

**A Decision Support System for Ecosystem-Based Tropical
Coral Reef Management**
Front-End Survey Results
February 13, 2011

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Executive Summary

General Information

- Between September 14, 2010, and January 5, 2011, there were 162 responses to the survey. Because response to most questions was optional, respondents to questions varied from 19 to 152.
- One hundred three respondents agreed to be contacted for future evaluation work in the project.
- Twenty-nine respondents used the low-bandwidth option for the survey. Six of these people cited bandwidth as a limitation to using the online products.
- The average time taken to complete the survey was just over 13 minutes.
- The survey worked as an information tool to some degree. In the open-ended comments, a number of people stated that they hadn't previously been aware of some of the products mentioned, but planned to use them in the future.
- Most respondents were involved in research, education/outreach, or resource management.
- There was a great deal of interaction with many different communities among respondents. Interaction with researchers, educators, and students was the most common, and interaction with the media was the least common.
- Just over half the respondents were from the USA; the rest were from 27 different countries around the world.

Use of Online Products

- Many respondents used the Coral Reef Watch coral bleaching alert products for a variety of uses—preparedness and planning, managing coral resources, fisheries and coral reef research, general understanding, and education and outreach. Very few used the products for policy making.
- The most common decision and planning uses for the Coral Reef Watch products were research, education, and management issues.
- *Sea Surface Temperature Data* was the most commonly used product, followed by *Bleaching Alert Area Maps*. The *Doldrums* product was the least commonly used.
- Educators who are not researchers or resource managers had not used *Satellite Bleaching Alert* emails, *Degree Heating Weeks*, *Virtual Stations*, and *Sea Surface Temperature Anomaly Data* very much; perhaps some additional educator tips on these products would be helpful.
- Almost half the respondents to the experimental products question had not used any of the products; *Bleaching Outlook* and *Free Online Data* were used by the most respondents. Most who had used them were researchers or resource managers.
- Google Earth resources were not used by many respondents, but users did include both researchers and educators.
 - Only twenty-one respondents had used the Google Earth datasets. Sixteen were researchers and five were educators.
 - Nineteen respondents had used the Google Earth products; *Sea Surface Temperature* was the most commonly used product. Fourteen were researchers or researcher/educators and three were primarily educators.
 - The June 2009 package appeared to be the most commonly used Google Earth package.
- Only fourteen respondents had used the datasets in HDF format.
- Sixteen respondents had used the Millennium Map Project.

- Forty respondents had used the educational products. *Reef Resilience and Climate Change Workshops* and *Remote Sensing and Coral Reefs Curriculum* were the most commonly used.
- Very few respondents reported any physical or institutional constraints to using the products—nine mentioned bandwidth or Internet issues.

Product Enhancements

- Among those who indicated a preference, the most-requested enhancement to the product was the *1 km pixel climatologies and HotSpot products*. Nineteen of the fifty-three open-ended suggestions for making the products more useful had to do with needing higher resolution products. A variety of other suggestions were offered.

Introduction

Members of the project team distributed the survey invitation to individuals and groups in the coral community. The survey invitation was customized for each group, but was based around the following text:

Want to Know What's Happening in Your Local and Also Global Coral Reef Ecosystem Environments?

Satellite Data Can Help! But We Need Your Input First!

The evaluators of a new project, funded by NASA to enhance NOAA's Coral Reef Watch monitoring products, seek your feedback to enhance the development of a set of cutting-edge high resolution tools. These tools will assist the scientific and resource management community to study and monitor the health of coral reefs.

All members of the coral reef community are invited to participate in this survey. It will take five or ten minute to complete.

***For high-bandwidth connections, go to
<https://www.surveymonkey.com/s/CoralTool>***

***For low-bandwidth connections, go to
<https://www.surveymonkey.com/s/CoralToolText>***

The survey contained up to 19 questions, depending on the logical branching. Questions were multiple choice or short-answer. The survey is presented in the Appendix of this report.

There were 162 responses between September 14, 2010, and January 5, 2011. All questions except the logical branching questions were optional; responses to each question varied from 19 to 152 responses. It took respondents an average of just over 13 minutes to complete the survey. The survey was presented in two formats on SurveyMonkey.com—one designed for high-bandwidth connections that included graphics, and one designed for low-bandwidth connections without graphics. Twenty-nine respondents used the low-bandwidth option; the rest used the high-bandwidth version. One hundred and three respondents agreed to be contacted in the future for further evaluation surveys.

Throughout this report, survey questions are presented in bold italics, direct quotes from respondents are in bulleted italics, and summary analysis comments are in bold text. Where available, professional role(s) of respondents are given in brackets following their direct quotes; only the three most common roles (Researcher, Educator, Resource Manager] are specified.

Survey Results

After the consent form, the first question of the survey was **How do you use the Coral Reef Watch coral bleaching alert products? (Select all that apply.)** There were 152 respondents.

Respondents use the products for a variety of p. The most commonly selected response was **General understanding**. However, all options were selected by 20 or more respondents except **Policy making**.

Responses are shown in Figure 1.

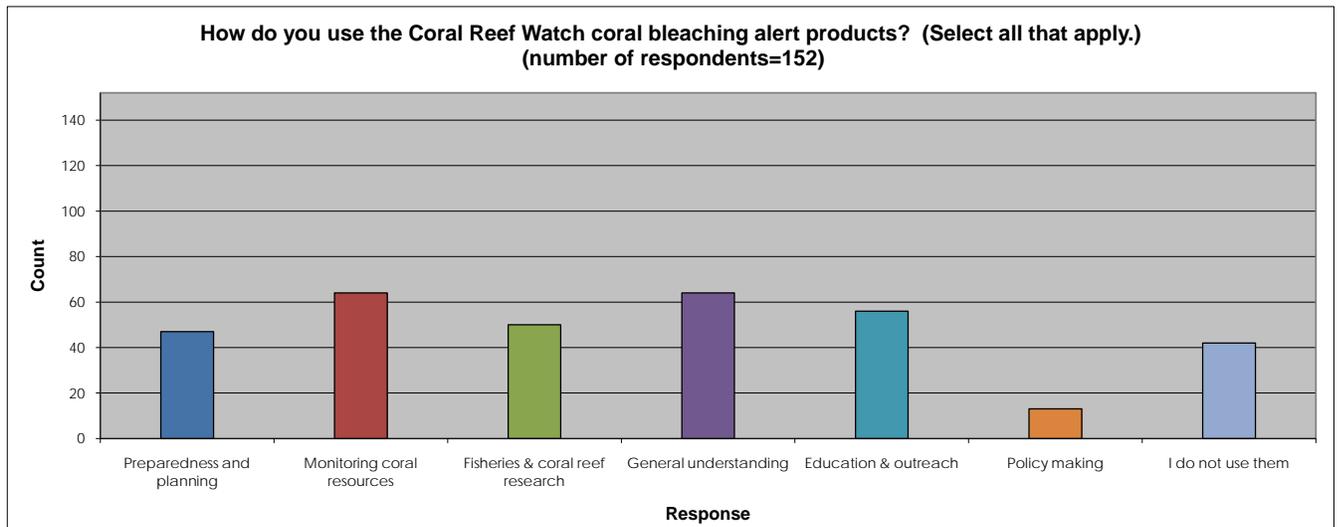


Figure 1. Use of Coral Reef Watch products.

Open-ended responses were as follows:

- *I currently do not use them, but will in future. This will be another tool in our kitbag in maintaining a watch over our area adjacent our Port Waters (Dampier, West Australia) [Resource Manager]*
- *I do not use the products much at present but see more potential uses in the future.*
- *I have used the CRW and Ocean Colour data to advise local government stakeholders of threats levels to coral reefs in the area. I have used the historical data on SST for the local virtual station to compare SST trends with bleaching events in trying to understand the causes of local bleaching events*
- *I do not use them at the moment, but I would like to use them in the future. [Researcher & Educator]*
- *I didn't know about it. [Educator]*
- *Coral reefs are part of the ecosystems in our standards. We are also interested in what is happening.*
- *Examples of how climate science can be made accessible and usable for real-time on-the-ground management. [Researcher & Educator]*
- *We hope "Experimental Virtual Stations" will soon be available for the Southwest Atlantic sites! [Researcher & Educator]*
- *To keep informed about coral reef ecosystem news[Researcher]*
- *First I have heard of this. If I had to choose one, it would be fisheries and coral reef research*

The next question was ***For what decision and planning issues do you currently use the Coral Reef Watch products?*** There were 58 respondents.

Most respondents described their use of the products for research, education, or management issues. Twenty-two respondents mentioned research on coral reef areas. Twelve said they used the products for education or information purposes. Seventeen mentioned working on coral reef management issues. Four work with advising government stakeholders.

Responses were as follows:

- *planning surveys on the ground [Researcher]*
- *To gauge destruction of coral reefs [Educator]*
- *planning when to begin coordinated bleaching monitoring, deciding which issues are of greatest concern in our reefs (elevated SS, acidification, etc...) [Researcher, Educator, Resource Manager]*
- *I have used them to plan surveys in the past. [Researcher & Resource Manager]*
- *I have participate of monitoring of reef (Program of Reef Check) as voluntarian in the Northeast of Brazil and monitoring the fisheries of reef fishes by trap during may PhD also in the Northeast of Brasil in Pernambuco Coast. [Researcher]*
- *Classroom and travel planning [Educator]*
- *We manage marine protected areas. [Resource Manager]*
- *To help the environmental entity identify the best monitoring protocols and to follow up the possible bleaching events [Researcher & Educator]*
- *I am coordinator of the project to restore marine ecosystems of the Tayrona National Park, and for us in very important to be aware of any change of our coral reefs. [Researcher]*
- *To anticipate bleaching events and what that means for our ongoing research projects [Researcher]*
- *For Research, learning and education young students [Researcher & Resource Manager]*
- *reef management [Researcher]*
- *Mainly to have an idea of possible bleaching and relating it to ground truthing A new comer, i am still barely skimming the surface [Researcher & Educator]*
- *I have used CRW and Ocean Colour data to advising local government stakeholders and diving community colleagues of the risk. I have used the historical data on SST for the local virtual station to compare SST trends with bleaching events in trying to understand the causes of local bleaching events*
- *To advise the relevant government departments in Malaysia such as the Marine Park Department. [Researcher & Educator]*
- *None [Researcher]*
- *MPA planning, zoning issues, monitoring design [Researcher, Educator, Resource Manager]*
- *Alert park managers to upcoming potential events [Resource Manager]*
- *for conservation, consumption and environmental management related issues, i currently use coral reef watch products [Researcher]*
- *Guiding reef managers and resilience planning Guiding watershed management and development [Researcher, Educator, Resource Manager]*
- *Planning for my teaching unit on corals [Educator]*
- *I use it as a resource for information only, and do not use it for decision making or planning [Educator]*

- I don't currently use any of the products but I am a new graduate student who will be researching coral reefs in the Cayman islands and I plan to use these products/services in the near future.
- I usually hear from other people that use them, but it helps me understand what is happening at a large scales. The products are too coarse for local level extents. [Resource Manager]
- Baseline conditions to be taken into account when monitoring for project related impacts on marine construction projects.
- Use these for students to understand how their energy use can effect more than just them [Educator]
- None.
- school stuff [Educator]
- status of reef health to support remote sensing research [Researcher]
- I work with marine botany and one of its components are algar associated to coral reefs.
- Decision to alert the public and reduce the pressure on those areas where the bleaching is occurring. [Resource Manager]
- education/satisfy curiosity [Educator]
- What I can have the kids use in class for their PBL projects.
- Establish protected areas
- predicting local coral reef bleaching events, so planning and preparation can be made for monitoring bleaching events. [Researcher & Resource Manager]
- Issuing bleaching alerts to local communities and prepping monitoring team for post event surveys. [Researcher, Educator, Resource Manager]
- What sites should be monitored and at what times to concentrate efforts in those areas
- coral bleaching communication - bleaching monitoring - area management - fisheries management [Researcher & Resource Manager]
- Whether to initiate response to a coral bleaching event based on alert level. Development of Mass Coral Bleaching Response plans. Decision & Planning training sessions, workshops. [Researcher, Educator, Resource Manager]
- informally, in meetings or general discussion, we might refer to it or cite it, or use images from it. [Researcher & Educator]
- Gain insight and raise awareness on regional trends which may lead to reef impacts [Researcher & Educator]
- marine spatial planning development of resource management plans in the face of uncertainty [Researcher & Educator]
- forward reaction planning [Resource Manager]
- For graduate studies, with a project for monitoring of coral bleaching.
- To study in coral monitoring project, at graduation. [Researcher]
- Desktop monitoring in order to conduct coral bleaching survey [Researcher, Educator, Resource Manager]
- increasing understanding of SST and bleaching pattern General information preparing for field assessments survey [Researcher, Educator, Resource Manager]
- Study design, understanding potential disturbances, building management objectives [Researcher, Educator, Resource Manager]
- To provide trends assessment and analysis over time; to examine specific locations for thermal stress and to explore possible patterns. [Researcher, Educator, Resource Manager]
- Advance warning of possible bleaching events. Increase monitoring efforts if bleaching events are likely to occur in a given year. [Researcher, Educator, Resource Manager]
- Currently, our capacity to respond to bleaching events is limited. However, an ad hoc rapid response team is sometimes tapped to investigate sites known to be vulnerable to thermal stress upon email notification from Coral Reef Watch that we are under a bleach

watch or warning. Investigations are usually qualitative, but occasionally quantitative data is collected. At the very least, the notifications put us on alert, so that even if we're not able to get to the reef sites during work hours we may alter our recreational plans to focus on these vulnerable sites. A few of my colleagues and I have also used the experimental bleaching forecasting tools in long-term preparations for the bleaching season. [Researcher, Educator, Resource Manager]

- Raising awareness within the Coral Triangle countries about the status of coral reefs and the issues that need to be considered in designing MPAs and MPA networks etc. [Researcher, Educator, Resource Manager]
- None. [Researcher & Educator]
- For making workplans to monitor coral reefs in Thai waters. For preparing a coral reef management plan. [Researcher & Educator]
- MPA monitoring [Researcher & Educator]
- pollution control [Researcher & Educator]
- When to do field work, when to keep eyes open for bleaching. [Researcher & Educator]
- yes [Researcher & Educator]
- evaluation of marine protected areas hot spot of coral bleaching [Researcher & Educator]
- I can use the bleaching prediction products to identify field sampling sites where I could take samples of recently dead coral skeletal material, thus avoiding destructive sampling of live specimens. [Researcher]
- They are used to help us plan for potential survey / management needs during predicted bleaching events.[Educator, Resource Manager]
- Primarily for tracking potential bleaching events to pass onto managers. [Resource Manager]
- to prepare for potential threats [Resource Manager]
- Awareness raising when there are major bleaching episodes as in the recent Asian and Caribbean events. Also to alert people in various regions (within the GCRMN) that they should be on the lookout for bleaching. Also in PPT talks on climate change and the status of coral reefs around the world. Use many of the products in this way; including the experimental predictions.
- Whether to do rapid assessment of bleaching impacts and recovery, and how to use the results for MPA design
- funding to expand GIS products as decision tools for CTI governments
- We never make decisions or plans based on Coral Reef Watch cards. We used the cards only to give example to communities/students to record the coral condition by simple method.
- We are monitoring the reef to provide actual data for the zoning process of this area as a Marine Protected Area.
- None. I am a scientist, not a decision maker or planner.

The next question was **Which of the following Coral Reef Watch products have you used in the past two years? (Select all that apply.)** There were 94 respondents.

The Sea Surface Temperature Data was the most commonly used product, followed by Bleaching Alert Area Maps. The Doldrums product was the least commonly used.

Sea Surface Temperature Data was the selected by all but 14 respondents. Bleaching Alert Area Maps, Degree Heating Weeks, HotSpots, Sea Surface Temperature Anomaly Data, and Bleaching Outlooks were all selected by 40 or more respondents. Doldrums was only selected by six people.

Responses were well-distributed among the respondents' professional roles with one exception—no educators who were *not* researchers or resource managers selected the *Satellite Bleaching Alert* emails or *Degree Heating Weeks*, and this group had only one selection each for *Virtual Stations* and *Sea Surface Temperature Anomaly Data*.

Responses are shown in Figure 2.

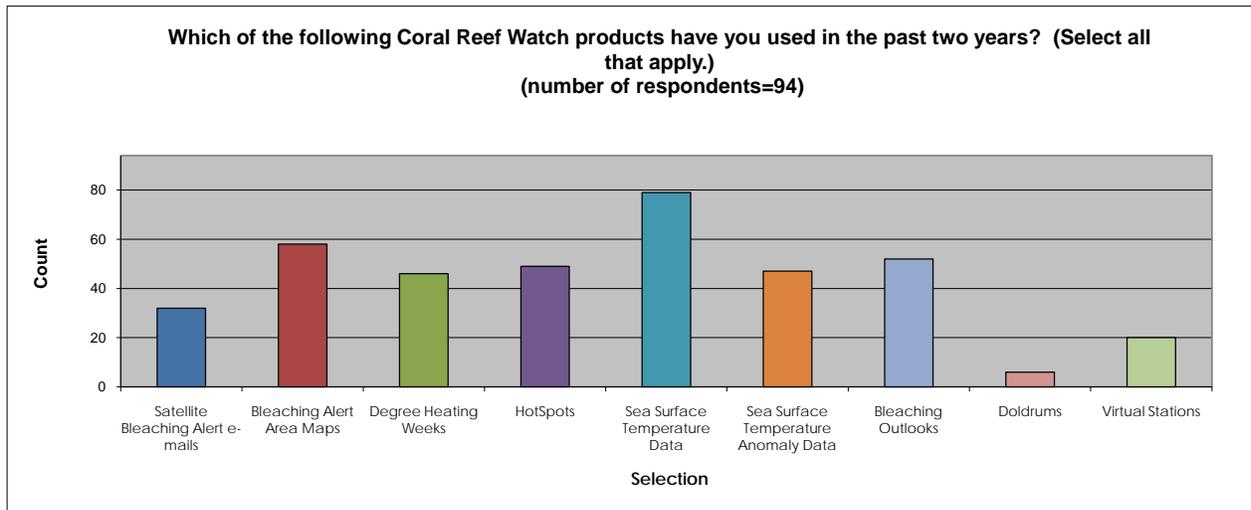


Figure 2. Recent and frequent use of Coral Reef Watch products.

Open-ended responses were as follows:

- *No, I have not used any of above. [Researcher & Resource Manager]*
- *Historical data sets from the website for the local virtual station*
- *none*
- *Our Bleachwatch Program in the Florida Keys provides a report that incorporates the next 2nd -5th items on the list, so I use these most frequently. [Researcher, Educator, Resource Manager]*
- *if you are referring to the use of this project is the first time I have used so I have not used any of the products offered.*
- *3 month predictions - or are these called 'Bleaching outlooks'*
- *We hope the "Experimental Virtual Stations" will be soon available for the Southwest Atlantic! [Researcher, Educator]*

The next question was **Which ONE of the following products do you use the most frequently?** There were 92 respondents.

Respondents were only allowed to select one answer. Again, **Sea Surface Temperature Data** was the most commonly selected option, followed by **Bleaching Alert Area Maps**. Nobody selected the **Doldrums** product.

Responses are shown in Figure 3.

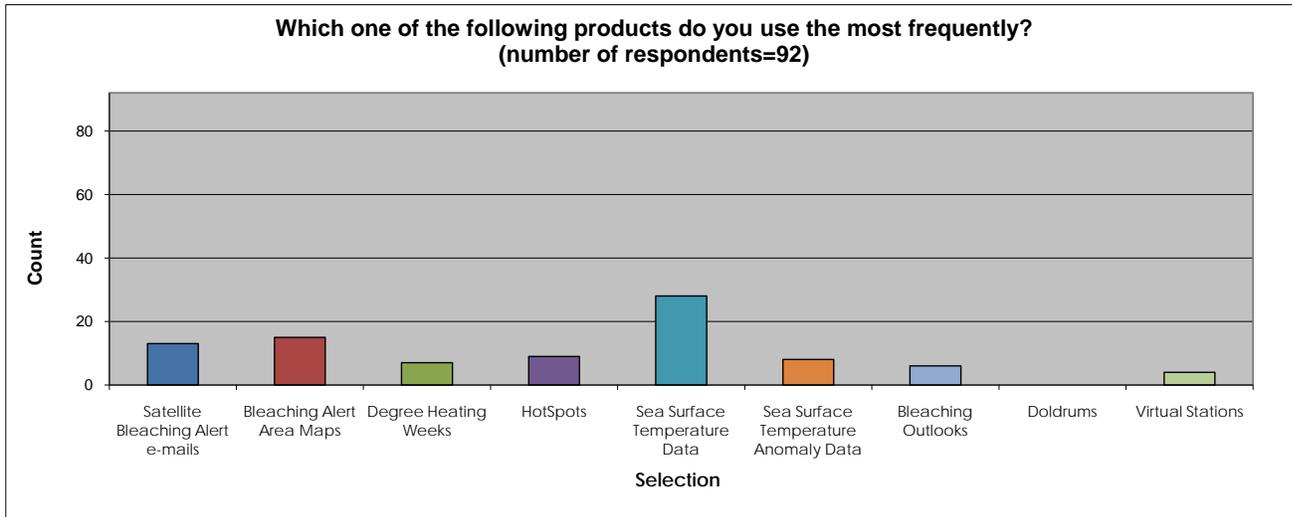


Figure 3. Products used the most frequently.

Open-ended responses were as follows:

- *No, I have not used any of above. [Researcher & Resource Manager]*
- *Please note that it is the historical and current SST data for the virtual station that I have used most*
- *none*
- *Our Bleachwatch Program in the Florida Keys provides a report that incorporates the next 4 items on the list, so I use these as frequently if not moreso. [Researcher, Educator, Resource Manager]*
- *if you are referring to the use of this project is the first time I have used so I have not used any of the products offered.*
- *rarely use only one - when i log on i look at a range of products and then select the one that will best present the story - usually hotspots*

The next question was *Which of the following Experimental Products at http://coralreefwatch.noaa.gov/satellite/current/experimental_products.html have you used? (Select all that apply.)* There were 81 respondents.

Almost half the respondents reported not having used any of the experimental products. The most commonly selected products were the *Bleaching Outlook* and *Free Online Data*. *Ocean Acidification, Disease Outbreak Risk, E50 SST, E50 HotSpots, E50 SST Anomaly, E50 DHW, and Enhanced 50km Products* each received ten or more selections, with all others receiving fewer.

Experimental products were selected almost exclusively by respondents who identified themselves as researchers or resource managers. There were fifteen respondents who identified themselves as educators but were not researchers or resource managers; of this group, there was only one who reported using any experimental product (*Bleaching Outlook*). There was one media representative who had used *Bleaching Outlook*, and one person who identified themselves as a program manager who had used *Bleaching Outlook* and *Ocean Acidification*.

Responses are shown in Figure 4.

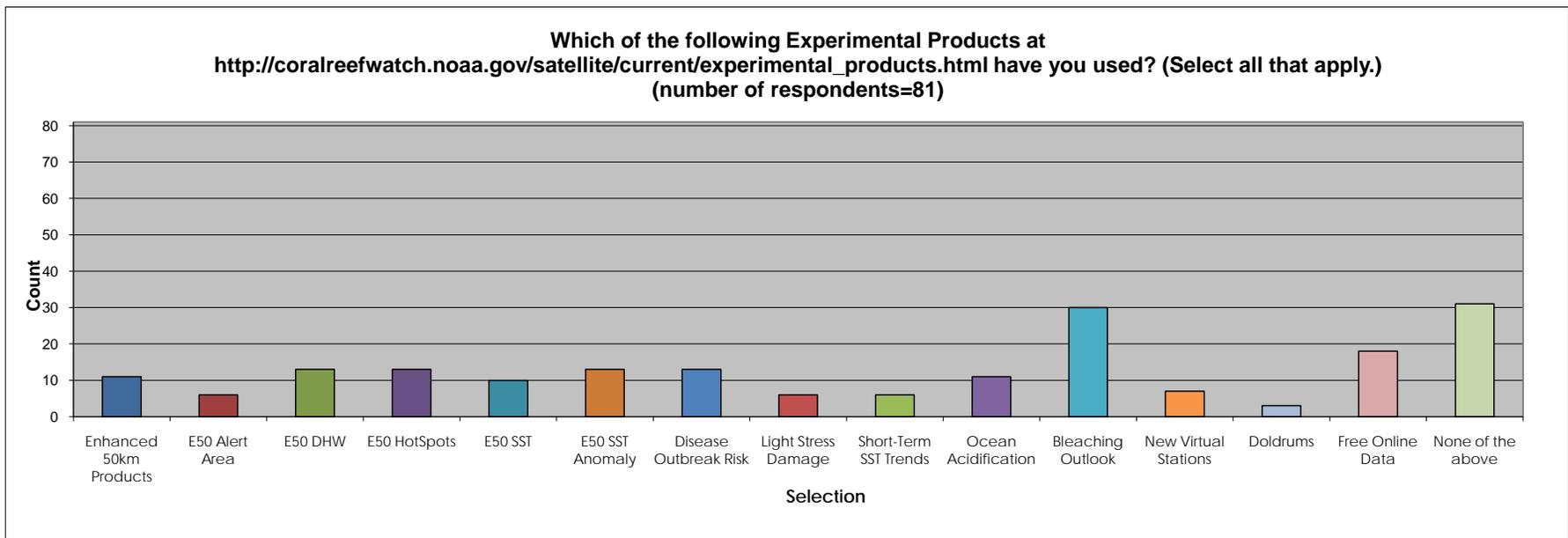


Figure 4. Use of Experimental Products.

Open-ended responses were as follows:

- *No, I have not used any of above. [Researcher & Resource Manager]*
- *I have monitoring the coral bleaching with the reef check tools. [Researcher]*
- *now that I have checked the website I will use several of these [Researcher, Educator, Resource Manager]*

The next question was *Have you used the Satellite Coral Bleaching Monitoring Datasets in Google Earth Format at <http://coralreefwatch.noaa.gov/satellite/ge/index.html>*? There were 90 respondents.

Only 21 respondents had used the datasets. Of these, sixteen identified one of their professional roles as researcher; the other five were three educators, one involved in recreation, and one who identified themselves as a program manager.

Responses are shown in Figure 5.

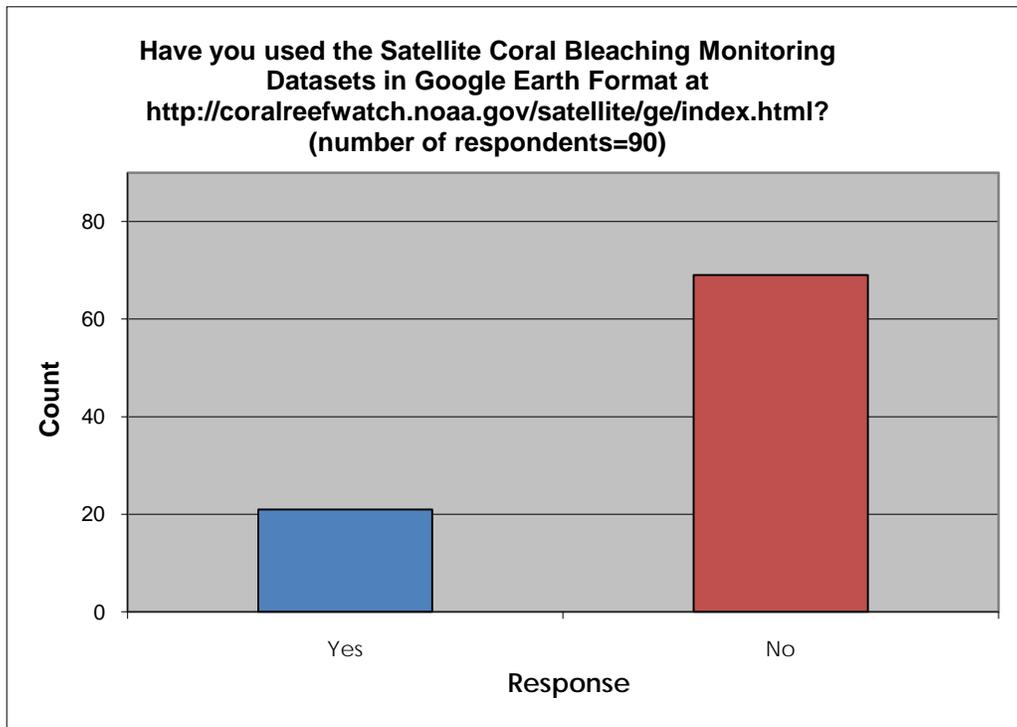


Figure 5. Use of Satellite Coral Bleaching Monitoring Datasets.

The next question was *Which of the <http://coralreefwatch.noaa.gov/satellite/ge/index.html> Google Earth products have you used? (Select all that apply.)* There were 19 respondents.

Sea Surface Temperature was the most commonly selected option. Nobody selected *Doldrums*. Fourteen respondents were researchers; the others were three educators, one involved in recreation, and one who identified themselves as a program manager.

Responses are shown in Figure 6.

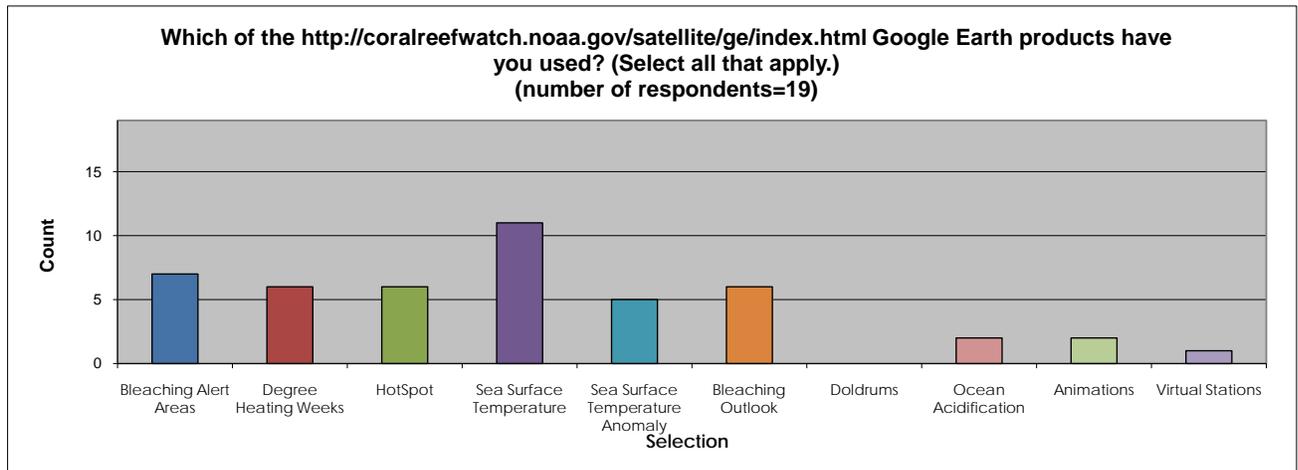


Figure 6. Use of Coral Reef Watch Google Earth products.

The next question was *Which of the Google Earth packages have you used? (Select all that apply.)* There were 22 respondents.

Selections were fairly even across the choices, with the exception that only one person picked the offline 2005 package.

Ten respondents selected the June 2009 package although one of these also selected *Not sure*. Seven selected the October 2009 package, and five selected the online 2005 package. Two researchers selected all three of these packages.

Responses are shown in Figure 7.

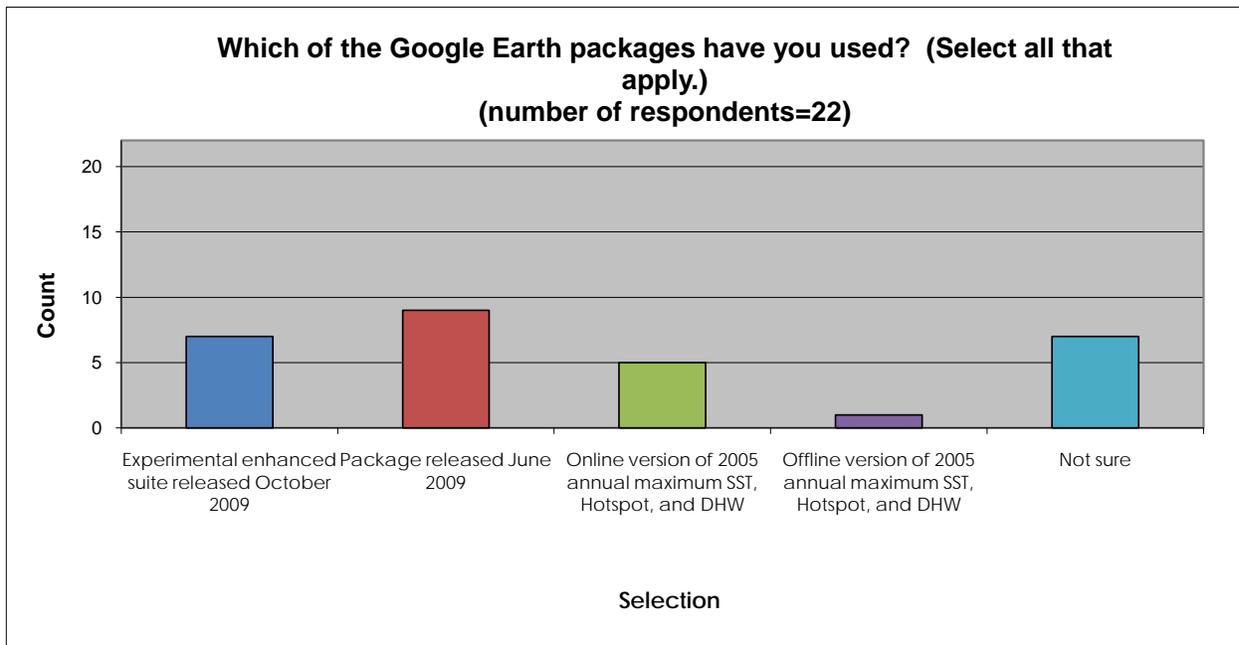


Figure 7. Use of Google Earth packages.

The next question was *Have you used the Satellite Coral Bleaching Monitoring Datasets in HDF Format at <http://coralreefwatch.noaa.gov/satellite/hdf/index.html>?* There were 84 respondents.

Only 14 of the respondents had used this product.

Responses are shown in Figure 8.

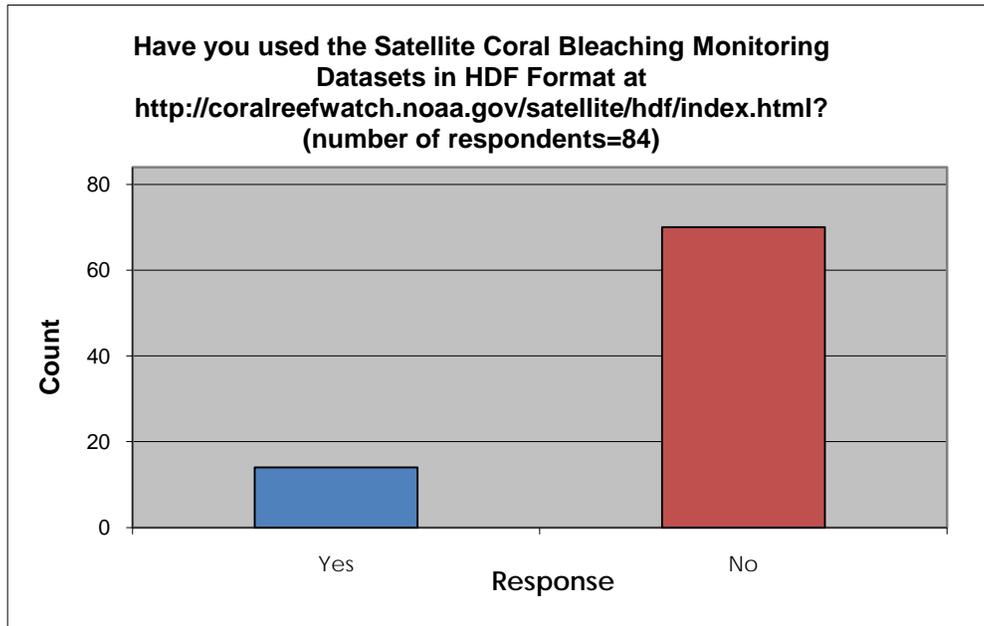


Figure 8. Use of Satellite Coral Bleaching Monitoring Datasets in HDF.

Open-ended responses were as follows:

- *the graphic representations are great for my students to look at to understand correlations of ocean temperature and how it relates to physical science [Educator]*
- *have not used the program [Researcher]*
- *to go back over past history to compare with current settings*

The next question was **How has the NASA Global Coral Reef Millennium Map Project been useful to you?** There were 30 respondents.

About half the respondents said they had not used it. Eleven respondents had used it in their research, planning, or general knowledge. Three have used it in education and outreach. One asked how they can get the details of their reefs incorporated into the database.

Open-ended responses were as follows:

- *my knowledge [Educator]*
- *No idea [Researcher]*
- *No, I have not used any of above. [Researcher & Resource Manager]*
- *I didn't use this map yet. But, I will begin to use. [Researcher]*
- *Our reefs are not shown on this map. I provided ReefBase with the details of our reefs nearly a year ago but they have not put the reefs on their database. How can I get our reefs on the map?*
- *I have not tried it out [Researcher & Educator]*
- *i have used it to plan for reef surveys [Researcher]*
- *To locate local reefs.*
- *We used the reef geomorphology product for a large-scale 1001 reef assessment for the Mesoamerican reef (based on regional representative sited selected from the basemap) [Researcher & Educator]*
- *identifying areas for further research/interest [Researcher]*
- *for my teaching and research in Universiti Malaya [Researcher & Educator]*
- *haven't used it [Educator]*
- *I have not used this in class, but am planning on using it in the future [Educator]*
- *coming from a 1rd world country with limited access to remote sensing data the site has been very valuable as a tool in monitoring and managing our coral reef work [Researcher & Resource Manager]*
- *data [Educator]*
- *I have never used this feature [Educator & Resource Manager]*
- *not used yet [Researcher, Resource Manager]*
- *i have not used it directly [Educator & Researcher]*
- *Provides a wide variety of products that help regional partners understand the potential impacts to reefs [Educator & Researcher]*
- *will help me get more data and information about the anomalies of temperature and its influence on coral bleaching, the subject of my study. [Researcher]*
- *General interest [Researcher, Educator & Resource Manager]*
- *Have not used it... [Researcher, Educator & Resource Manager]*
- *for educ and outreach [Researcher, Educator]*
- *I have downloaded several cloudless Landsat scenes for the Southwest Atlantic. [Researcher, Educator]*
- *It provides useful data for understanding and planning of MPA network design. [Researcher, Educator]*
- *I have not used it. [Researcher]*
- *I'm not sure. I assume that some of the products I use are derived from this project, but it was not clear if/how they are related to the Millennium Map Project.[Educator & Resource Manager]*
- *Have not used it - maybe i should*
- *Yes, we use it for MPA design when we can get access to it.*

The next question was *Which of the following educational resources have you used at the Coral Reef Watch website? (Select all that apply.)* There were 81 respondents. Forty had used one of the educational resources listed.

Reef Resilience and Climate Change Workshops was selected by 21 respondents. *Remote Sensing and Coral Reefs Curriculum*, *Online Tutorial*, and *Ocean Acidification Tutorial* were each selected by over ten respondents. *Science on a Sphere Module*, *Hands-On Oceanography Activity*, *Bilko Training Session*, *Background Presentation*, *Data Activity*, and *"Mark Trail" Comic Strip* all received less than five selections.

Of the fifteen respondents whose professional roles were only education and outreach, six had used at least one of the resources. Of the twenty-one who worked both in education/outreach and research, fourteen had used at least one of the resources. Ten of the twenty-six researchers who did not list education/outreach as part of their work had used at least one of the resources. The Reef Resilience and Climate Change Workshops had been used by researchers and reef managers, but no pure educators.

Responses are shown in Figure 9.

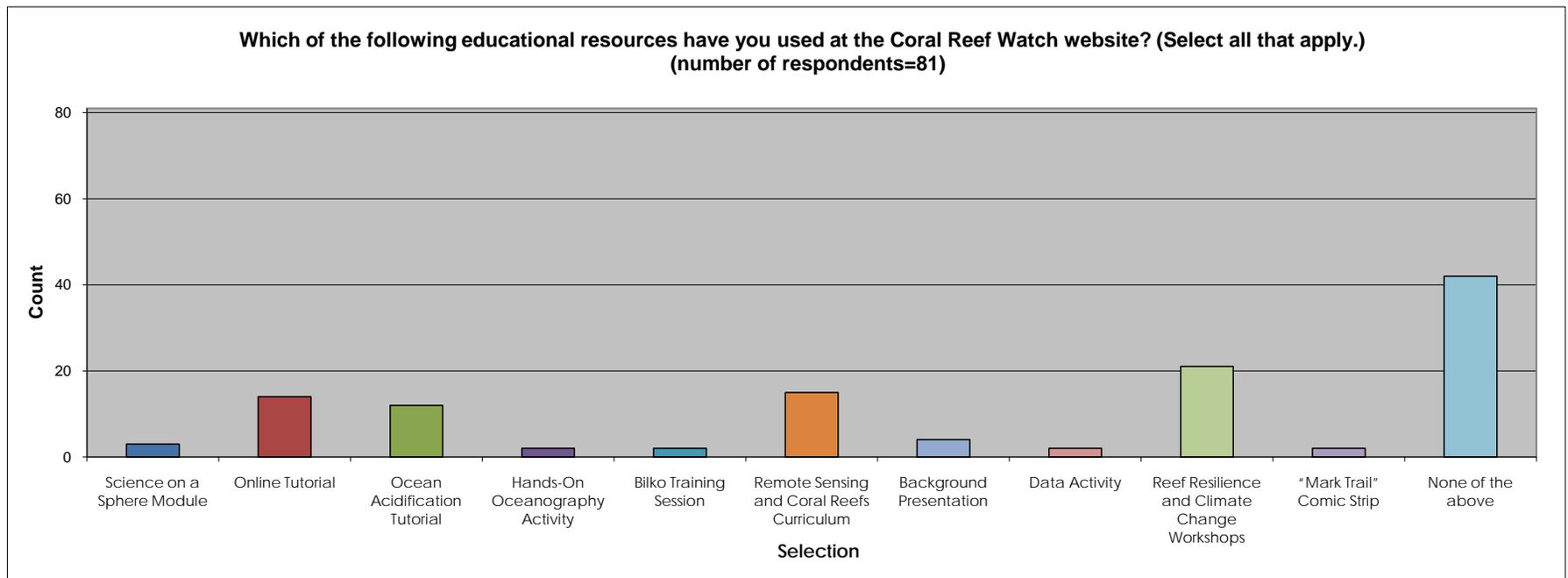


Figure 9. Use of educational resources.

The open-ended responses were as follows:

- *Remote sensing and the electromagnetic spectrum [Educator]*
- *Responding to Climate Change and Coral Bleaching Workshops [Researcher, Resource Manager, Educator]*
- *i have used none of these, but may now that i am aware of them i most likely will [Researcher & Educator]*
- *have not used the program [Researcher]*
- *I am hoping to use some of these other resources in the coming year. [Resource Manager, Educator]*

The next question was *Considering enhancements for the products, which type of SST data would be the most valuable to you? (Select all that apply if you would prefer a combination.)* There were 121 respondents.

Among those who indicated a preference, by far the most common response was the 1-km pixel option. Of the fifty-four researchers who had an opinion in answer to this question, all but eight selected the 1-km pixel option; three of these eight selected the 4-km pixel option, three selected 8-km pixel, and four selected 50-km. Of the twenty managers who had an opinion, fourteen selected 1-km pixel products and two selected 4-km pixel products. Most pure educators had no opinion.

Responses are shown in Figure 10.

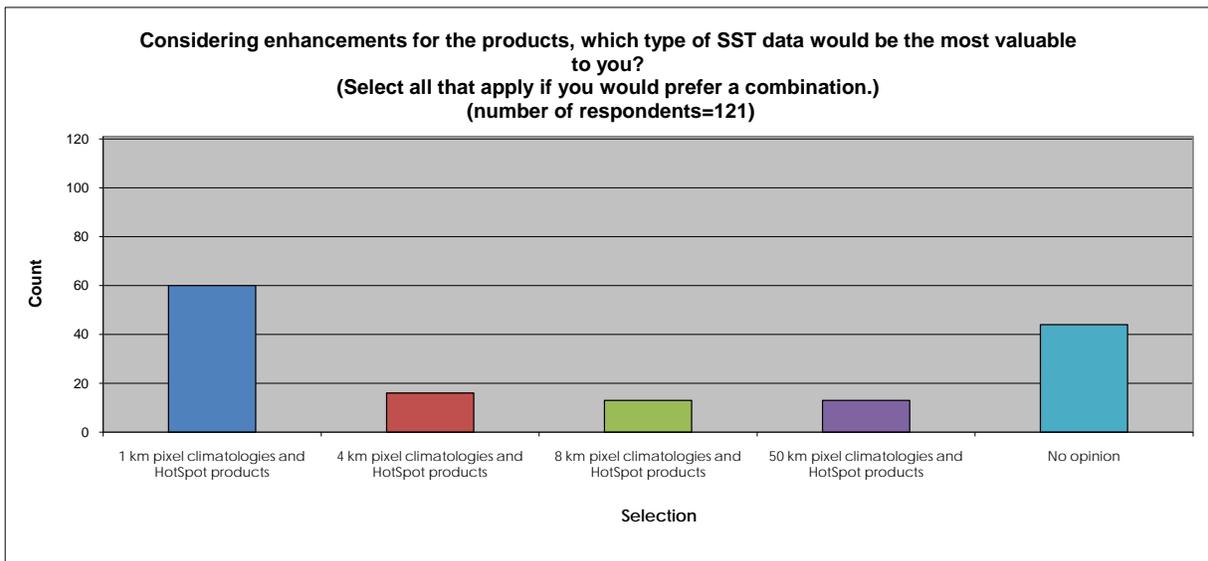


Figure 10. Value of SST data types.

Open-ended responses were as follows:

- *Our reefs are relatively small patch reefs between 1 and 11km offshore. High resolution data is necessary to develop correlations between temperature data and bleaching or disease behaviours.*
- *In the nearshore 1km pixels are a maximum pixel size for utility [Researcher]*
- *We are located in a small island system - the British Virgin Islands and the mapping scale is too vague for our area. [Resource Manager]*
- *High spatial resolution products, like 110 m (or less). Some coral reefs are so small that 1 km is not good enough. [Researcher & Educator]*
- *Since we don't have a virtual station that covers our area (Bonaire) I use Curacao/Aruba and Los Roques virtual stations. Higher resolution won't help in this situation but would be useful in case your area is in one of the virtual station [Researcher, Resource Manager]*
- *Of course 1km pixel would be most useful, but depends on expense whether or not this is really worth it. [Researcher, Resource Manager, Educator]*
- *Would like to have detailed SST data on near-shore area. In American Samoa we have a lot of backreef areas that are likely to have greater stress due to lower circulation/flushing. Knowledge of difference between specific near shore sites would allow us to target areas of interest for research/monitoring. [Researcher, Resource Manager, Educator]*

- *It would be nice to have somewhat finer resolution, but I'm not sure if it is truly cost effective to take it to the smaller pixel sizes. There is so much variation in bleaching due to light, shading, etc. that it may not be that helpful. [Resource Manager, Educator]*
- *Sorry, again have not use this products*

The next question was *What would make the Coral Reef Watch products more useful to you in your work?* There were 64 respondents, 53 of whom suggested enhancements.

Nineteen respondents requested higher resolution and five asked for greater coverage. Three people appreciate or would like email alerts and one suggested an RSS feed for alerts. Other specific requests included the following:

- better map organization
- additional virtual stations
- ecosystem information
- integration of ocean color products
- point-and-click data provision for SST and carbonate saturation
- long-term trends
- ASCII/text format for data downloads (two requests)
- Shape file format
- information on correlation with education standards
- enhancement of the website working with NASA communication people
- information on near-shore processes
- better communication with the community on available products
- increased input from users
- additional education activities

Open-ended responses were as follows:

- *I like the periodic email alerts. It would be helpful to have the maps for example organised in a way similar to the Hurricane Centre (i.e., easy for non specialists to select and view information). If there is one screen for this I have not found it yet and always end up hopping through web addresses until I find what I'm looking for I did not even know there were outreach/learning tools [Resource Manager]*
- *Is very helpful at this moment [Resource Manager]*
- *having a smart board in classroom [Educator]*
- *Research facilitation through provision of data on coral reefs, mangroves and other coastal ecosystems [Researcher]*
- *will be useful to educate students [Researcher & Resource Manager]*
- *Due i didn't know nothing about coral reef watch yet, i'll study these programs and give you this kind of feed back as soon as i can. [Researcher]*
- *We need help to better understand local behaviours in relation with CRW products. For example where I have most diving and Reef Check monitoring experience we are relatively close to a CRW NOAA virtual station but the correlation in 1001 between CRW and local effects was poor and in 101 very good. This probably shows that regional scale effects like El Nino are modeled well but local effects are not. There is a large river outflow close to the virtual station and we feel this is likely to influence local effects and the CRW product but perhaps in divergent ways. Higher resolution data may help. We need help with adapting CRW algorithms to local effects. Research has shown that nutrient levels are important effects in coral bleaching and health. We see massive seasonal changes in ambient ocean colour (from experience in diving and from Modis data) and presumably chlorophyll in the water. It would be interesting to see whether such ocean colour products can be integrated into CRW.*
- *Higher resolution in the Bermuda area [Researcher & Resource Manager]*
- *lesson plans [Educator]*
- *It looks like there is a lot improvements. I don't want to comment about the resolution being too coarse if this has changed. I like how the product is global. But finer resolution is needed in the Caribbean. [Resource Manager]*

- I still need to familiarise myself more
- more user friendly interface [Researcher, Educator & Resource Manager]
- RSS feed with the new products would be welcome to stay current without actually having to go and search for the info on the noaa website...
- Note of current research or link to local entities.
- point and click specific SST data for any pixel, that you can then enter in data temporal range of interest and retrieve data products.... Ditto with carbonate saturation state. [Researcher, Educator & Resource Manager]
- higher resolution - better cover in my area - Western Australia [Researcher]
- better identification of sources and associated researchers to aid collaboration [Researcher]
- more software on google so as can have easy access. also this is much easier to use to convince the layperson in the government departments that actually make the decisions
- being able to access the finest resolution products available so that smaller scale interactions can be investigated [Researcher]
- if it became an enforcing body [Educator]
- having a mail-list informing updating
- If they were directly correlated with state standards as well as national [Educator]
- More sensors in our area, especially on the northern coast of Anegada [Resource Manager]
- An automated e-mail alert if SST reached critical levels in an area of interest. [Resource Manager]
- delineate coral reef areas at high resolution
- Access to more detailed satellite images of coral reef areas for assisting in mapping [Researcher & Resource Manager]
- It would be great to download the data in ascii or txt format instead of binary format or others. For people not trained in the use of such binary data formats it is very difficult to access the data.
- If they would cover more areas in the Arabian Gulf and Gulf of Oman, most of the time there is some areas with no data.
- Higher temporal and spatial resolution.
- suggested activities for middle school or high school use suggested activities for scuba certified students-we have tons of these at our 1-11 school in FL [Educator]
- finer resolution. with lower res the gulf stream current conditions dominate the pixel and coastal waters, where reefs exist, aren't well represented [Researcher & Resource Manager]
- I simply need to become more familiar with the products and then integrate them into my Caribbean fisheries management activities. [Resource Manager]
- I don't use them. [Educator]
- awareness of what's available [Educator]
- I would like to try them out. [Educator]
- Never heard of them.
- Near real time products and high spatial resolution.
- I do not get any Coral Reef Watch products, so it would be useful to learn about them to include them in my curriculum as a teacher. [Educator]
- Resolution has been a major issue as pixels currently average conditions for oceanic and coastal areas. [Researcher, Resource Manager, Educator]
- a higher resolution (i.e. 1km or less) data points [Resource Manager & Educator]
- include our area [Researcher, Resource Manager]
- disease predictions more time available to research them [Researcher, Resource Manager, Educator]

- *my internet connection, being on a small island, is not always the greatest. so while the products are great, accessing them is not necessarily easy. when i can, i try to give my community easy to use tools- in their language: Spanish, French, Creole- that makes sense to them and that they can clearly see the connection to their lives. "why does coral reef watch matter to you? let me show you how..." trying to convince people outside of the scientific community that climate predicting, coral bleaching, etc is useful them is not an easy task [Researcher, Educator]*
- *Increased resolution and regional specific products (e.g. Caribbean) [Researcher, Educator]*
- *If you could convince all of NOAA, and other federal agencies for that matter, to develop interfaces like those of Coral Reef Watch for sharing there climate and environmental data the world would be a better place. I am not certain why Coral Reef Watch is not the model for climate.gov. [Researcher, Resource Manager, Educator]*
- *It may be useful to look at trends over a longer timeframe, but I find it pretty useless on a day to day level [Researcher, Resource Manager, Educator]*
- *Presentation makes a big difference in how information is used. I think NASA does an above average job of communicating its science to the general public, and I believe the organization has skills that it could teach to NOAA and Coral Reef Watch in presenting information and in improving how the various products can be used and combined. CRW has been doing a better job than many other government websites, but a close partnership with NASA's communication professionals (or contractors) could conceivably improve how the CRW site gets used. [Researcher, Resource Manager, Educator]*
- *Of course the impossible, improved spatial resolution of products. It's getting close to helping elucidating island scale patterns, so as a manager and scientist I desire that. Easier communication with developers. Seems like a black box and we never have any input. [Researcher, Resource Manager, Educator]*
- *finest possible scale products that have direct application to coral reef monitoring and MPA selection and design/zoning[Researcher, Resource Manager, Educator]*
- *Obviously any improvement in accuracy would be helpful, but I think that the products are plenty useful as they are. The problem we have is the limited capacity to carry out monitoring and respond in other ways to thermal stress, even with advanced warning through Coral Reef Watch products. Another improvement would be the availability of local-scale water temp data and products derived from this base data set. We have a very poor understanding of local patterns of resilience, which is what we need to effectively develop policy at the level of a given state/territory. [Researcher, Resource Manager, Educator]*
- *More details on nearshore processes[Researcher, Resource Manager, Educator]*
- *maps and alerts[Researcher, Resource Manager, Educator]*
- *Just knowing more about them since my exposure so far has been limited. Would like to link information on the Coral Triangle countries to the Coral Triangle Atlas that is based in the World Fish Center with technical assistance of TNC and others. [Researcher, Resource Manager, Educator]*
- *"Experimental Virtual Stations" for the Southwest Atlantic[Researcher, Educator]*
- *downloadable in either txt format or in shape files[Researcher, Educator]*
- *We need the high resolution data because most coral reef sites in Thai waters are relatively small areas (less 1 km²). [Researcher, Educator]*
- *More advertising to the community about the available data. I thought I knew about the program and there were lots of new products that I was unaware of until taking this survey. [Researcher]*
- *Inclusion of the region ~27 degrees S; 32 degrees E [Researcher]*
- *More technical details on how the products are constructed [Researcher]*

- *They already are very useful. Improved forecasts of potential bleaching would be useful. We were quite worried with some of the experimental forecasts for the Marianas this year and were thankful that they were incorrect (they predicted potential for severe bleaching and although we experienced many watches this year we experienced only minor bleaching). Although, they thankfully were incorrect this year, this type of forecast has the potential to be very useful as it will allow us to obtain resource, educate policy makers, and form partnerships in advance of a bleaching event.[Resource Manager, Educator]*
- *Your format is good for global perspective. Local managers need greater resolution, preferably by the NWHI and MHI. .[Resource Manager]*
- *Smaller scale to be more useful for identifying small scale patterns of ssts and bleaching*
- *ease of access to these products*
- *cannot think of anything*

The next question was ***Are there physical or institutional constraints that prevent your using the Coral Reef Watch products in your work?*** There were 62 respondents.

Forty-one people said there were not any constraints. Nine mentioned bandwidth or internet limitations. One person mentioned institutional constraints, one mentioned buy-in from the community, two mentioned the lack of productive actions, and another described government policy issues.

Open-ended responses were as follows:

- *only bandwidth [Resource Manager]*
- *Institutional constraints [Resource Manager]*
- *yes [Educator]*
- *No*
- *no*
- *no*
- *NO*
- *I still need to familiarise myself more [Researcher]*
- *bandwidth issues (I am on a small Caribbean island with poor internet capacity) [Researcher, Educator & Resource Manager]*
- *no*
- *No.*
- *no*
- *No*
- *none*
- *slow internet access sometimes [Researcher]*
- *coral is being destroyed at an alarming pace... and no enforcing body can convince the government to stop dredging and back filling off land on live coral areas [Educator]*
- *not that I am aware [Researcher]*
- *no*
- *No*
- *Not really. We don't have great bandwidth here in the northwest re e-mails and large data products on-line. [Resource Manager]*
- *lack of time and knowledge. [Researcher & Resource Manager]*
- *no*
- *No*
- *No*
- *it should be tied to science Next Generation standards for FL [Educator]*
- *no*
- *No*
- *I must submit a special request to my IT dept for anything that needs to be downloaded, e.g., Google Earth. Therefore, I'm not able to use something that I find "at the last minute"...special requests must be submitted a week or more before I need it. [Educator]*
- *No*
- *Unfamiliar with the products' applications to environmental management; Interested to learn more!*
- *Don't have a coral reef here.*
- *No*
- *no*
- *Not that I know of.*
- *not enough time in the day. grin.*

- none
- No.
- no
- no
- none
- *yes. internet connections. resistance from the community/slow acceptance of new technology from important user-groups. [Researcher & Educator]*
- No
- *Not a one. We encourage broad use of coral reef watch.*
- *Impossible to act productively in the face of warnings - what do you do? Interesting information of little practical value. [Researcher, Educator, Resource Manager]*
- No
- *I can freely use these products at work, but, as mentioned above, very limited capacity and the myriad local-scale stressors we're struggling with addressing make it difficult to follow through with thermal stress-related monitoring, policy-development and advocacy, etc. [Researcher, Educator & Resource Manager]*
- *Internet connections at times [Researcher, Educator & Resource Manager]*
- no
- *No, but it is usually a matter of what information is needed that is most relevant to solve the immediate threats which are not all climate change related. [Researcher, Educator & Resource Manager]*
- *scale is the major one - too coarse [Researcher, Educator & Resource Manager]*
- *Slow internet speed [Researcher, Educator & Resource Manager]*
- *Availability only! [Researcher, Educator]*
- *low band-width [Researcher, Educator]*
- no
- No.
- None.
- No.
- No.
- no
- *cannot think of anything*
- No

The next question was *What is(are) your role(s) in the coral community? (Select all that apply.)* There were 114 respondents.

Most respondents were researchers, education/outreach roles, or a combination of both.

Thirty-nine of the sixty-two researchers also selected education/outreach. Nineteen selected education and outreach without selecting research. Twenty-three researchers also selected resource manager, nine respondents selected only resource manager, and two selected resource manager and education/outreach.

Responses are shown in Figure 11.

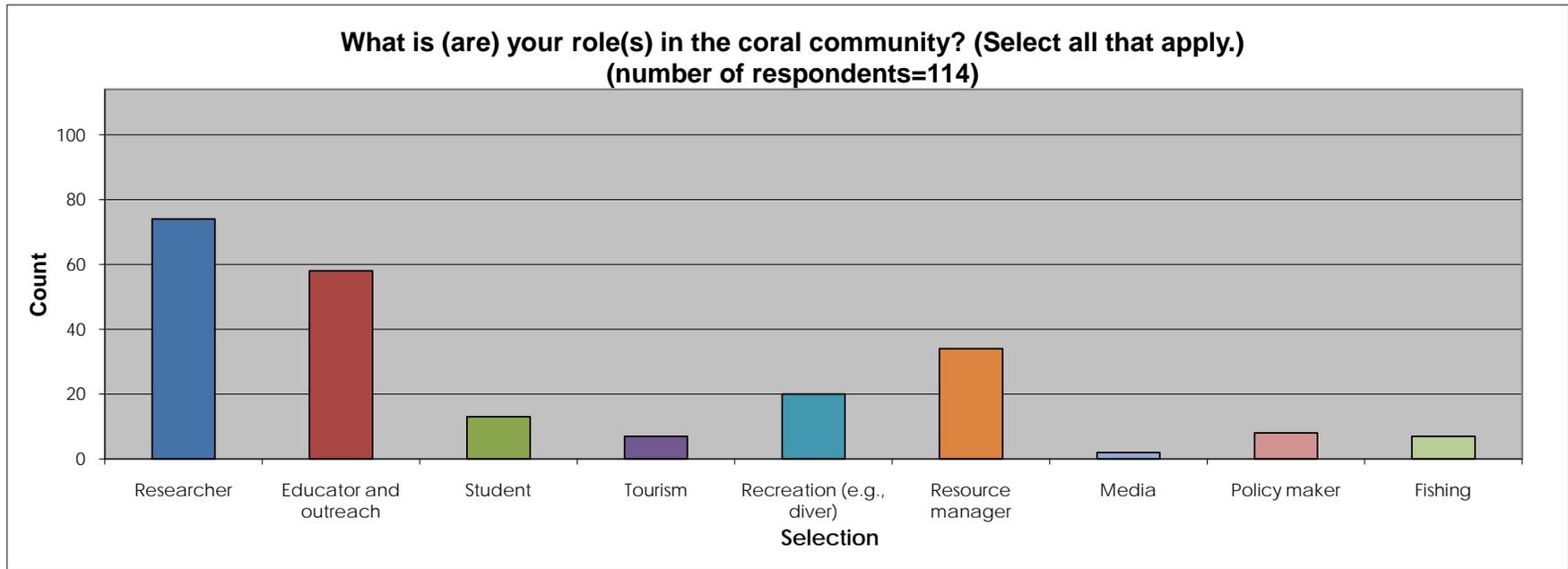


Figure 11. Role(s) in the coral community.

Open-ended responses were as follows:

- *I am the Director of a regional network of protected areas*
- *environmental consultant*
- *I am a recent Marine Biology graduate and unemployed, there is only up from here!*
- *usually in an advisory capacity to the relevant government departments*
- *Teacher*
- *conservation*
- *Resource Stewardship Scientist*
- *marine conservation project manager*
- *raising awareness at all scales via the Global Coral Reef Monitoring Network - so provably an advocate for change and conservation of coral reefs*
- *Marine scientist supporting MPA design and monitoring*
- *program manager*

The next question was *Which other communities interested in coral reefs do you interact with? (Select all that apply.)* There were 113 respondents.

There is a lot of interaction with other communities among respondents. Most researchers and resource managers interact with most of the other communities mentioned. Most educators interact with only students and other educators, though a few interact with other communities. All but seven of the respondents who interact with the media were researchers who also do education and outreach. Interactions with other communities were fairly well dispersed among the professional roles.

Responses are shown in Figure 12.

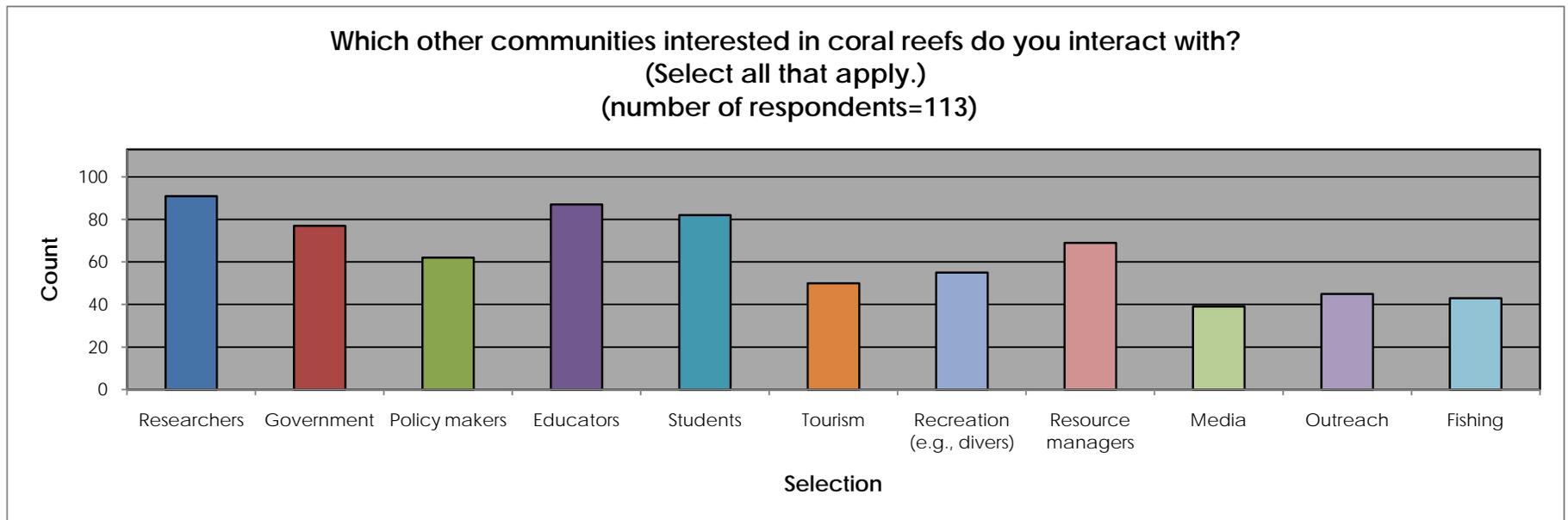


Figure 12. Other communities with which participants interact.

Open-ended responses were as follows:

- *Communities in the grassroots*
- *Volunteers*
- *Donors; Non-governmental organizations*
- *artists agriculture/farmers (runoff) boaters/sailors (not tourists but also those that live on boats and are frequently encountering issues with reefs, mpas, managers, restrictions, moorings, etc.) developers (runoff)*

The next question was *City; State/Province/Territory/County; Country*. There were 111 respondents.

Respondents were from 29 countries. USA was by far the most common response, accounting for over half the responses. Open-ended responses are shown in Figure 13.

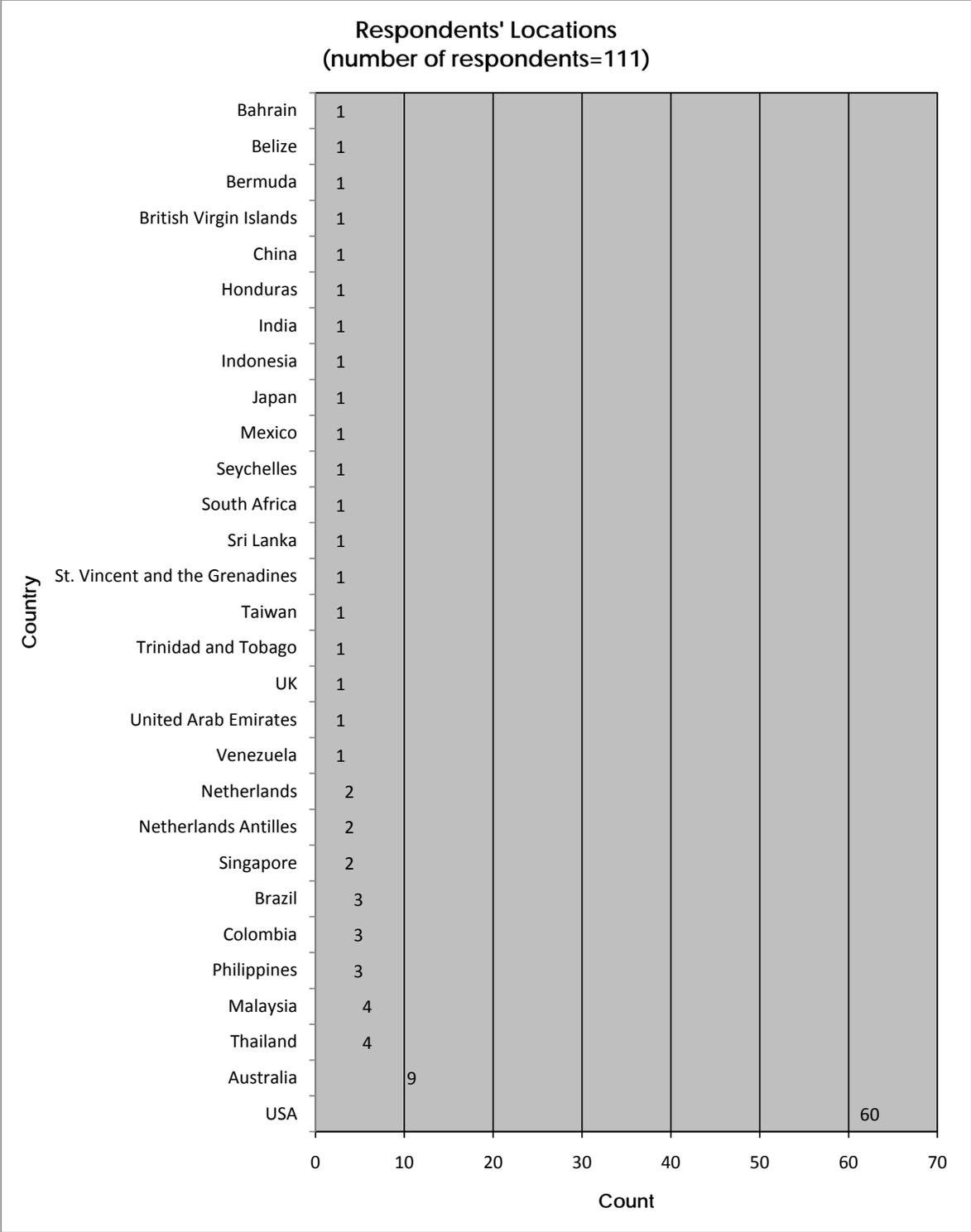


Figure 13. Survey respondents' locations.

Florida, Hawaii, and Puerto Rico were the most common locations in the USA among respondents. Distribution of respondents from the USA is shown in Figure 14.

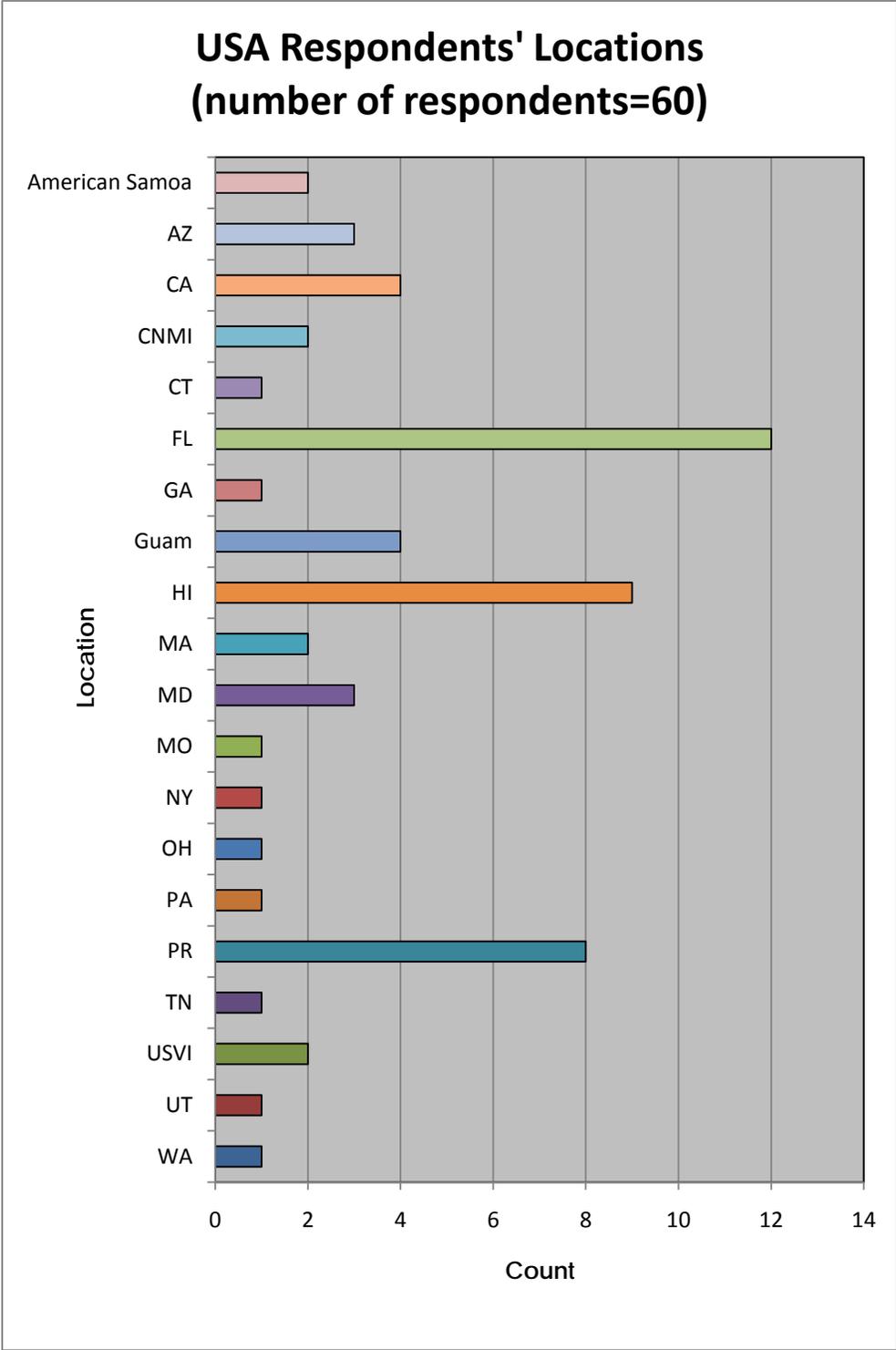


Figure 14. USA respondents' locations.

Appendix--Evaluation Instrument

Coral Tool Survey--High Bandwidth

Introduction

Want to Know What's Happening in Your Local and Also Global Coral Reef Ecosystem Environments?

Satellite Data Can Help! But We Need Your Input First!

The evaluators of a new project, funded by NASA to enhance NOAA's Coral Reef Watch monitoring products, seek your feedback to enhance the development of a set of cutting-edge high resolution tools. These tools will assist the scientific and resource management community to study and monitor the health of coral reefs.

Evaluators at the Cooperative Institute for Research in Environmental Sciences (CIRES) have developed this survey on possible high resolution satellite coral bleaching monitoring and nowcast products.

It will take about ten minutes to complete; you may skip any questions that you prefer not to answer.

The [NOAA Coral Reef Watch \(CRW\)](#) program has been providing near-real-time, Web-accessible Sea Surface Temperature (SST) products to pinpoint the areas where thermal stress may cause mass coral bleaching around the globe. The near-real-time data help quickly identify areas at risk to assist management response as well as identify sites of interest for research. Retrospective analyses are also provided for reef management and scientific research.

This [new project](#), entitled A Decision Support System for Ecosystem-Based Tropical Coral Reef Management, has begun to test enhanced products using higher spatial resolution imagery, including data from the [NASA MODIS](#) (Moderate Resolution Imaging Spectroradiometer) [] and NOAA AVHRR (Advanced Very High Resolution Radiometer) sensors, as well as from the [NASA Global Coral Reef Millennium Map Project](#). Throughout this project, we will be asking for feedback from current and potential users of these resources.

This survey is the first in a series of opportunities for you to provide comments and suggestions on these tool enhancements. Your responses will be of great help to improve our understanding of the user needs and to shape a best set of the products to be delivered to coral reef community scientists and managers. If you provide your contact information for future survey opportunities, it will be kept separate from your responses to this survey. All responses will be reported anonymously.

If you would like to participate in brief surveys or phone interviews to provide feedback on the new products being developed, please indicate that in the question below to access the consent form for the project. If you have any questions about the evaluation of this project, please contact Susan Lynds at susan.lynds@colorado.edu.

*** Would you be interested in being notified of future surveys about these products?**

- Yes, please take me to the consent form and then the survey
- No, but I'd like to take this survey

Coral Tool Survey--High Bandwidth

Consent Form to Participate in Survey

A Decision Support System for Ecosystem-Based Management of Tropical Coral Reef Environments PROGRAM EVALUATION INFORMED CONSENT FORM

The following survey is designed to collect input for guiding this new NASA research. This process is conducted by Susan Lynds, University of Colorado at Boulder's Cooperative Institute for Research in Environmental Sciences Education and Outreach Program, UCB 449, Boulder, CO, 80309-0449; Phone: 303-492-1714.

This survey should take about ten minutes to complete.

By signing this first survey, we will invite you to participate in subsequent surveys.

Your experience will help improve the Coral Reef Watch products.

Source of Funding:

Funding for this study is being provided by the National Aeronautics and Space Administration (NASA).

Confidentiality:

We will make every effort to maintain the privacy of your data. If you provide your contact information in order to receive emails about subsequent survey or interview opportunities, your contact information will be stored separately from your survey responses. All data will be stored anonymously for analysis and reporting. At the completion of the study, all data will be destroyed. Other than the researchers, only regulatory agencies such as the Office of Human Research Protections and the University of Colorado Institutional Review Board may see your anonymized data as part of routine audits.

Questions?

If you have any questions regarding your participation in this research, you should ask the investigator before signing this form. If you should have questions or concerns during or after your participation, please contact Susan Lynds at 303-492-1714.

If you have questions regarding your rights as a participant, any concerns regarding this project or any dissatisfaction with any aspect of this study, you may report them -- confidentially, if you wish -- to the Executive Secretary, Institutional Review Board, 563 UCB, ARCE Room A15, University of Colorado at Boulder, Boulder, CO 80309, (303) 735-3702.

Authorization:

I choose to be in this study. I know that I can withdraw at any time. By entering my name and clicking on "Yes, I agree to participate" in the boxes below, I am providing my electronic signature equal to my physical signature. Please enter your name in the box below.

*** Your name (This will only be used to verify your consent to participate in this survey and to inform you of future surveys.)**

Your email address (This will only be used to inform you of future surveys in this project.)

Your email address again for verification

Coral Tool Survey--High Bandwidth

*** Please select one:**

- Yes, I agree to participate.
- No, I do not agree to participate, but I'd like to take this survey.

Coral Tool Survey--High Bandwidth

How do you use the [Coral Reef Watch](#) coral bleaching alert products? (Select all that apply.)

- Preparedness and planning
- Monitoring coral resources
- Fisheries and coral reef research
- General understanding
- Education and outreach
- Policy making
- I do not use them

Other (please specify)

Coral Tool Survey--High Bandwidth

For what decision and planning issues do you currently use the [Coral Reef Watch](#) products?

Coral Tool Survey--High Bandwidth

Which of the following [Coral Reef Watch](#) products at have you used in the past two years? (Select all that apply.)

- Satellite Bleaching Alert e-mails
- Bleaching Alert Area Maps
- Degree Heating Weeks
- HotSpots
- Sea Surface Temperature Data
- Sea Surface Temperature Anomaly Data
- Bleaching Outlooks
- Doldrums
- Virtual Stations

Other (please specify)

Coral Tool Survey--High Bandwidth

Which *one* of the following [Coral Reef Watch](#) products do you use the *most frequently*?

- Satellite Bleaching Alert e-mails
- Bleaching Alert Area Maps
- Degree Heating Weeks
- HotSpots
- Sea Surface Temperature Data
- Sea Surface Temperature Anomaly Data
- Bleaching Outlooks
- Doldrums
- Virtual Stations

Other (please specify)

Coral Tool Survey--High Bandwidth

Which of the following Experimental Products at http://coralreefwatch.noaa.gov/satellite/current/experimental_products.html have you used? (Select all that apply.)

- Enhanced 50km Products
- E50 Alert Area
- E50 DHW
- E50 HotSpots
- E50 SST
- E50 SST Anomaly
- Disease Outbreak Risk
- Light Stress Damage
- Short-Term SST Trends
- Ocean Acidification
- Bleaching Outlook
- New Virtual Stations
- Doldrums
- Free Online Data
- None of the above

Other (please specify)

Coral Tool Survey--High Bandwidth

* Have you used the Satellite Coral Bleaching Monitoring Datasets in Google Earth
Format at <http://coralreefwatch.noaa.gov/satellite/ge/index.html>?

Yes

No

Coral Tool Survey--High Bandwidth

Which of the [Google Earth products](#) have you used? (Select all that apply.)

- Bleaching Alert Areas
- Degree Heating Weeks
- HotSpot
- Sea Surface Temperature
- Sea Surface Temperature Anomaly
- Bleaching Outlook
- Doldrums
- Ocean Acidification
- Animations
- Virtual Stations

Other (please specify)

Which of the [Google Earth packages](#) have you used? (Select all that apply.)

- Experimental enhanced suite released October 2009
- Package released June 2009
- Online version of 2005 annual maximum SST, Hotspot, and DHW
- Offline version of 2005 annual maximum SST, Hotspot, and DHW
- Not sure

Other (please specify)

Coral Tool Survey--High Bandwidth

Have you used the Satellite Coral Bleaching Monitoring Datasets in HDF Format at <http://coralreefwatch.noaa.gov/satellite/hdf/index.html>?

Yes

No

Comments

How has the [NASA Global Coral Reef Millennium Map Project](#) been useful to you?

Coral Tool Survey--High Bandwidth

Which of the following educational resources have you used at the Coral Reef Watch website (<http://coralreefwatch.noaa.gov/satellite/education/index.html>)? (Select all that apply.)

- Science on a Sphere Module
- Online Tutorial
- Ocean Acidification Tutorial
- Hands-On Oceanography Activity
- Bilko Training Session
- Remote Sensing and Coral Reefs Curriculum
- Background Presentation
- Data Activity
- Reef Resilience and Climate Change Workshops
- "Mark Trail" Comic Strip
- None of the above

Other (please specify)

Coral Tool Survey--High Bandwidth

Considering enhancements for the products, which type of SST data would be the most valuable to you? (Select all that apply if you would prefer a combination.)

- 1 km pixel climatologies and HotSpot products
- 4 km pixel climatologies and HotSpot products
- 8 km pixel climatologies and HotSpot products
- 50 km pixel climatologies and HotSpot products
- No opinion

Other (please specify)

Coral Tool Survey--High Bandwidth

What would make the Coral Reef Watch products more useful to you in your work?

Are there physical or institutional constraints that prevent your using the Coral Reef Watch products in your work?

Coral Tool Survey--High Bandwidth

What is(are) your role(s) in the coral community? (Select all that apply.)

- Researcher
- Educator and outreach
- Student
- Tourism
- Recreation (e.g., diver)
- Resource manager
- Media
- Policy maker
- Fishing

Other (please specify)

Coral Tool Survey--High Bandwidth

Which other communities interested in coral reefs do you interact with? (Select all that apply.)

- Researchers
- Government
- Policy makers
- Educators
- Students
- Tourism
- Recreation (e.g., divers)
- Resource managers
- Media
- Outreach
- Fishing

Other (please specify)

Coral Tool Survey--High Bandwidth

Where do you live?

City

State/Province/Territory/County

Country

Coral Tool Survey--High Bandwidth

Thank you for your interest in Coral Reef products.