and Haʻena in October 2018 and have included community members and monitoring coordinators for each community in our workshops and meetings. The Community Monitoring Hui provided critical input to the survey tool deployed in May 2019 to collect information on monitoring methods used in and by communities. Information on the survey (including intent, developers and partners, and next steps) as well as the survey link was sent to a variety of partners including community members, managers, researchers, and other NGO's to distribute to their contacts and networks. Project staff emphasized distributing the survey tool to as many individuals and communities who actively engage in observations and monitoring in their geographies or who work and partner with those that do. Project staff determined that the desired number of survey responses would be 20 in order to receive a variety of information on method type, descriptions of costs and benefits, and good geographic representation. The outreach was successful in reaching that goal with 20 responses received and included in the analysis.

Project staff analyzed survey results and shared the results with Community Monitoring Hui members in follow-up meetings (Appendix 2 – subset of analyzed data). Additionally, during the 2019 Hawaiʻi Conservation Conference, project staff organized and held a workshop entitled, "Community-based Marine Resource Monitoring" to share out results from the survey and solicit more potential survey responses and engage in additional dialogue with new and established project partners. The workshop was attended by nearly 100 participants ranging from resource managers and community members to regulatory officials and researchers. The workshop included a presentation on the survey results as well as a small-group breakout session in which participants engaged in discussions around the opportunities and perceived limitations of community-based monitoring efforts. Preliminary information was shared on the power analysis report but was not publicly shared with conference attendees due to the need for additional internal and key partner review.

The Community Monitoring was convened for a final 2019 meeting in December to gain feedback on the draft scientific power analysis report, discuss DNLR-DAR monitoring efforts and data gaps, and future parternships to support community-based monitoring efforts as they related to community needs and state management priorities. Interest in on-going discussion and identifying specific desired outcomes for the Community Monitoring Hui were highlighted during the December 2019 meeting. Project staff in parternship with DAR were able to secure additional funding support through a local private foundation to advance the discussion around and the development of integrated (western and indigenous science) monitoring methods to be piloted in several communities. This NOAA-supported project was an important catalyst for evaluating and documenting community-based marine monitoring and creating a collaborative space for sharing approaches and advancing monitoring capacity within the Hui.

Throughout the current project, CI staff have met regularly with DAR staff and officials to coordinate project activities and ensure alignment with state marine management goals and objectives. The project has supported the strong collaboration with community members and state managers that was critical to establishing and maintaining the Community Monitoring Hui. We anticipate this strong partnership with various stakeholders will continue to be vital to long-term success of collaborative and effective marine stewardship efforts in Hawaiʻi.

Proposed Task 2. Review the current monitoring methods within a scientific power analysis to determine the best options for the monitoring design of each method (i.e. how often to monitor, at what intensity (# of surveys) for a given power (ex. 80% probability that a difference is detected) and effect size (ex. 30% difference between resource abundance before and after management measure)). We identified 9 citizen science marine resource survey data sets to be incorporated into this project. However, we will include additional datasets as they are identified and shared through our community outreach. Different survey method variations that are identified by communities will be applied to each of the datasets through data sub-setting and manipulation. For example, setting model parameters to account for fixed or random transect selection. We will analyze each data using R using the package *fishmethods*, designed to run power analyses for detecting trends in linear regression using the methods developed by Gerrodette 1987.

Task 2 Accomplishments:
The inclusion of methods in the analysis was based on data availability and accessibility. Data sharing for some of the communities required a MOU and data sharing plan. This contract was not possible for some of the communities and datasets in the timeframe for this project.
The methods that were included were fish snorkel timed swim surveys (DAR), fish snorkel belt transects, and CREEL and fisher intercept surveys. Survey variations such as fixed versus random transect design was not assessed as only random survey transect data was available. Power trend analysis was done for these methods and attached as a scientific report.

We have documented our methods throughout by using R and GitHub for transparency and drafted the code for testing the trend power analysis for new monitoring methods as they come along or as data becomes available.

Recommendations from the power analysis included utilizing fisher knowledge when and where possible to enrich data sets and build inclusive partnerships around marine monitoring. Additionally, catch per unit effort (CPUE) was found to be highly variable among fishers, reducing the methods ability to determine if changes in catch are occuring. This variability could be greatly reduced by selecting for experienced fishers. This modification of survey design to work with experienced fishers would be recommended when the objective for the monitoring is to determine if subsistence fishing effort and catch is increasing or decreasing over time. Fisher logbooks would be a recommended approach for gathering information on effort, catch, and fish size for tracking trends in CPUE and mean fish size from the fishery.

The power analysis (Appendix 3) was shared out with DAR officials and staff as well as the Community Monitoring Hui at two meetings. Feedback was solicited and received at both gatherings

Proposed Task 3. Review citizen science ecological methods with DAR and community partners. In particular review objectives of monitoring, within method variability, and power to detect change for citizen science ecological monitoring methods for CBFAs. As part of this process, a workshop will be held with DAR biologists, statisticians, community coordinators, and managers to review the results of the power analysis and discuss the community input on the level of cost and benefit for each method. The objective of this meeting is to communicate the results of the analysis and to get feedback on the utility of these monitoring methods by DAR for CBSFA management. The presented citizen science survey methods will be reviewed by DAR and ranked in terms of value and contribution to CBSFA management. As part of the review of available methods it is important to clarify that citizen science monitoring methods are just one form of community monitoring and observation and that traditional Hawaiian knowledge and local knowledge is a robust way of understanding and monitoring place-based resources that is acquired through cultural practices and generations of knowledge sharing and observation. Additionally, community-based science and data collection that elevates the role of community members as co-developers of research questions and sample design is also a significant contributor to marine monitoring and management efforts and outcomes. Citizen and community-based science monitoring are additional forms of monitoring approaches that may be used to support CBSFA, while the use and application of traditional and local knowledge should also be prioritized when and where possible.

Task 3 Accomplishments:
Two workshops were held to better understand community monitoring, fisher knowledge, and incorporation of both into state monitoring and management. The first workshop was held on May 23, 2019 between DLNR-DAR, scientists, and community-based organization leaders and marine monitors. There were 30 participants, which included community members from Molokai (Moʻomomi), Hawaiʻi (Hoʻokena), and Oahu.

The second workshop was held at the Hawaii Conservation Conference on July 12, 2019, (reported in the previous section). Over eighty participants attended this workshop. The project methodolgy and survey results were presented and break out sessions were held to get feedback on community-based monitoring methods.

Additionally, a review of the use of citizen science methods for CBFAs was discussed at a meeting with DAR on May 31, 2019. The power analysis results were shared and the methods were reviewed for use in CBSFA monitoring. Fisher logbooks and fish koʻa or aggregations surveys were selected as two of the DAR supported community monitoring methods and one of the recommended next steps discussed was to develop a standardized datasheet and fisher logbook template. A voting exercise was not done to select between methods as the participants agreed on the methods that they recommended to develop further and incorporate into DAR monitoring and management.

Proposed Task 4. Translate the findings of the community monitoring methods review, DAR ranking, and scientific analysis into a decision framework for when to utilize each method and how to interpret the results. This will support the standardization of citizen science monitoring methods by clearly outlining objectives of each method along with costs and benefits. The decision framework will also increase communication and interpretation of these methods with community, scientists, NGO, and state partners. This decision framework will be reviewed with DAR and community partners, including a process to adapt guidelines as new methods come along. The use of citizen science monitoring information will be guided by the results of this project through the decision framework, but the State of Hawaii DAR will ultimately have to decide how to incorporate citizen and community-based science data into state management and determine the role of the state and communities within the CBSFA designation.

Task 4 Accomplishments:
DAR provided input on the recommended format of the decision framework and recommended a monitoring use and description guide with a clear section on monitoring uses, objectives, and resources needed for each method to guide community participants in selecting monitoring methods that fit their abilities and management objectives. During the project, staff collaborated with the Hawaiʻi Pacific University to mentor a graduate student in their Marine Science

department. The graduate student, Ms. Kelsey Doughten, conducted a comprehensive literature review of community-based management in Hawai‘i and interviewed several key partners on marine management in Hawai‘i through the implementation of marine protected areas. As a part of Ms. Doughten's practicum project, she led the draft development of content for the decision-supporting guidebook and organized the layout for the print-version of the guidebook. The guidebook includes descriptions and examples of current Hawai‘i state marine management designation types. Each designation type will include examples and descriptions of marine monitoring methods and approaches used by DAR, NGOs, community organizations, and individual practitioners. Additional resources on the monitoring methods are also provided for the reader to pursue. The draft guidebook was completed in December 2019 and submitted to project staff (Appendix 4). To increase use and outreach of the guidebook, a digital interactive version was also drafted by CI staff in February 2020. Both the print and interactive version were shared out to the Community Monitoring Hui during a March 2020 meeting to gain feedback on guidebook intent, content, format, and general comment by Hui members. Full roll out of the guidebook will occur after all feedback and additional methods have been added and will be done in coordination with DLNR-DAR and the Community Monitoring Hui.

Proposed Task 5. Communicate the results of the analysis back to communities interested in CBFA designation and supporting community partners (UH researchers and NGOs). This will be achieved through the sharing of a summary report of citizen science ecological monitoring methods and how they support coral reef conservation. The summary report will be shared with our community networks and Kua‘āina Ulu ‘Auamo (a non-profit that supports a network of marine stewardship community groups) to disseminate to all interested community networks to ensure that this information will reach the 12-15 communities that have shown an interest in monitoring and marine resource stewardship. We will meet with participating communities to review this report and address any questions they may have.

Task 5 Accomplishments:
As reported in previous sections, staff have successfully disseminated project products (the scientific power analysis, community-based monitoring methods survey, and draft decision-supporting monitoring guidebook) to our numerous partners and collaborators in an effort to gain feedback on content and format and to guide further distribution of project products. Through the Community Monitoring Hui meetings and workshops, the materials have been shared with over 20 individuals and partners, who represent communities of place & practice, natural resource managers, NGOs, and research partners. The scientific power analysis has been an effective tool in driving Hui discussions on marine monitoring sample design and monitoring implementation with and by community partners. This project has highlighted the unique challenges and opportunities related to community-based marine monitoring. We strive to develop and provide tools and resources that support the needs and interests of both community members and state managers, while also continuing to highlight the importance of place-based and indigenous-knowledge based approaches in marine stewardship in Hawai‘i.

Effective marine resource management continues to be defined in Hawai‘i through partnerships and collaborations between the state management agency, numerous communities, and other stakeholder groups. NGO support is crucial in this space as facilitators and convenors where topics, including marine resource monitoring, can be discussed and pathways for collective advancement of inclusive management approaches can be defined and implemented. This project highlighted the importance of dissecting one aspect of effective marine management (i.e. resource monitoring) to better understand the gaps and opportunities of successful implementation, while also creating space for critical dialogue and producing tangible products that support the goal of healthy marine ecosystems in Hawaiʻi.

References

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Appendices

1. Community-based monitoring survey
2. Community-based monitoring survey results
3. Power analysis report
4. Draft community-based monitoring guidebook

Community-Based Marine Resource Monitoring Survey

What is it?

This survey is a voluntary survey designed to collect information to better understand the types of community-based monitoring on marine resources that occur across Hawai‘i and to determine the benefits and costs of citizens participating in community-based marine resource monitoring.

Why take it?

The survey will be used in a meta-analysis of the most common monitoring methods using surveys (repeated observations or documentation of resources) that are utilized by communities and citizen scientists for evaluating the intertidal and ocean resources of a place. Your answers to these questions will allow us to better understand the needs of communities and allow for recommendations to supporting researchers, NGOs, and DAR on the intensity, costs, and benefits of community-based monitoring methods. This survey will support a larger analysis of Hawai‘i's community-based monitoring methods and how they can be used to support community-based subsistence fisheries area designation, post monitoring requirements, and detecting changes in resources for management purposes.

Survey Audience?

This survey is intended for community members who are involved in marine resource monitoring.

Consent Statement

Your participation in this research study is voluntary. You may choose not to participate or you may withdraw at any time. The procedure involves filling a survey that will take approximately 20 minutes. Your responses will be confidential, and data will be aggregated. We do not collect identifying personal information.

1. What survey or monitoring have you done in the past or currently do in your community? (check all that apply)

- ◻ Fish snorkel surveys
- ◻ Coral and benthic snorkel surveys
- ◻ ‘Opihi and intertidal surveys
- ◻ Seasonal observations and calendars (example: kilo, Huli ‘ia)
- ◻ Fish and/or invertebrate spawning seasons (gonad observations)
- ◻ Coral health surveys (disease, bleaching, etc)
- ◻ Journals to record marine resource observations
- ◻ Water quality
- ◻ CREEL and/or fisher intercept surveys
- ◻ Human use surveys/ interviews to gather stories on uses and changes in marine resources
- ◻ Socioeconomic assessment/monitoring
- ◻ Mo‘olelo and storytelling, customary knowledge sharing
- ◻ Other 1 (please specify)

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- ◻ Other 2 (please specify)

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2. In what community or communities do you do marine resource monitoring?

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3. How often do you or did you participate in each survey that you are or were involved in? What is/was the frequency? Circle your responses.

Monitoring Methods	1 = Never	2 = Daily	3= Weekly	4= Monthly	5= Seasonally	6= Yearly
Fish snorkel surveys	1	2	3	4	5	6
Coral and benthic snorkel surveys	1	2	3	4	5	6
‘Opihi and intertidal surveys	1	2	3	4	5	6
Seasonal observations and calendars (ex. kilo, huli ‘ia)	1	2	3	4	5	6
Spawning seasons	1	2	3	4	5	6
Coral health surveys	1	2	3	4	5	6
Journals to record marine resource observations	1	2	3	4	5	6
Water quality	1	2	3	4	5	6
CREEL	1	2	3	4	5	6
Human use surveys/ interviews to gather stories on uses and changes in marine resources	1	2	3	4	5	6
Socioeconomic assessment/monitoring	1	2	3	4	5	6
Mo‘olelo and storytelling, customary knowledge sharing	1	2	3	4	5	6
Other 1 - specified above	1	2	3	4	5	6
Other 2 - specified above	1	2	3	4	5	6

4. On average, how long did it take to complete data collection for the surveys in order to get the information needed to assess the resource for that time period? Circle your response for methods that you have participated in.

Monitoring Methods	1 day or less	2-3 days	4-7 days	8-14 days	15-21 days	>22-28 days	>28 days
Fish snorkel surveys	1	2	4	8	15	22	28
Coral and benthic snorkel surveys	1	2	4	8	15	22	28
‘Opihi and intertidal surveys	1	2	4	8	15	22	28
Seasonal observations and calendars (ex. kilo, huli ‘ia)	1	2	4	8	15	22	28
Spawning seasons	1	2	4	8	15	22	28
Coral health surveys	1	2	4	8	15	22	28
Journals to record marine resource observations	1	2	4	8	15	22	28
Water quality	1	2	4	8	15	22	28
CREEL	1	2	4	8	15	22	28
Human use surveys/ interviews to gather stories on uses and changes in marine resources	1	2	4	8	15	22	28
Socioeconomic assessment/monitoring	1	2	4	8	15	22	28
Moʻolelo and storytelling, customary knowledge sharing	1	2	4	8	15	22	28
Other 1 - specified above	1	2	4	8	15	22	28
Other 2 - specified above	1	2	4	8	15	22	28

5. For only the methods that you participate or participated in, how many years did you actively participate in the monitoring method? Circle your response for methods that you have participated in.

Monitoring Methods	1 yr or less	2 yrs	3 yrs	4 yrs	5-9 yrs	10-19 yrs	>20 yrs
Fish snorkel surveys	1	2	3	4	5	10	20
Coral and benthic snorkel surveys	1	2	3	4	5	10	20
‘Opihi and intertidal surveys	1	2	3	4	5	10	20
Seasonal observations and calendars (ex. kilo, huli ‘ia)	1	2	3	4	5	10	20
Spawning seasons	1	2	3	4	5	10	20
Coral health surveys	1	2	3	4	5	10	20
Journals to record marine resource observations	1	2	3	4	5	10	20
Water quality	1	2	3	4	5	10	20
CREEL	1	2	3	4	5	10	20
Human use surveys/ interviews to gather stories on uses and changes in marine resources	1	2	3	4	5	10	20
Socioeconomic assessment/monitoring	1	2	3	4	5	10	20
Mo‘olelo and storytelling, customary knowledge sharing	1	2	3	4	5	10	20
Other 1– specified above	1	2	3	4	5	10	20
Other 2- specified above	1	2	3	4	5	10	20

6. For only the methods that you participate in or have participated in the past, please rank the extent to which the monitoring has increased your understanding of your resources?

Monitoring Methods	1 (not at all)	2 (slightly)	3 (moderatel y)	4 (very)	5 (extremely)	6 (Unsure/ Don't know)
Fish snorkel surveys	1	2	3	4	5	6
Coral and benthic snorkel surveys	1	2	3	4	5	6
'Opihi and intertidal surveys	1	2	3	4	5	6
Seasonal observations and calendars (ex. kilo, huli 'ia)	1	2	3	4	5	6
Spawning seasons	1	2	3	4	5	6
Coral health surveys	1	2	3	4	5	6
Journals to record marine resource observations	1	2	3	4	5	6
Water quality	1	2	3	4	5	6
CREEL	1	2	3	4	5	6
Human use surveys/ interviews to gather stories on uses and changes in marine resources	1	2	3	4	5	6
Socioeconomic assessment/monitoring	1	2	3	4	5	6
Moʻolelo and storytelling, customary knowledge sharing	1	2	3	4	5	6
Other 1– specified above	1	2	3	4	5	6
Other 2- specified above	1	2	3	4	5	6

7. For only the methods that you participate in, please rank the extent to which the monitoring has increased your ability to steward or take care of the resources?

Monitoring Methods	1 (not at all)	2 (slightly)	3 (moderately)	4 (very)	5 (extremely)	6 (Unsure / Don't know)
Fish snorkel surveys	1	2	3	4	5	6
Coral and benthic snorkel surveys	1	2	3	4	5	6
‘Opihi and intertidal surveys	1	2	3	4	5	6
Seasonal observations and calendars (ex. kilo, huli ‘ia)	1	2	3	4	5	6
Spawning seasons	1	2	3	4	5	6
Coral health surveys	1	2	3	4	5	6
Journals to record marine resource observations	1	2	3	4	5	6
Water quality	1	2	3	4	5	6
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Socioeconomic assessment/monitoring	1	2	3	4	5	6
Mo‘olelo and storytelling, customary knowledge sharing	1	2	3	4	5	6
Other 1– specified above	1	2	3	4	5	6
Other 2- specified above	1	2	3	4	5	6

8. How is your monitoring data and information being used?

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9. The monitoring information that I collect, and my community collects has been (or will be) used to inform state resource management?

□ Yes
□ No
□ I don't know

If you answered yes, how has your data/monitoring information been used to inform state management (i.e. CBSFA designation, clusure, etc)?

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If you answered no, please comment as to why?

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10. What does it cost you **per day** to do these surveys (includes all aspects of monitoring (plan, conduct, analyze))? Please factor in time away from work or childcare, travel expenses, and equipment or supplies that you purchase yourself.

Monitoring Methods	0= nothing ($0)	1= >$1 and <$100	2= >$100 and <$200	3= >$200 and <$300	4= >$300	5= Unsure/ don't know
Fish snorkel surveys	0	1	2	3	4	5
Coral and benthic snorkel surveys	0	1	2	3	4	5
'Opihi and intertidal surveys	0	1	2	3	4	5
Seasonal observations and calendars (ex. kilo, huli 'ia)	0	1	2	3	4	5
Spawning seasons	0	1	2	3	4	5
Coral health surveys	0	1	2	3	4	5
Journals to record marine resource observations	0	1	2	3	4	5
Water quality	0	1	2	3	4	5
CREEL	0	1	2	3	4	5
Human use surveys/ interviews to gather stories on uses and changes in marine resources	0	1	2	3	4	5
Socioeconomic assessment/monitoring	0	1	2	3	4	5

Mo‘olelo and storytelling, customary knowledge sharing	0	1	2	3	4	5
Other 1– specified above	0	1	2	3	4	5
Other 2- specified above	0	1	2	3	4	5

11. Please rank your level of agreement with the following statements:

Value Statement	1= Strongly disagree	2= Disagree	3= Neutral	4= Agree	5= Strongly Agree
Marine resource monitoring should be left to agencies and universities.	1	2	3	4	5
Community knowledge is important for marine resource monitoring and management.	1	2	3	4	5
Community-based resource monitoring provides a way to share important information for management that can't be collected or obtained through standard scientific surveys.	1	2	3	4	5
Participating in community-based monitoring brought me closer and strengthened relationships I had with other people in my community.	1	2	3	4	5
Participating in community-based monitoring brought me closer and strengthened my relationships to my place and the marine resources found there.	1	2	3	4	5

12. Do you receive outside support (from NGOs, management agencies, or research institutions) for you marine resource monitoring?

□ Yes
□ No
□ I don't know

If you answered yes, please specify what agencies and how these agencies provide your community with support for marine monitoring.

____
____
____
____

13. Do you see an additional need for support or capacity building for your community-based marine resource monitoring?

□ Yes
□ No
□ I don't know

If you answered yes, please specify what additional support is needed.

14. I obtain data and information about marine resources from (check all that apply)

- □ My own observations & data collections
- □ Stories & observations from my elders
- □ Peers, communities & network groups
- □ Mo‘olelo, Oli, Ka‘ao
- □ Journals & peer reviewed literature
- □ Newspaper
- □ Social media and online news outlets
- □ Other (please specify) ________________

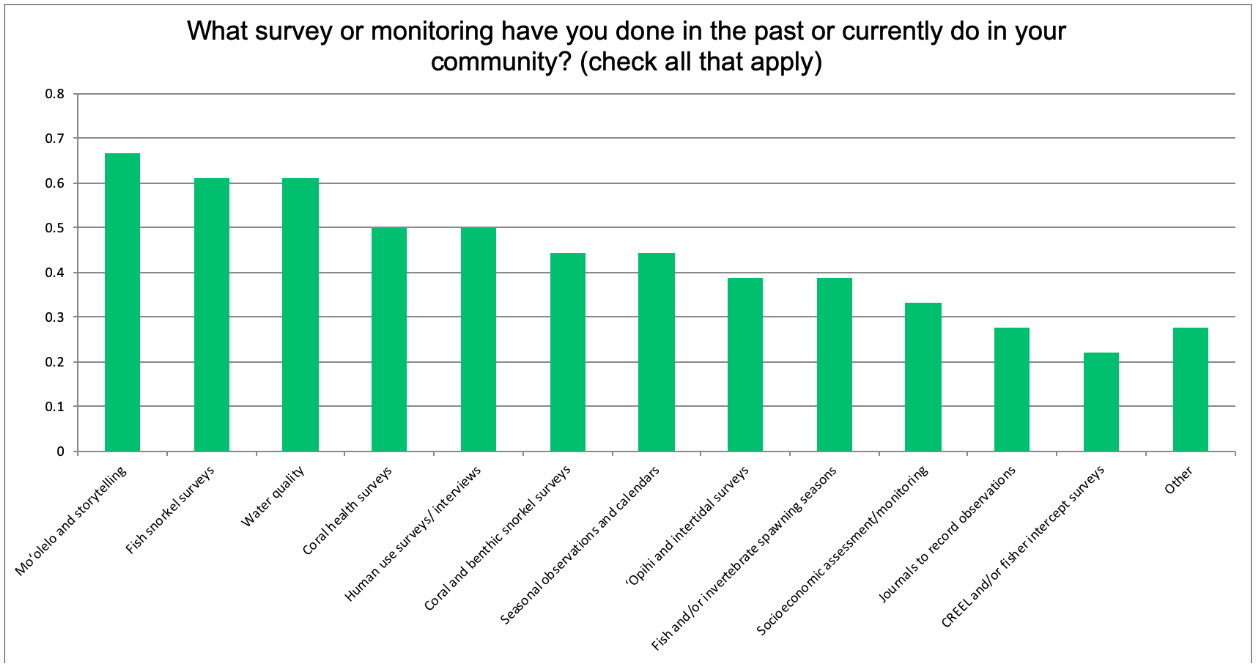
15. Any other comments, considerations for marine monitoring that you would like to add?

14. What is your age?

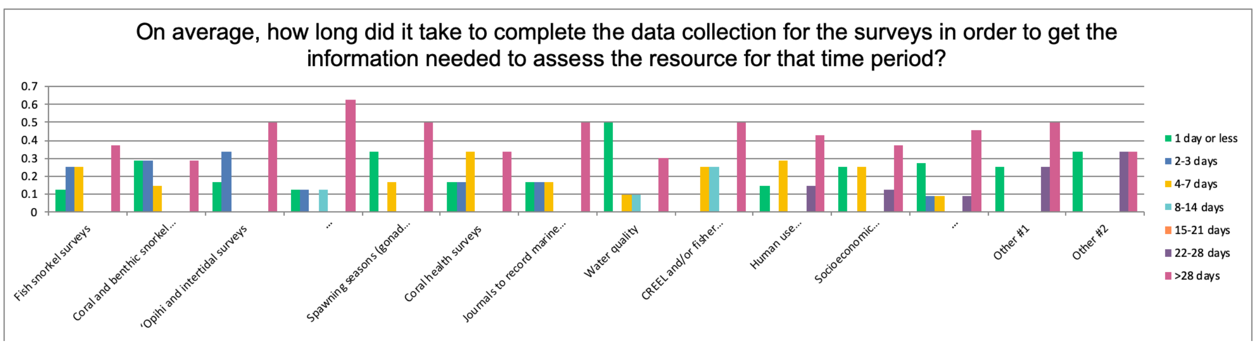
- □ 20 years or younger
- □ 21-29 years
- □ 30-39 years
- □ 40-49 years
- □ >50 years

17. What is your ethnicity (check all that apply)?

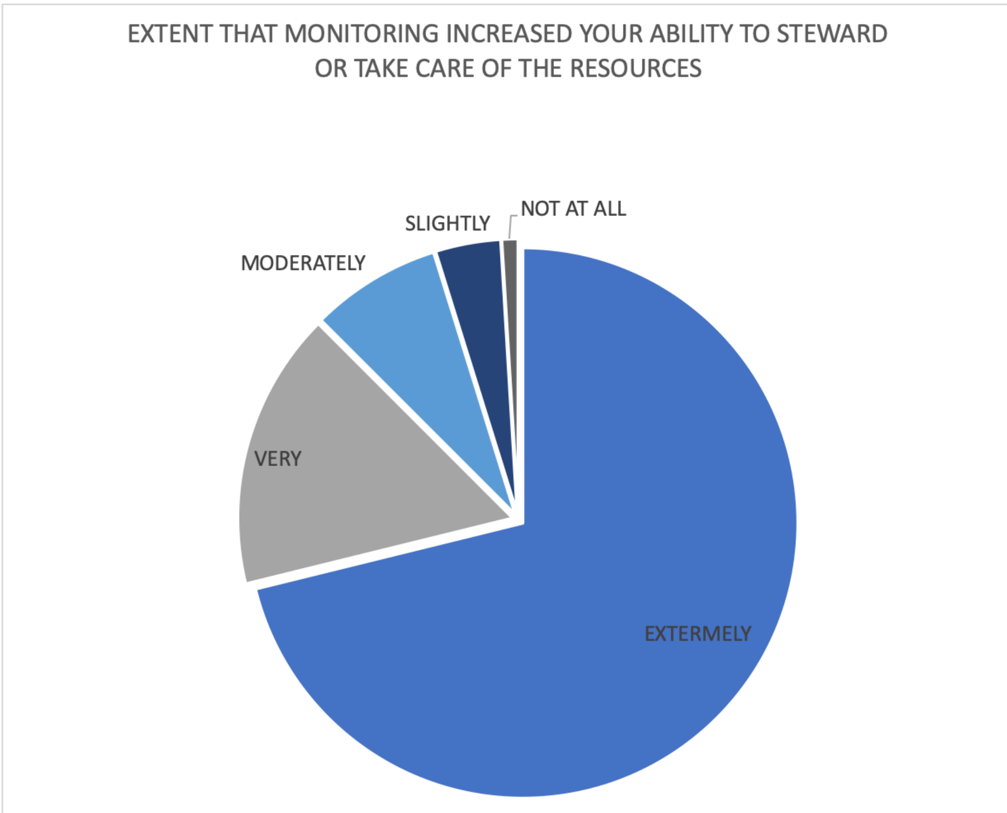
- □ Caucasian
- □ African Americam
- □ Hispanic or Latino
- □ Asian
- □ American Indian or Alaska Native
- □ Native Hawaiian
- □ Other Pacific Islander (please specify) ________________



Question #1 – Respondents were able to indicate one or more applicable monitoring methods that they currently use or have used in their community monitoring efforts. Mo'olelo (traditional stories) of place and resource status and storytelling was the most commonly used method for tracking resource change over time.



Question #4 – Data collection periods varied highly across method types. Intensive surveys requiring community outreach and interaction to complete (i.e. CREEL surveys) not surprisigly took the longest to compile enough data to assess the resource.



Question #6 – As expected, respondents largely indicated that marine monitoring, not matter the method used, increased their perceived ability to mālama (to care for) their marine resources. Increased regular interaction with and in resources leads to a more intimate relationship with place thus allowing for individuals to better understand their resource and assess any changes over time.

A Scientific Power Analysis of Community-Based Marine Monitoring Methods used in Hawai‘i

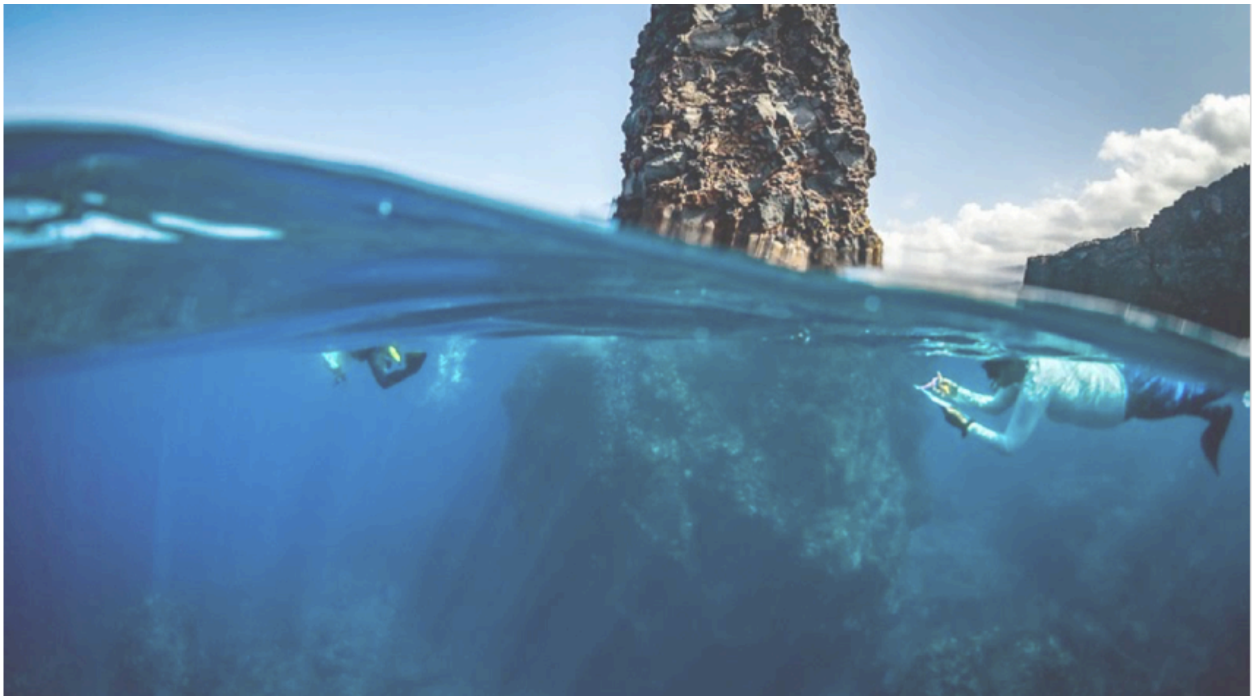


Photo by Atdarock Photography Paul Cox

Background

Power analysis is an essential component when designing effective marine monitoring methods that will meet analysis requirements, incorporate community capacity and needs, and meet management objectives. There are three common data assessment approaches for analyzing the impact of marine management. They are to compare a baseline assessment to future assessments (before and after management regulations), compare between inside and outside of marine management areas, and assess trends over time (see Figure 1). Trends over time is ideal as it can incorporate natural variability in the resource over time and can reduce confounding factors that may impact the analysis. Community monitoring is uniquely positioned to be able to examine trends in marine resources. Our objective was to determine the scientific power of each community-based monitoring method to understand trends in the resources over time. This assessment will help communities and DLNR-DAR and supporting NGOs to better understand the ability of each commonly used community-based monitoring method to detect changes in the resource and the number of surveys required to detect trend with a given degree of confidence.

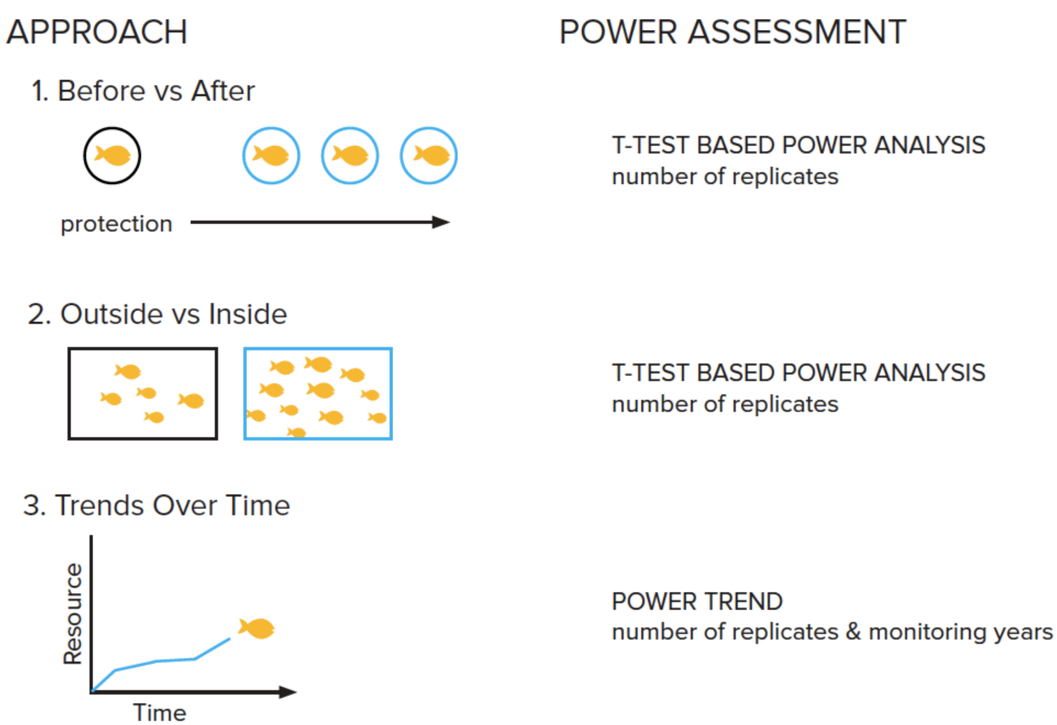


Figure 1. Three common approaches to assess impacts of marine management actions and power analysis used to assess each method.

Methods

Power Analysis

The data available for each method varied. Community data was used for the CREEL data and intertidal survey data. For the fish and habitat utilization survey, data was from the University of Hawai‘i and was aggregated from two sites. For the timed swim data, data was from the Division of Aquatic Resources and aggregated across all of the Oahu sites. Community data from fixed transects was not obtained and therefore the analysis was not performed for this method. Benthic data for the fish and habitat utilization survey was not able to be transformed to meet the normality requirements for the power analysis and therefore was excluded from the analysis.

The common indicators for assessing change in resource condition were identified for each method. The indicators vary by method and include mean length (fish, ‘ōpihi), biomass (fish), abundance (fish and ‘ōpihi), and CPUE (catch per unit effort). Bootstrapping (1000 times) with resampling with replacement was done to estimate means and standard errors for each survey method and applicable indicator for sample sizes ranging from 25 to 100 (15, 30, 25, 50, 75, 100). Proportional standard error (pse) was computed (se/mean) and used in the power trend analysis.

Monitoring indicator data was transformed to meet normality. Normality was tested for each indicator using the Shapiro-Wilk test and the transformations applied depended on the data, but included log+1, square root, and Tukey‘s ladder of powers.

The trend analysis was done to assess number of years for each method to detect a 20% change in the resource indicator (abundance, biomass, size, catch per unit effort (CPUE)) at 80% power level with an alpha of 0.05. The analysis was run in R using the package power-trend (Gerrodette 1987).

Results & Discussion

Fishery Independent Methods
Fisher independent methods do not rely on fisher catch data and therefore are called fishery independent. These methods are commonly used to examine resource abundance and biomass. We compared two methods, belt transects and timed swims. Belt transects were found to have lower variability and therefore the time to detect trends were reduced (Table 1). Timed swims are designed to survey larger, more mobile fish species. Additionally, we found that for both methods, biomass was a more reliable indicator (Table 1). The method that is chosen should also depend on the monitoring and management question.

Benthic habitat data such as percent coral cover was not able to be transformed to meet normality and the assumptions of the model. The data was also highly variable. The variability can be reduced by grouping the analysis by habitat type.

We examined a few species (*Acanthurus triostegus* and *Naso* unicornis) to look at the ability of each method for detecting trends in commonly harvested species. These species can be concentrated or schooled in specific areas or koas which can reduce the precision and increase the standard error and therefore our ability to detect trends in these species using random survey designs. *Acanthurus triostegus* was found to have a very low detection ability and low power to detect trends using timed swim surveys (Figure 3 A). *Naso unicornis* was also found to have a low detection ability and low power to detect trends using timed surveys (Figure 3 B). Utilizing fisher knowledge on when and where species aggregate can help to develop surveys that have the precision to track trends in species abundance and biomass in these areas.

Fishery Dependent Methods

Power trends were calculated for mean fish size from fisher intercept surveys from a community CREEL dataset. Fish mean size was a robust indicator with a relatively high power to detect trends at reasonable sample sizes (Figure #).

CREEL catch data (catch per unit effort) was analyzed by common gear/fishing types (spearfishing, handpole, and thrownet). Due to the variability (se and cv), CREEL catch data was found to be an ineffective way to track trends in catch (Table 1). The variability in the data likely is caused from including fishers with various skill levels. CREEL studies are a common scientific survey design to gather information on estimated total catch and fishing effort for a region. The variability could be greatly reduced by selecting for experience fishers or konohiki. This modification of survey design to work with experienced fishers (konohiki) would be recommended when the objective for the monitoring is to determine if subsistence fishing effort and catch increasing or decreasing over time. Fisher logbooks would be a recommended approach for gathering information on effort, catch, and fish size for tracking trends in CPUE and mean fish size from the fishery.

Table 1. Power trend analysis results for community-based fishery monitoring methods.

Survey Method	Variations	Indicator	Standard Error (se)	N (# of surveys)	Coefficient of Variance (se/mean)	Trend Analysis (years to detect 20% change (power 0.8, alpha = 0.05)	Transformation
Fishery Independent Methods							
Fish Snorkel Surveys	Snorkel belt transect with GPS & randomly selected transects	Total fish abundance (#/m2)	0.1	15	22%	>20	sqrt
			0.1	25	17%	>20	
			0.1	50	12%	12	
			0.1	75	10%	8	
			0.1	100	8%	7	
		Total fish biomass (g/m2)	5.8	15	36%	19	log(x+1)
			4.6	25	27%	12	
			3.3	50	19%	7	
			2.7	75	16%	6	
			2.3	100	14%	5	
	Snorkel with timed swim	Total fish abundance (#/m2)	0.1	15	20%	>20	log(x+1)
			0.1	25	17%	>20	
			0.1	50	13%	>20	
			0.1	75	11%	16	
			0.1	100	10%	12	
		Total fish biomass (g/m2)	15.8	15	29%	16	log(x+1)
			12.8	25	25%	10	
			10.0	50	20%	7	
			8.3	75	17%	5	
			7.3	100	15%	5	

Survey Method	Variations	Indicator	Standard Error (se)	N (# of surveys)	Coefficient of Variance (se/mean)	Trend Analysis (years to detect 20% change (power 0.8, alpha = 0.05)	Transformation
Fishery Dependent Methods							
		Kala mean size (cm)	2.5	15	8%	18	none
			2.0	25	7%	11	
			1.4	50	5%	7	
		Manini mean size (cm)	1.3	15	8%	19	none
			1.0	25	7%	12	
			0.7	50	5%	7	
	Gear CPUE	Handpole CPUE (lbs)	3.1	15	31%	>20	log(x+1)
			2.4	25	24%	>20	
			2.3	30	23%	>20	
			1.8	50	18%	>20	
		Spearfishing (speargun & three prong) CPUE (lbs)	5.7	15	33%	>20	log(x+1)
			4.5	25	26%	>20	
			3.8	30	24%	>20	
			3.2	50	19%	14	
		Thrownet CPUE (lbs)	2.0	15	24%	>20	sqrt
			1.6	25	19%	>20	
			1.5	30	17%	>20	
			1.1	50	13%	20	

Fish Snorkel Surveys: Timed swims

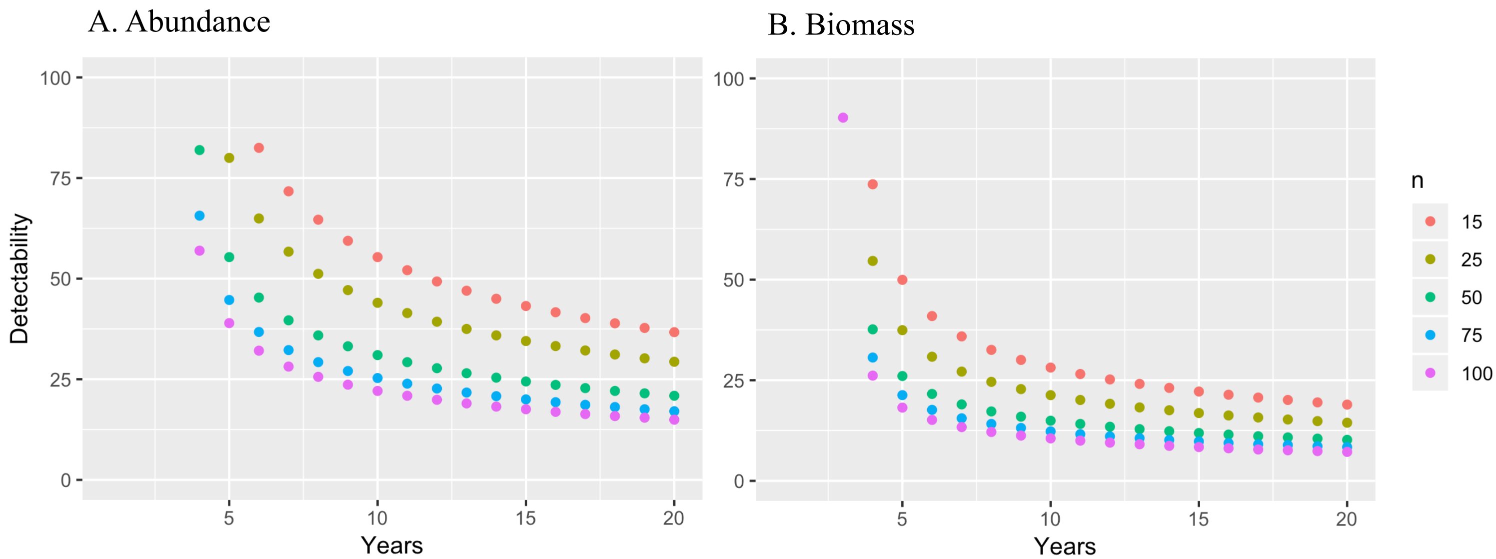


Figure 2. Trend power analysis for total fish abundance (A) and biomass (B) from fish snorkel timed swim surveys (n=number of surveys).

Fish Snorkel Surveys: Belt transect

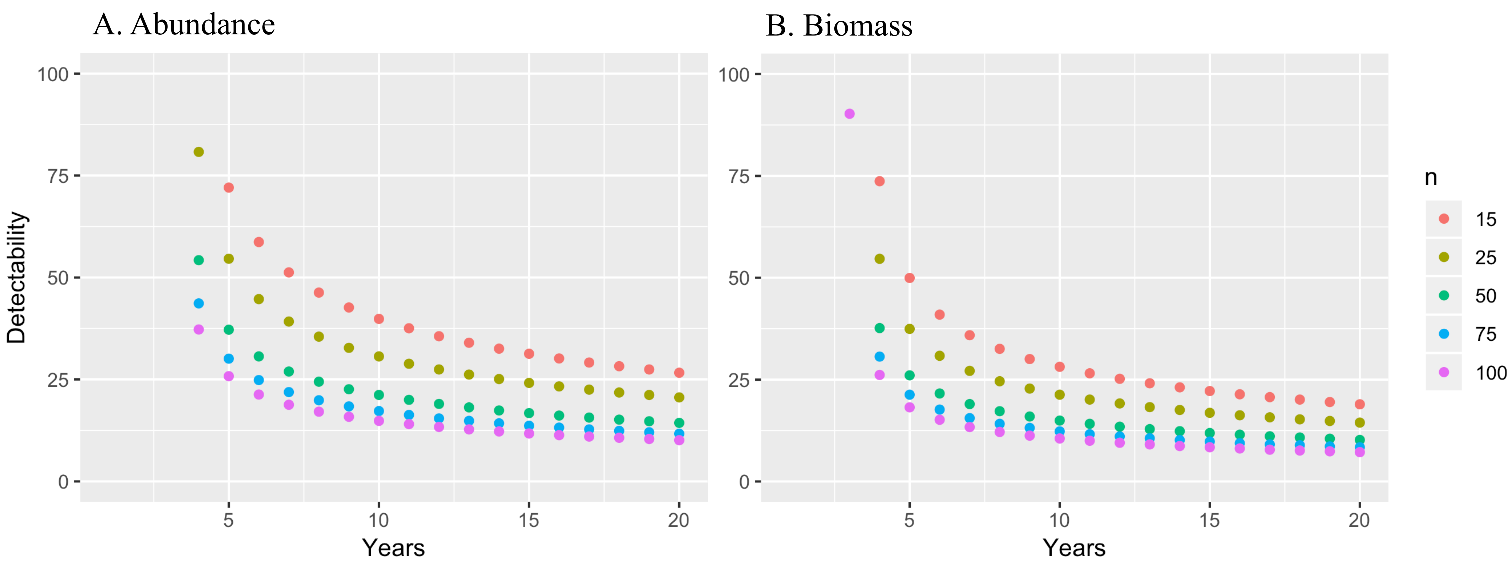


Figure 3. Trend power analysis for total fish abundance (A) and biomass (B) from snorkel fish and habitat utilization 25-meter belt surveys (n=number of surveys).

Fish Snorkel Surveys: HAFA timed swim

A. Manini (*Acanthurus triostegus)* B. Kala (*Naso unicornis)*

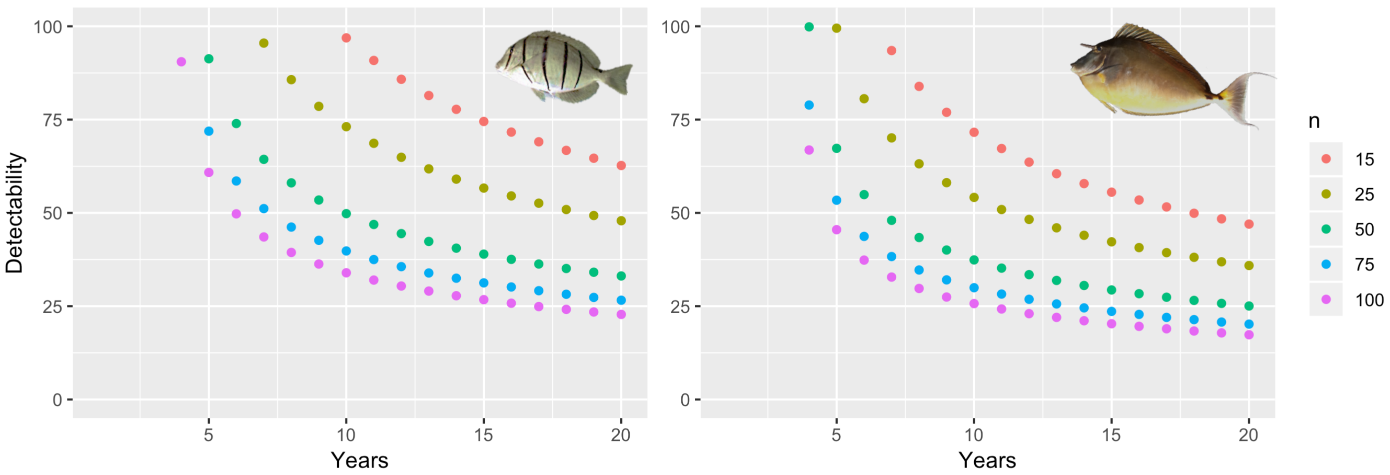
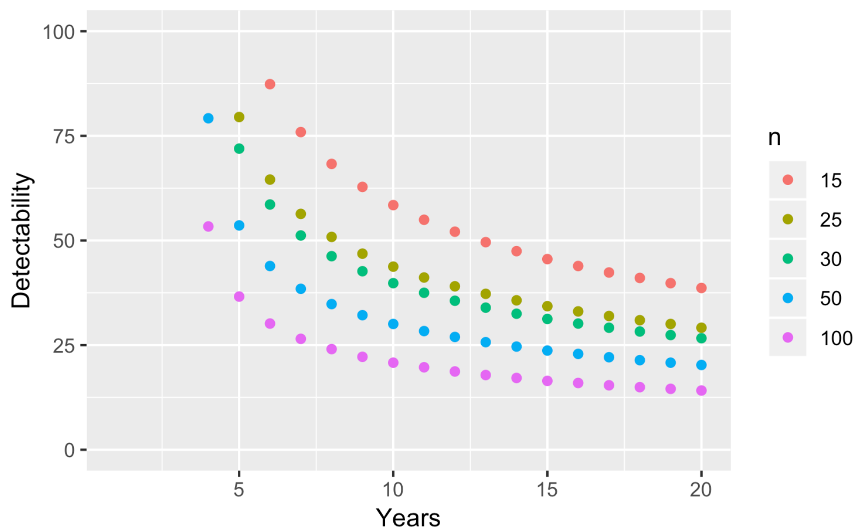
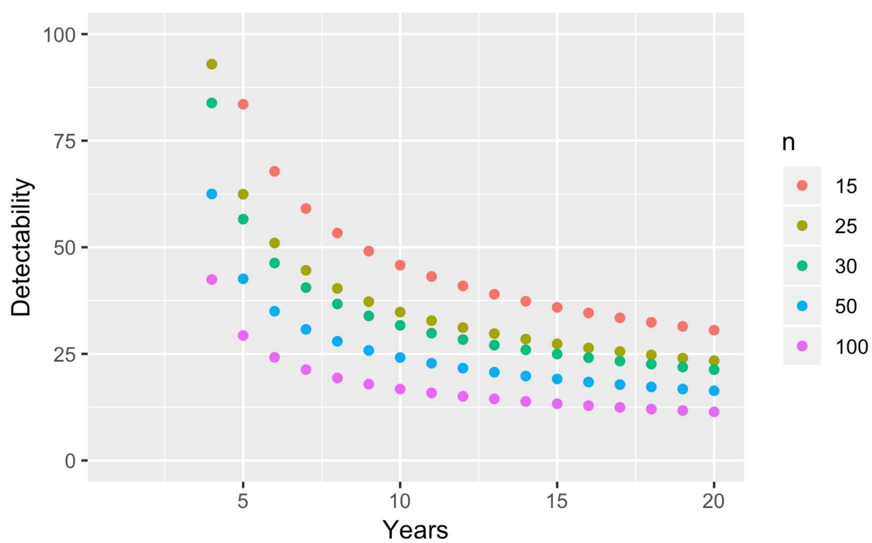


Figure 4 (below). Trend power analysis of catch (lbs) by gear type (handpole (A), spear (speargun and three prong) (B), and thrownet (C)) (n=number of surveys).

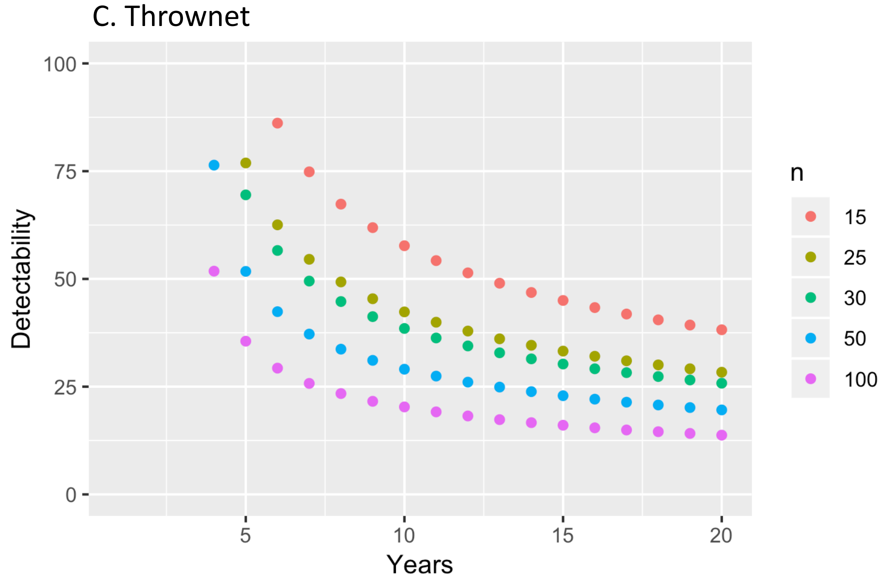
A. Handpole



B. Spear



C. Thrownet



CREEL, Fisher Logbook, Fisher Intercept: Mean Fish Size

A. Manini (*Acanthurus triostegus)* B. Kala (*Naso unicornis)*

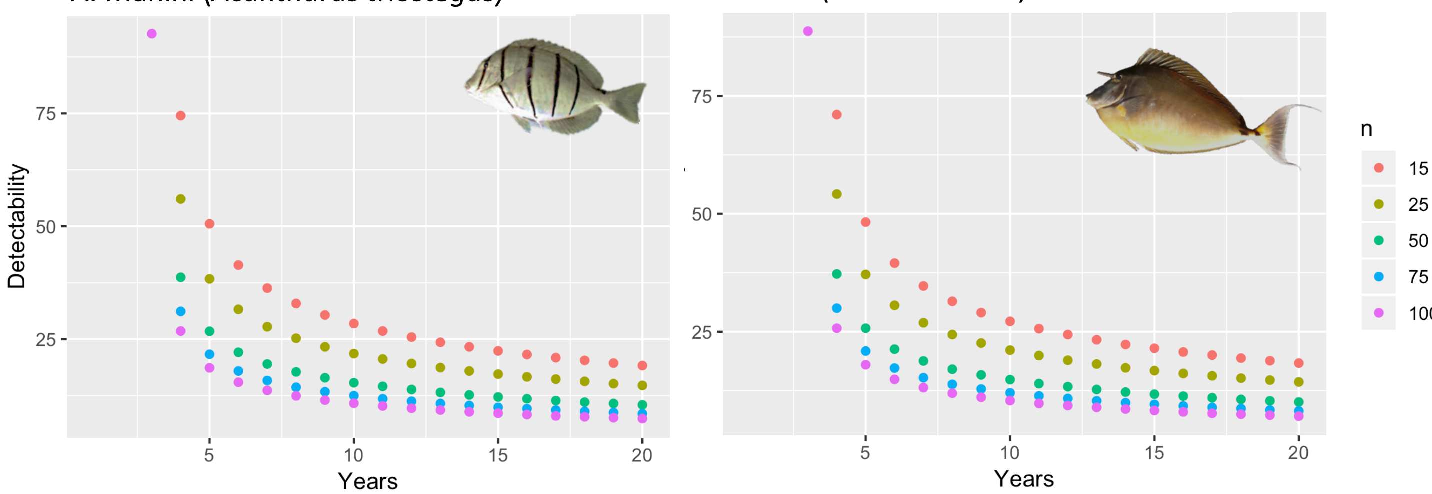


Figure 5. Trend power analysis of mean fish size for (A) Manini (*Acanthurus triostegus*) and (B) Kala (*Naso* unicornis).

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Hawai‘i Marine Monitoring Guidebook

Drafted by Kelsey Doughten with Conservation International for completion of her Master’s in Marine Science Practicum project

CONSERVATION INTERNATIONAL

HAWAI‘I

Table of Contents

Overview

This guidebook was developed to be used as a tool to help inform communities about common, effective marine monitoring strategies that can provide valuable data for guiding sustainable management here in Hawaiʻi. It contains information on marine management areas and designations in the Main Hawaiian Islands, as well as suggestions for effective monitoring plans within these designations.

Currently, Hawaiʻi's marine ecosystems are suffering from pressures of climate change, unsustainable fishing practices, and general human use. At the time of writing this guide, only 1% of Hawaiʻi's state budget is dedicated to natural resource management. However, the Division of Aquatic Resources (DAR) has initiated the Marine 30x30 plan, in which the goal is to effectively manage 30% of Hawaiʻi's nearshore waters by the year 2030. We hope that this guidebook serves as a supplement to this initiative, by empowering community members to get involved in resource monitoring and providing guidance on the best ways to do so.

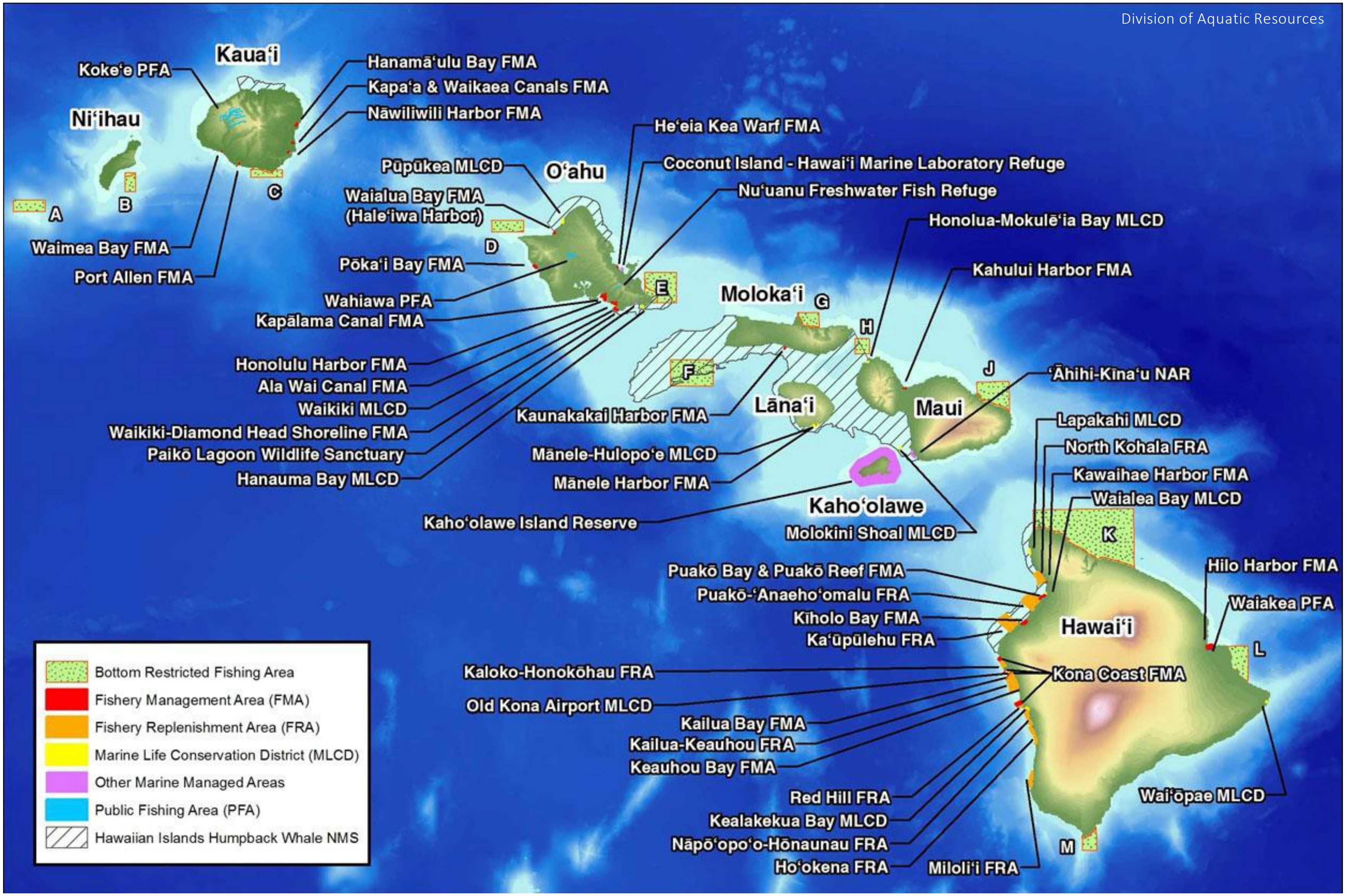
The methods described in this document are just some of the strategies we have found effective through our research and interviews with communities and organizations around Hawaiʻi, and by no means do we consider it to be a complete list. However, we hope that it provides a good starting point for those interested in learning more.

Marine Managed Areas (MMAs) in Hawai‘i

There are a variety of management designations used to protect marine areas in Hawai‘i, but many of these areas fit into one of the following three statutory authorities:

1) HRS Chapter 190: Marine Life Conservation Districts (MLCDs)
2) HRS Chapter 188-53: Fisheries Management Areas (FMAs)
3) HRS Chapter 180-22.6: Community-Based Subsistence Fishing Areas (CBSFAs)

To note key management areas that do not fit into these primary designations, we also include an “Other” category. It is also important to note that these designations can be broad, and specific regulations may vary between specific management areas.



Division of Aquatic Resources
Ni'ihau
Kaua'i
O'ahu
Moloka'i
Lāna'i
Maui
Kaho'olawe
Hawai'i
Koke'e PFA
Hanamā'ulu Bay FMA
Kapa'a & Waikaea Canals FMA
Nāwiliwili Harbor FMA
Waimea Bay FMA
Port Allen FMA
He'eia Kea Warf FMA
Coconut Island - Hawai'i Marine Laboratory Refuge
Nu'uanu Freshwater Fish Refuge
Honolua-Mokulē'ia Bay MLCD
Kahului Harbor FMA
Pūpūkea MLCD
Waialua Bay FMA (Hale'iwa Harbor)
Pōka'i Bay FMA
Wahiawa PFA
Kapālama Canal FMA
Honolulu Harbor FMA
Ala Wai Canal FMA
Waikiki MLCD
Waikiki-Diamond Head Shoreline FMA
Paikō Lagoon Wildlife Sanctuary
Hanauma Bay MLCD
Kaunakakai Harbor FMA
Mānele-Hulopo'e MLCD
Mānele Harbor FMA
Kaho'olawe Island Reserve
Molokini Shoal MLCD
'Āhihi-Kīna'u NAR
Lapakahi MLCD
North Kohala FRA
Kawaihae Harbor FMA
Waialea Bay MLCD
Puakō Bay & Puakō Reef FMA
Puakō-'Anaeho'omalu FRA
Kīholo Bay FMA
Ka'ūpūlehu FRA
Hilo Harbor FMA
Waiakea PFA
Kaloko-Honokōhau FRA
Kona Coast FMA
Old Kona Airport MLCD
Kailua Bay FMA
Kailua-Keauhou FRA
Keauhou Bay FMA
Red Hill FRA
Kealakekua Bay MLCD
Nāpō'opo'o-Hōnaunau FRA
Ho'okena FRA
Miloli'i FRA
Wai'ōpae MLCD
A
B
C
D
E
F
G
H
J
K
L
M
Bottom Restricted Fishing Area
Fishery Management Area (FMA)
Fishery Replenishment Area (FRA)
Marine Life Conservation District (MLCD)
Other Marine Managed Areas
Public Fishing Area (PFA)
Hawaiian Islands Humpback Whale NMS

HRS 190: Marine Life Conservation Districts

Management Goal:
To restore, conserve, and increase marine populations and biodiversity through restricting the taking of marine life.

Regulations:
Requires that DLNR develop rules regulating taking/conserving fish, live coral, crustaceans, mollusks, or other marine organisms for the benefit of conservation. These regulations may include prohibition of activities that disturb/alter the environment, establishment of open/closed fishing seasons and no-take areas, or regulation of fishing methods used.

Examples:
Hanauma Bay, Pūpūkea, and Waikīkī (Oʻahu); Keakakekua Bay, Lapakahi, Waialea Bay, the Old Kona Airport, and Waiʻōpae Tidepools (Hawaiʻi Island); Molokini Shoal, Honolua- Mokulēʻia Bay (Maui), and Manele-Hulopoe (Lānaʻi)

Source: HRS 190-3

HRS188-53: Fisheries Management Areas

Management Goal:
To manage, preserve, protect, conserve, and propagate freshwater and marine resource species.

Regulations:
DLNR may establish, maintain, manage, and operate freshwater or marine fishing reserves, refuges, and public fishing areas, and may adopt/amend rules or issue permits for management of these areas.

Examples:
Waikīkī-Diamond Head Shoreline Fisheries Management Area (Oʻahu) and Kaʻūpulehu Marine Reserve (Hawaiʻi Island)

Source: HRS 188-53

HRS 188-22.6: Community-Based Subsistence Fishing Areas

Management Goal:
To protect and reaffirm fishing practices customarily and traditionally exercised for Native Hawaiian subsistence, culture, and religion.

Regulations:
DLNR may designate waters to be used for community-based subsistence fishing areas and develop management strategies determined suitable for these areas and communities.

Examples:
Current subsistence-based fishing areas were authorized under distinct statutes, such as Hāʻena (HRS 188-22.9) and Miloliʻi (HRS 188-22.7), though they operate as CBSFAs

Source: HRS 188-22.6

Other

A number of other statutory provisions have been passed by the state to help regulate and protect certain areas of Hawaiian waters from some fishing activities, each possessing its own specific regulations. Some key provisions worth noting are:

- HRS 188-34: Restricted fishing in Honolulu Harbor and Hilo Harbor – unlawful to take/kill fish by means of draw, drag, or seine net in waters of Honolulu Harbor; unlawful to take/kill fish by means of any net in waters of the portion of Hilo Bay bounded by breakwater
- HRS 188-35: Fishing in certain waters – unlawful to take/fish in the following areas: Waikīkī reclamation canal, drainage canal connected to Kapiolani Blvd., Kapālama drainage canal, He‘eia-Kea wharf, portions of Waialua Bay and Pokai Bay, Kapa‘a and Waiākea canals
- HRS 188-36: Hawai‘i marine laboratory refuge – unlawful to take any aquatic life from Hawai‘i marine laboratory refuge, with exception for those with permits for scientific purposes
- HRS 189-2.5: Longline fishing prohibition – longline fishing gear consisting of $\geq$ 1 mainline over 1 nautical mile in length prohibited in all Hawaiian waters

Source: hawaii.gov

Community-Based Monitoring Methods

- Snorkel surveys (fish, benthic, coral health)
- Intertidal surveys
- ʻOpihi surveys
- Fish and/or invertebrate spawning seasons (gonad observations)
- CREEL and/or fisher intercept surveys
- Water quality
- Human use surveys
- Seasonal observations and calendars
- Journals to record marine resource observations
- Interviews to gather stories on uses and changes in marine resources
- Moʻolelo and storytelling, customary knowledge sharing
- Other


Photo: TNC

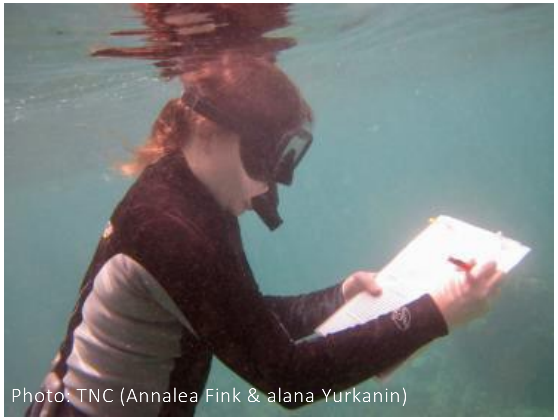


Photo: TNC (Annalea Fink & alana Yurkanin)


Photo: CI (Ulu Ching)

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Snorkel Surveys

Snorkel surveys are a valuable tool that can be used to monitor many different types of marine resources. There are a variety of methods that can be used depending what resources you are interested in monitoring, with some of the most common ones being belt transects, stationary point counts, and photoquadrat surveys. Some snorkel survey methods may be more suitable than others for detecting changes in a given resource, so it is important to consider what questions you are trying to answer when selecting a method.

Location is important, and things like depth, site complexity, distance from shore, side of island, and time of year will all be key factors in determining how/when to survey. Other key considerations are costs, time/duration, and training. Surveyors will need to have swimming experience to conduct these surveys and may need some level of experience in species identification. Depending on the method you select, snorkel surveys are typically low to moderate cost. In general, snorkel methods can be broken down by three types of surveys: fish surveys, benthic surveys, and coral health surveys. These surveys will be described in more detail on the following three pages.

*Common supplies: snorkel, mask, fins, waterproof data sheets, clipboards, pencils, species identification guides, transect tape, quadrat, waterproof watch/timer

Fish Snorkel Surveys

Description: There are several types of methods that can be used to monitor changes in fish populations, so the method you select will depend on several things. You must first think about the questions you are trying to answer and where you will be surveying. Several good indicators of changes in population to monitor would be abundance/biomass, presence/absence, size, and species richness. Some estimates, such as biomass, may need to be calculated after data collection and cannot be surveyed directly. Snorkel surveys are most commonly done in communities to assess abundance of priority species. Surveyors will need to have swimming experience and some level of training in fish species identification in order to conduct these surveys.

These surveys need to be standardized to a time or distance. One common way to do this is to have a timed swim or to lay a transect line down of a known distance and count fish along it.

Methods: stationary belt transect, stationary point, timed swim, random sampling, towed survey

Supplies: snorkel, mask, fins, waterproof data sheets, clipboards, pencils, species identification guides, transect tape, quadrat, waterproof watch/timer

Additional resources: Conservation International, The Nature Conservancy, University of Hawaii Quest (see appendix)

Photo: TNC (Roxie Sylva)

Investment

- $ - average from survey
- Recommended minimum # surveys (n) = 25
- Time to complete 1 survey ~ 20 min
- Recommended # years: 7 yrs to detect 25% change in resource

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Benthic Snorkel Surveys

Description: Similarly to fish snorkel surveys, there are a variety of approaches to benthic survey methods that depend mostly on the questions you are trying to answer. Common survey questions might be about the abundance of a certain invertebrate or percent coverage of coral. Benthic surveys can give us important information about the health of the ecosystem as a whole by studying keystone and resource species. Surveyors will need to have swimming experience and some level of training in identification of key benthic species (e.g. coral, limu, wana) in order to conduct these surveys.

Methods: stationary belt transect, photoquadrat, random sampling

Supplies: common supplies*, underwater camera

Additional resources:

Investment

- $ - average from survey
- Recommended minimum # surveys (n) =
- Time to complete 1 survey ~
- Recommended # years:

Photo: TNC (Annalea Fink & Alana Yurkanin)

Coral Health Snorkel Surveys

Description: Coral health can also be monitored with snorkel surveys. These surveys would be done to assess the presence/severity of coral bleaching, disease, or mortality. Coral reefs provide habitat and nursery grounds for many important marine resource species, as well as shoreline protection and recreation for humans. Corals can be quite sensitive to changes in their environment and they are currently facing many threats, such as climate change, pollution, ocean acidification, overfishing, and sedimentation, thus making it very important to monitor changes in coral health. Surveyors must be trained in identification of coral species and be able to identify coral bleaching, disease, and predation in order to conduct these surveys.

Methods: stationary belt transect, photoquadrat, towed survey, random sampling

Supplies: common supplies*, coral bleaching key, underwater camera

Additional resources:

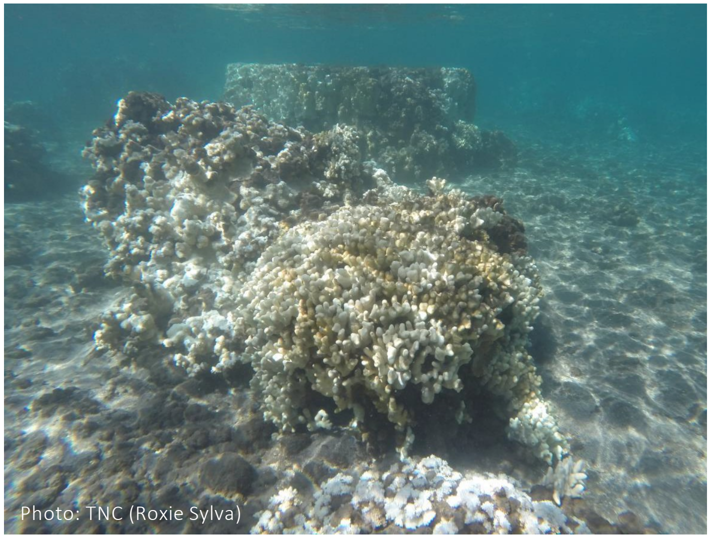

Photo: TNC (Roxie Sylva)

<u>Investment</u>

- $ - average from survey
- Recommended minimum # surveys (n) =
- Time to complete 1 survey ~
- Recommended # years:

Photo: TNC (Annalea Fink)

Intertidal Surveys

Description: Rocky intertidal surveys can be conducted to assess things like abundance, size, and distribution of various important intertidal species. Using intertidal surveys to gather abundance, spawning, recruitment, and general demographic data about key species (such as limu, intertidal fishes, ‘opihi, snails, and other invertebrates) can tell us about their distributions throughout the intertidal zone and assess how populations are changing over time. Surveyors must be able to identify different intertidal species of interest being surveyed.

Methods: stationary belt transect, random quadrats

Supplies: transect tape, quadrat, click counters, ruler, waterproof watch/timer, gloves, identification guides

Additional resources:

Photo: Conservation International

Investment

- $ - average from survey
- Recommended minimum # surveys (n) =
- Time to complete 1 survey ~
- Recommended # years:

Photo: TNC (Roxie Sylva)

‘Opihi Surveys

Description: ‘Opihi (limpet) are an important resource species in Hawai‘i, with three species that are endemic to the Hawaiian Islands (*Cellana exarata, Cellana sandwicensis*, and *Cellana talcosa*); however, populations have been steadily declining over the years due to unsustainable/overharvesting. Conducting surveys of ‘opihi populations is critical for assessing population changes and guiding management of these threatened species. Using ‘opihi intertidal surveys to gather abundance and demographic data (such as size and location) can tell us about whether populations are continuing to decline or improve. Surveyors must be able to identify the different species of ‘opihi.

Investment
- $ - average from survey
- Recommended minimum # surveys (n)
- Time to complete 1 survey ~
- Recommended # years:

Methods: rapid assessment, stationary belt transect, random quadrats

Supplies: transect tape, quadrat, click counters, ruler, waterproof watch/timer, gloves, GPS

Additional resources:

Spawning Seasons

Description: Gonad observations can be used to determine whether fish and invertebrates (such as ‘opihi) are spawning or not. By studying the gonad size regularly, we can assess peak spawning seasons for different resource species and gather information that is critical to determining when it is suitable to fish/harvest a given species sustainably. Spawning seasons for many species of fish and invertebrates can be predicted based on lunar cycles, so it is important to keep track of lunar phases when deciding when to collect sample species.

Methods: fish gonad dissection, ‘opihi gonad dissection

Supplies: scalpel/knife, ruler/measuring tape, scale

Additional resources:

Investment

- $ - average from survey
- Recommended minimum # surveys (n) =
- Time to complete 1 survey ~
- Recommended # years:

CREEL/Fisher Intercept Surveys

Description: CREEL/fisher intercept surveys are used to gather information from anglers about what, where, how, when, and how many fish are being caught at a given time. These surveys can provide valuable information on population dynamics (e.g. how many fish are being harvested, or what are species' size distributions like?) of important resource species, simply by collecting catch data that already exists from fishers. Important indicators to assess population changes are catch per unit effort (CPUE), size (both average and at maturity), and spawning seasons.

Methods: CREEL, fisher intercept, surveys/interviews, fishing logs

Supplies: survey sheets, binnoculars

Additional resources:

Photo: Conservation International

Investment

- $ - average from survey
- Recommended minimum # surveys (n) =
- Time to complete 1 survey ~
- Recommended # years:

Photo: CI (Matthew Ramsey)

Water Quality

Description: Water quality surveys provide information that is key to assessing overall health of the marine environment, as well as identify potential threats to marine resources and humans. Even small changes in temperature, nutrients, and bacteria levels could lead to negative impacts on marine ecosystems, their inhabitants, and humans alike. It can be particularly important to monitor water quality after storm events, due to impacts of terrestrial flooding/runoff. Examples of important indicators used to track changes in water quality over time are temperature, salinity, pH, nutrients (e.g. nitrogen & phosphorous), dissolved oxygen, chlorophyll, bacteria (e.g. enterococcus), chemicals/heavy metals, and turbidity.

Methods: *in situ*, colorimetric testing, seawater collection/analysis

Supplies: YSI, colorimetric test strips/kits, Niskin bottle, Secchi disk, nephelometer

Additional resources: (phone number for sending samples off)

Photos: University of Hawai i (Kiana Frank)

<u>Investment</u>

- $ - average from survey
- Recommended minimum # surveys (n) =
- Time to complete 1 survey ~
- Recommended # years:

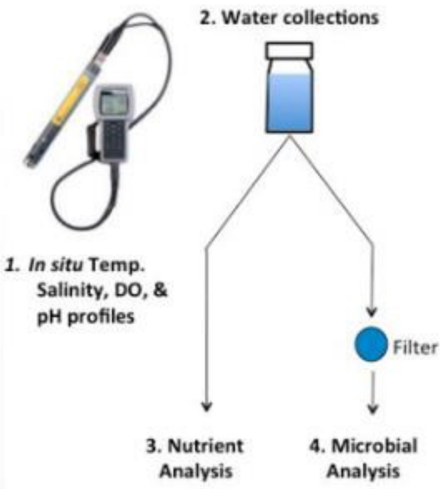

Photo: University of Hawai i (Kiana Frank)

Human Use Surveys

Description: Human use surveys can provide valuable information from the public on how marine resources and ecosystems are used by both residents and visitors of Hawaiʻi. These surveys collect data on when, where, and what types of activities are occurring (and by whom) with relation to marine environments/resources, thus helping to identify the potential impacts of human use in a given area. Surveys can be broad or target a certain audience to assess more specific impacts, and could include questions about: the participant's background, the participant's knowledge of a certain area/resource, how often the participant uses the marine area and for what activities, how the participant feels about the area, if the participant has comments/concerns, or if the participant would like to get involved/volunteer.

Methods: observations, random or targeted surveys

Supplies: survey sheets, pencil

Additional resources:

Seasonal Observations/Calendars

Description: Documenting observations of cycles and occurrences both within and surrounding marine environments provides important data on how ecosystems and organisms are changing over time. These observations help us identify natural cycles within ecosystems, as well as occurrences that may be out of the ordinary, and assess potential relationships between these cycles. Examples of important indicators to record would be weather, solar/lunar cycles, flowering/fruiting plants, tides/currents, waves, presence/absence of species, fish/coral spawning and recruitment, and algal blooms. For these surveys, observers must be conscious of their surroundings, using all of their senses to study the environment as a whole. Although anyone can conduct these observations, it is most beneficial to do so with groups of observers from different backgrounds/experiences, as the way they see the world and the things they pay attention to might be different. It is also recommended that the observation groups be led by at least one person with experience in this type of data collection.

Methods: Huliʻia, Na Kilo ʻAina

Supplies: observation datasheets, pencil, identification guides

Additional resources:

Recorder..
Participants.

Huli i ka lani! Huli i ka honua! Huli i ke kai!
Observation Datasheet

Location:..

Date: **Moon Phase:** **Kau:**

LANI		HONUA		KAI	
Clouds: high/mid/low, shape, color, % cover, etc		Plants: Flowering or Fruiting		Tide & currents: time, strength, debris, foam, low / high / extreme	
Wind: dominant direction, strength, direction change & time		Plants: Seeding or new growth / dying back		Waves, swell, ocean conditions: direction, size, etc	
Weather Report: storming, clear skies, wind storm, etc.		Animals reproducing, pregnant, birthing		Fish Nearshore: presence / absence, spawning, recruiting, congregating	
Weather (describe) rainbows, rain (duration, direction)		Birds: depart/arrive, present/absent, color of plumage, etc		Fish Reef system: presence / absence, spawning, recruiting, congregating	
Flora/Fauna adrift... birds, swarming insects, seeds/pollen		Precipitation: dry/wet, waonahele, kula, kahakai... describe landscape		Fish pelagic: presence / absence, spawning, recruiting, congregating	
Visibility: distance of sight, haze, color		Rivers & springs: water level, color, current strength, etc		Misc. spawning / congregating / recruiting	
Sunrise / Sunset: Colors, location, time, specific activities related		Flora/Fauna rivers: reproducing, pregnant, birthing, limu & other plants		Misc. presence / absence. Whales, Mantas, sharks, jellyfish & location	
Moonrise / Moonset: Colors, location, time, specific activities related, phase		Smells / Scents: waonahele, kula, kahakai...		Smells / Scents: lihikai, near shore, deep sea	
Starlines/Stars: note location and time of night		Lihikai: limu line, inverts, plants, presence, absence, behavior		Harvesting / Resting / planting / etc. practices	
General temperature, humidity, & other lani related observations		Lihikai/Kaheka: fish, birds, behavior & activity, stages of growth		Personal reflection: how do you feel?	

Journal Observations

Description: Similar to other methods employing surveys and interviews, important information can also be gained through the use of journals to record changes in resources/ecosystems over time. Individuals that have knowledge of and use marine areas/resources can take note of changes that they see themselves, and share their observations through interviews, focus groups, and surveys to help provide a better picture of the past and current state of Hawaiʻi's marine ecosystems. These observations do not have to be taken by experts, but those with personal/traditional/kamaʻāina knowledge who have worked with or studied Hawaiʻi's ecosystems would provide the most useful data. Surveys/interviews to collect information about these observations should include questions about the observer's background and knowledge of Hawaiʻi's marine ecosystems, what is the past/present condition of the ecosystem/resources in question, their perception of how/why that ecosystem may have changed over time, and what recommendations they have to improve resource management.

Methods: surveys, interviews, group meetings

Supplies: weatherproof field notebook, voice recorder, video camera, maps of specific locations

Additional resources:

Photo: Jhana Young

Photo: Rite in the Rain

Interviews

Description: Marine monitoring and biological data collection provides important information about the current state of ecosystems and resources but using these methods exclusively may not show us the full picture. It is also important to know the *past* state of these ecosystems/resources in order to understand how they are changing over time, as well as what conditions are when monitoring is not occurring. One way to collect this type of information is through interviews of communities and marine resource users. Interviewers should talk to participants about specific locations that they have used/visited, and ask questions like: what is the past/present condition of the ecosystem/resources, if they feel like the condition has changed then why, are there any major seasonal/periodic events that occur here, what is the area known for, who fishes here and how, and what management actions do they think should be enacted?

Methods: The Knowledge Transect

Supplies: maps of locations, interview datasheets, voice recorder, video camera

Additional resources:

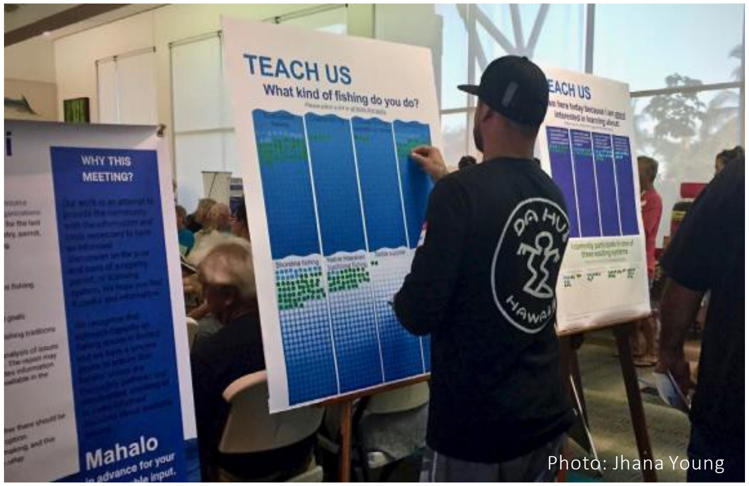

Photo: Jhana Young


Photo: Jhana Young

Moʻolelo & Storytelling

Description: Another key source of information about the state of our ecosystems comes from customary knowledge sharing and moʻolelo. Conducting oral interviews of Hawaiians who share personal and traditional knowledge of Hawaiʻi's ecosystems/resources can provide invaluable information on how the ecosystems have been used throughout time, as well as how they have changed. It is important to select participants that have genealogical ties to early residents of the specific areas being studied, and who share traditional knowledge of the land through native beliefs, traditions, or customs/practices. Interviewers should ask questions about the participant's background, how they know about/use the locations they are describing, stories/knowledge of the environment that have been passed down to them, the past and current condition of Hawaiʻi's ecosystems/resources/fisheries, their perception of how/why Hawaiʻi's marine ecosystems have changed over time, and their recommendations for addressing those changes.

Methods: interviews, storytelling

Supplies: voice recorder, video camera, maps, interview datasheets

Additional resources:


Photo: Conservation International


Photo: Conservation International

Afterword

As previously stated in the beginning of this guidebook, it is not meant to be a complete list of all possible ways to monitor resources, and there may be other methods that you are interested in learning about. We encourage communities to find what works best for their monitoring and management interests, and to use the resources/contacts listed within this guide and the appendices to help determine those strategies or set up their own monitoring programs.

We would also like to emphasize the importance of working with and listening to local communities/individuals who possess traditional, cultural, kamaʻāina knowledge of Hawaiʻi. Their knowledge of Hawaiian history, traditional practices, and use of the marine environment/land is critical for furthering our understanding of Hawaiian ecosystems and resources, and thus the development of sustainable practices and management strategies. It is also important to use any data collected by/for communities appropriately and with permission.

Finally, we find that it is important to mention that the creation of this book has been a very collaborative effort that would not have been made possible without the help of many organizations, communities, and individuals around Hawaiʻi. Thank you to all who have contributed their time, energy, and interests in this project.

CONSERVATION INTERNATIONAL HAWAIʻI

Hawaii Division of Aquatic Resources

The Nature Conservancy Hawaiʻi

NOAA — National Oceanic and Atmospheric Administration, U.S. Department of Commerce

Appendices

- Data sheets & protocols
- Training resources
- Contact information
- Common fish ID
- Common intertidal ID
- Common benthic/coral ID