

## Communicating Harmful Algal Blooms: Does Design Really Matter?

### **Abstract**

Harmful algal blooms (HABs) are occurring in increased frequency, duration and severity (Anderson, 2009). HAB events in CA have the potential to cause harm to marine organisms and humans alike. The Central and Northern California Ocean Observing System (CeNCOOS), is ideally suited to be able to not only research HABs but also to communicate HABs issues to its stakeholders. There is little research on the public's knowledge of HABs or evaluation of outreach impacts in informally communicating this issue. To investigate the question "Communicating HABs: Does design really matter?" this project focuses on four aspects; 1) using data collected from website analytics to determine the audience profile, 2) using data collected from a crowdsourced social media knowledge survey to identify misconceptions about HABs, 3) using research based design components to guide redesign of web resources, 4) evaluation of website outreach resources. The preliminary results of this project indicate that most visitors to the CeNCOOS website are 18-30 year old American males who spend an average of 3 minutes on a particular page and do not engage in additional web resources beyond the page they visit. The HABs knowledge survey revealed misconceptions about HABs that were focused on during web resource re-redesign. Interactivity, scaffolding, storytelling and short videos were selected for use in the re-design of web resources on the CeNCOOS website because of their potential to engage diverse web audiences. Evaluation of re-designed web resources is still in process. The greater significance of this project is in adding to the knowledge base on better communicating marine science issues.

### **Introduction**

*Pseudo-nitzschia* blooms were first reported along the west coast of CA in the 1990's. *Pseudo-nitzschia* blooms produce a biotoxin called domoic acid, which caused the death of pelicans and cormorants that ate domoic acid contaminated sardines and anchovies (Walz et al., 1994). The seabird deaths associated with the 1990s HABs blooms were a powerful visual indicator of the potentially devastating effects of algal blooms. In 2015, a bloom of *Pseudo-nitzschia* species *P. australis* produced the highest concentrations of the biotoxin domoic acid ever recorded in Monterey Bay. The bloom had significant impacts not only on marine life, with hundreds of seabird and sea lion deaths, but also on coastal resources like fisheries and shellfish industries through economic loss. It is estimated that due to the 2015 HAB event, the direct economic loss experienced by the dungeness crab and rock crab fisheries is nearly \$49 million (Howard, 2016).

Harmful algal blooms (HABs) are increasing in frequency, duration, distribution and severity (Anderson, 2009). The Central and Northern California Ocean Observing System (CeNCOOS), is ideally suited to be able to not only research HABs but also to communicate HABs issues to its stakeholders. The potentially devastating effects of HABs on the environment, for marine and human life and economic loss make HABs a priority focus area for CeNCOOS.

CeNCOOS is one of the 11 regional associations under U.S Integrated Ocean Observing System (IOOS®), whose mission is to enable sustained and coordinated measurements, model nowcasts and forecasts, and integrated products to inform decisions about our regional ocean (CeNCOOS strategic plan 2014-2016). HABs are complex and not well understood by scientists and the public alike, making communicating HABs essential to CeNCOOS's work on HABs.

There is little research on the public's knowledge of HABs or evaluation of the outreach impacts in informally communicating this issue through web resources.

To increase the success of communicating this issue, the project team is investigating the question "Communicating HABs: Does design really matter?" for the algal bloom "Learn" section of the CeNCOOS website . This project focuses on four aspects; 1) using data collected from website analytics to determine audience profile, 2) using data collected from a crowdsourced social media knowledge survey to identify misconceptions about HABs, 3) using research based design components to guide redesign of web resources, 4) evaluation of website outreach resources. We hypothesized that by utilizing google analytics to understand who CeNCOOS visitors are, conducting a HABs survey to find out what people know, using research based design rationale for re-designing web resources and evaluating visitor experience, engagement and learning gains with web resources, CeNCOOS will be able to appeal to a diverse audience group that spends more time on the website using multiple web resources.

## **Methods**

### *Google analytics*

We used Google Analytics on the CeNCOOS website from 2015-2017 to establish an audience profile. This consisted of looking at standard visitor demographics: age, gender, location of visitors, method of viewing website (ex. desktop, mobile),;length of time visitors spent on particular pages; top visited CeNCOOS web pages; and visitor website behavioral pathways (number of times the same visitor returned to the website, additional CeNCOOS resources used and visitor website exit behaviors) (van Barneveld, Arnold and Campbell, 2012) (Wolfgang and Drachsler, 2012).

### *HABs knowledge survey*

The next step in this project focused on assessing the general public's knowledge about HABs. This consisted of collaborating with CeNCOOS staff to establish a set of basic questions and desired responses for a survey created in google forms. The knowledge survey was disseminated three different ways; by crowdsourcing responses through facebook, posting the survey on the CeNCOOS homepage and asking in-person outreach event attendees to take the survey. The results of the survey were used to identify misconceptions people have about HABs and aspects of the issue to highlight.

### *Web resource re-design*

A literature review was conducted to select design components to guide web resource re-design. Interactivity, using multimedia, scaffolding information, storytelling and short videos were selected as design components for their potential to engage visitors with web resources (Alexander and Levine, 2008) and support characteristics of adult learners (Cercone, 2008). Characteristics of adult learners include self directedness and the importance for open ended learning opportunities that promote problem solving or investigating an issue utilizing a number of different resources (Cercone, 2008). Incorporating interactivity and multimedia in web resources allows visitors the opportunity to pursue multiple learning pathways, choosing their method and pace for learning (Alexander and Levine, 2008). This should appeal to adult learners because of their need to have control over what is being learned and how they are learning (Cercone, 2008) Scaffolding information creates chunks of information or content that is more manageable and digestible (Alexander and Levine, 2008). Scaffolding information is an effective way to highlight specific topics (Alexander and Levine, 2008). An ArcGIS Story Map

was used to create an open ended learning environment that takes advantage of interactivity, multimedia and web storytelling. This method of storytelling encourages the exchange of information by including additional resources as part of interactive design, increasing the likelihood of it being used similarly as a resource in another's interactive story (Alexander and Levine, 2008). A video series, CeNCOOS Shorts, was produced and edited using the techniques of first person perspective, short duration, interspersed talking with other pictures or slides and filming in informal settings (Guo, Kim and Rubin, 2014). An iPhone 6S Plus was used for most of the interview video. These video production and editing decisions were made based on their potential to be more engaging than longer and more formal, "talking head, big-budget studio production styles" (Guo, Kim and Rubin, 2014).

### **Preliminary Results**

#### *Google Analytics*

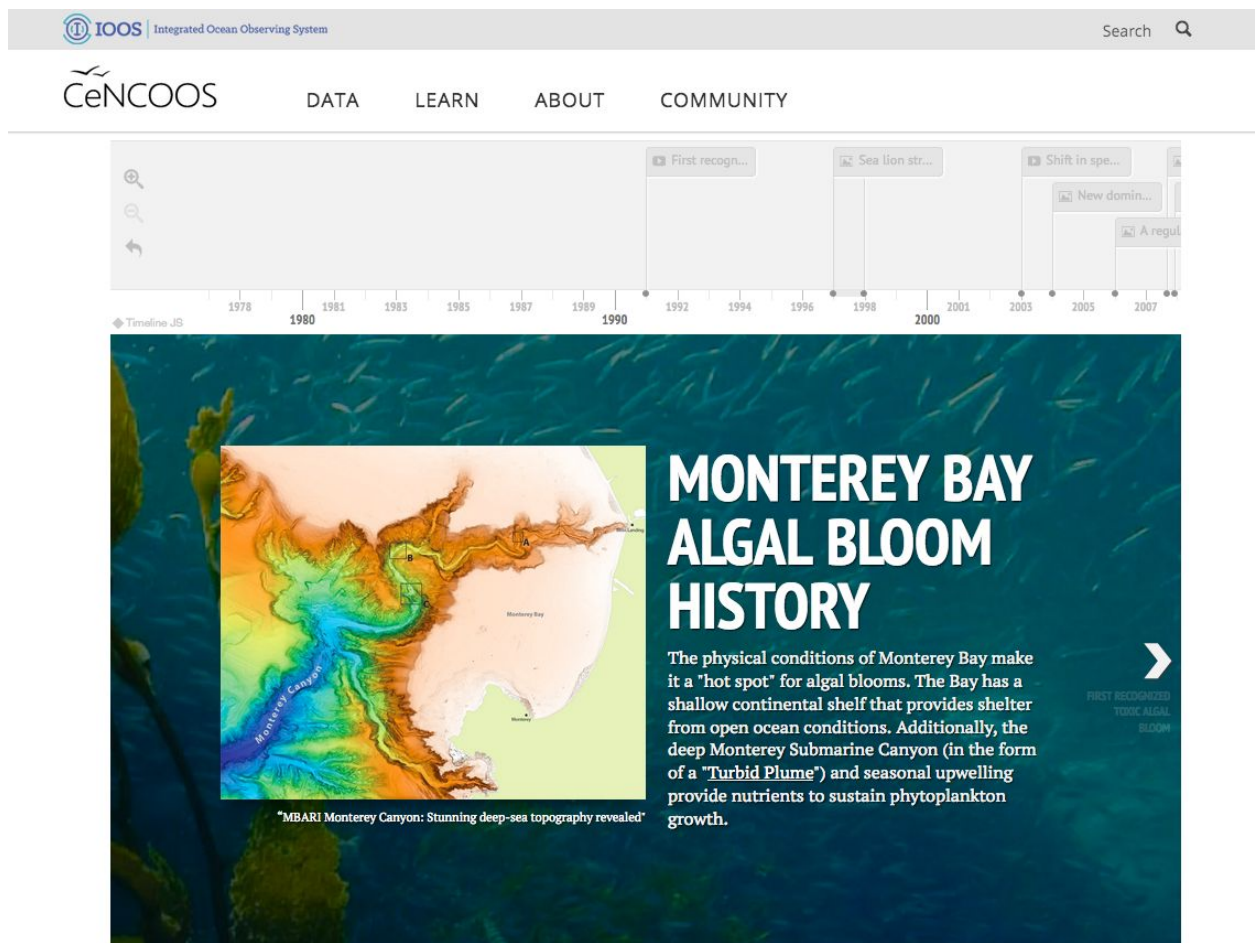
From analysis of Google analytics a primary target audience was identified as 18-30 year old American males who mostly use their desktop to view CeNCOOS websites for an average of 2 minutes and 54 seconds and who typically exit the CeNCOOS site after viewing the page they originally began on. A secondary goal emerged from identifying the target audience: to expand on the visitor base and draw in more visitors to the website, and get visitors to spend more time viewing and engaging with CeNCOOS resources. Incorporating this as a goal maximizes outreach possibilities and resources. The analysis also revealed that two of the top ten pages viewed on the CeNCOOS site included topics related to HABs titled "Phytoplankton bare facts," and "Colors of an algal bloom." These two websites have been included as part of the re-designed web resources and evaluation phase.

### *HABs knowledge survey*

The HABs knowledge survey was able to solicit 316 respondents from facebook, 4 from the CeNCOOS website, 36 from an in-person outreach event. The results of the HABs crowdsourced social media knowledge survey indicated that for each question approximately 10% of respondents selected “I have no idea” as a response. Approximately 40% of respondents from facebook weren't sure or thought that all algal blooms are harmful. There was considerable variability in responses to the question “what is a harmful algal bloom?” Responses indicated that people thought HABs had an impact on marine mammals and water quality but people didn't recognize as readily that HABs have a significant impact on humans. Approximately 20% of responses to the question “where do harmful algal blooms occur,” were incorrect or inaccurate. Similarly, responses to the question “what contributes to harmful algal blooms,” were highly variable and responses were often inaccurate and incomplete. Nearly 88% of people did recognize that HAB events would occur when conditions are favorable for a bloom. Open house respondent data mirrored facebook respondent data. There was little variation in question answers of respondents from the CeNCOOS website (who were thought to have more knowledge about HAB issues). CeNCOOS respondents also accurately and thoroughly answered all HABs knowledge survey questions. There is no additional data on how many people may have guessed when responding to the knowledge survey other than selecting “I have no idea” as a response. Another limitation of this survey is that people who participated already have an interest in the ocean and issues that affect it. Questions from the knowledge survey that had highly variable responses and a majority of incorrect or inaccurate responses were used as guiding themes to organize content information and highlight subtopics.

## Web resource re-design

The re-designed web resources consist of an interactive multimedia story timeline, three multimedia ArcGIS Story Maps that utilize and update existing HABs content and resources, and a series of videos, “CeNCOOS Shorts.” The HABs knowledge survey data was also used for structuring interview questions for interviews conducted with marine scientists and researchers. The interviews were used to provide the content for the “CeNCOOS Shorts” video series. See Figure 1: Screenshot of re-designed web resource, Timeline of algal blooms in Monterey bay and Figure 2: Description of re-designed web resources.



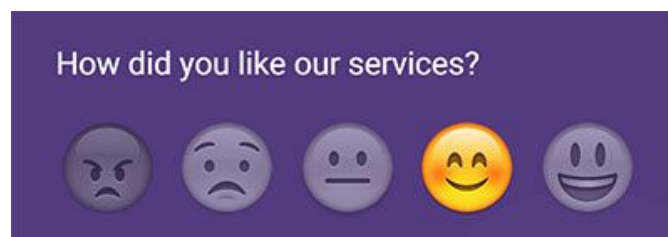
*Figure 1: Screenshot of re-designed web resource, Timeline of algal blooms in Monterey Bay. This figure shows the front page of one of the web resources that were re-designed for this project.*

Web-resource	Description	Intended impact	Design elements
Timeline “Algal bloom history of Monterey Bay”	An story timeline of the history of Algal blooms in Monterey Bay.	-Address the survey question “Are all algal blooms harmful?”	-Interactivity -Use of multimedia -Storytelling -Scaffolding information
ARCGIS storymap “Meet the HABs”	A spyglass map that introduces visitors to 9 of the most harmful algal species in CA.	-Increase awareness about key HABs species -Provide access to continued exploration of resources by highlighting relevant CeNCOOS data and tools	-Interactivity -Use of multimedia -Storytelling -Scaffolding information
ARCGIS storymap “Understanding harmful algal blooms”	A cascading storymap where visitors learn about the basics of harmful algal blooms.	-Address survey misconceptions: What is a HAB, when and why do they occur, what are the impact of HABs -Increase awareness about the types of HABs and the trend towards an increase in HAB events	-Interactivity -Use of multimedia -Storytelling -Scaffolding information
ARCGIS storymap “CeNCOOS’s work with HABs”	A cascading storymap where visitors learn about the work CeNCOOS does in monitoring for, forecasting, coordinating, communicating and teaching harmful algal blooms in CA.	-Highlight CeNCOOS data resources -Share story of C-HARM model development and use -Provide information and access to additional CeNCOOS related HABs data and resources.	-Interactivity -Use of multimedia -Storytelling -Scaffolding information
CeNCOOS Shorts	A video series developed using interviews with marine scientists and researchers.	-Augment and support other re-designed web resources -Highlight current CeNCOOS work on HABs	-Shot from a first person perspective -3 minute long duration -Realistic production quality -Storytelling -Scaffolding information

**Figure 2: Description of re-designed web resources. This figure summarizes the design rationale for re-designed web resources.**



The evaluation plan for the re-designed web resources uses a combination of Google Analytics, emoji visitor survey, and a HABs test to assess visitor engagement, satisfaction and potential learning outcomes. Google Analytics A/B test will be used to compare original web resources with new web resources (van Barneveld, Arnold and Campbell, 2012). Gender, age, time spent on HABs resources and visitor behavioral pathways will be compared to better understand how visitors have engaged with re-designed web resources (van Barneveld, Arnold and Campbell, 2012) (Wolfgang and Drachsler, 2012). The emoji visitor scale consists of a series of emojis to represent visitor satisfaction (see Figure 3: Emoji visitor scale).



**Figure 3: Emoji visitor scale, this figure provides an example of the emoji user scale used for evaluation of re-designed web resources.**

An emoji scale is used because of its potential in marketing research to elicit visitor feedback and for their growing popularity for use in communications (Sundar, Kim, and Gambino, 2017). The HABs test is modified from the HABs knowledge survey to include a performance score and answer key. Using social media as a dissemination tool allows for people to comment on their experience with HABs content. An interesting and unintended outcome of the HABs knowledge survey is the HABs quiz used as an evaluation tool. The HABs quiz was created based on interest from facebook survey respondents and wanting a score associated with their participation in the survey and as they associated it with a test or quiz. The information will be used to assess how well visitors understood HABs issues after interacting with web resources

(Oblinger, 2014). The emoji visitor survey and HABs test will also be used as indicators of engagement if visitors found their experience with web resources to be pleasant and engaging, they are more likely to participate in additional activities associated with the topic (Oblinger, 2014) (Aguiar, Nagrecha, and Chawla, 2015) (Guo, Kim and Rubin, 2014). Evaluation data will be collected for eight months. The evaluation data will be used to make modifications to web resources, inform future resource design and the assess the overall effectiveness of HABs outreach resources on the CeNCOOS website (Oblinger, 2014).

### **Discussion**

This project is a unique example of marine scientists, science organizations and science education researchers working together to gain valuable information about public knowledge of HABs and how to better engage the public in informal science outreach efforts. It is necessary to continue investigating public knowledge and misconceptions about HABs and refining the “HABs knowledge survey” is a critical next step in this process. Expanding evaluation methods to include possible visitor interviews or utility of resources for younger audiences would be valuable in providing further insight into the limitations of design components. The resources used for both re-designing resources and in evaluation are free, easily accessible and can be applied to nearly any topic. The authors hope other groups reading this paper are able to use the methodology to better engage their target audience and maximize outreach efforts through the proposed evaluation methods.

### **Acknowledgements**

The authors would like to thank all the contributing scientists, MBARI, and CeNCOOS staff for their time and support of this project.

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