ABSTRACT

Christopher M. Pugmire for the degree of Master of Science in Marine Resource Management presented on September 20, 2007.
Title: Development of the Project CROOS Website: Laying the Groundwork for the Future of Fisheries Research.

Fisheries researchers and the general public can greatly benefit from the rapid data sharing and collaborative research that is facilitated by the both the internet and modern digital technology. One of the pioneers of this new strategy of conducting and utilizing fisheries research is Project CROOS (Collaborative Research on Oregon Ocean Salmon). Project CROOS is a cooperative research effort between scientists and fishermen that uses genetic information, along with digital traceability systems to track salmon stocks in the ocean, as well as individual salmon after harvest, for management, science, and marketing purposes. To facilitate the utilization of this research, project CROOS is in the process of developing an interactive website. The website is intended to house all project data and results, enabling multiple users the opportunity to access this information in formats that best satisfy their specific interests, preferences, and needs. To initiate the development process, project CROOS has begun laying a foundation for the website by (1) establishing expectations, (2) reviewing web design literature and project relevant websites, and (3) acquiring user-specific input through the use of focus groups. The next phase in the developmental process is to physically create a draft of the website. Once a draft is produced, a series of focus groups composed of potential users will be organized to test and evaluate the website in an effort to finalize its design and functionality.

Development of the Project CROOS Website:
Laying the Groundwork for the Future of Fisheries Research

by
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in partial fulfillment of
the requirement for the
degree of

Master of Science

Presented September 20, 2007
Commencement Fall 2007

ACKNOWLEDGEMENTS

I wish to express my sincere appreciation to everyone who has contributed to my project. Specifically I would like to thank my advisor, Gil Sylvia, and the other members of my committee for their guidance and direction. I would also like to thank Diane Moody, Jeff Feldner, Nancy Fitzpatrick, Pete Lawson, and Renee Bellinger of the CROOS website development team for their continual contributions throughout every stage of my project. Lastly, I would like to thank everyone associated with project CROOS, especially the fishermen, managers, and scientists who so kindly participated in the focus group component of my research.

TABLE OF CONTENTS

LIST OF FIGURES

Development of the Project CROOS Website:
Laying the Groundwork for the Future of Fisheries Research

Introduction

Collaborative research has evolved significantly over the years. In the past, scientific collaborations relied heavily on slow, costly methods, such as face-to-face interactions, group meetings, and the mail system, to share critical data and information [1]. Beginning in the late 1990's, the combination of less expensive computing power, the expansion of the web, and the establishment of several successful service providers enabled researchers to greatly enhance their collaborative potential [2]. By utilizing the rapid digital communication mediums associated with the internet, researchers became equipped with the ability to share information faster and more efficient than ever before.

Since then, computers, internet, and digital technology have continued to progress. As a result, collaborative research methods have also improved as a reflection of the advancing technology. Now, instead of relying solely on email-based data exchanges, entire websites are being developed to facilitate cooperative interactions and information sharing among researchers. Through the use of these websites or "collaboratories", as they have come to be known, researchers are able to interact with colleagues, access instrumentation, share data and computational resources, and access information in digital libraries [3]. Some of the more advanced sites even have the technology to facilitate real-time data sharing among researchers, a breakthrough made possible due largely in part to recent advancements in the development of remote satellite-based data

recording instruments. As a result of this new collaboratory approach to research, a new paradigm for intimate collaboration among scientists has emerged, which has accelerated the development and dissemination of basic knowledge, optimized the use of research instruments, and minimized the time between discovery and application [1].

In addition to optimizing the collaborative efforts of researchers, this new strategy of web-based data sharing has also benefited other interested parties outside of the scientific community. Perhaps the most significant benefit has been the increase in data accessibility. By utilizing websites to broadcast research information across the internet, the general public has now gained the ability to access and utilize scientific data in ways that were never before possible. As a result, many websites that began as "collaboratories" have evolved into online communities, where a vast diversity of users are able to interact with one another and benefit from scientific research in their own unique ways.

An example of a recent effort to develop such a collaboratory/online community is the Integrated Ocean Observing System (IOOS). "IOOS is a network of systems that routinely and continuously provides quality controlled data and information on current and future states of the oceans and Great Lakes" [4]. This valuable information is made available to the public through the IOOS website and its various regional systems' websites. Utilizing these sites, IOOS provides oceanographers, scientists from other disciplines, educators, policy makers, and all other interested parties the opportunity to collectively view and utilize the data and results that they have generated. This approach

greatly improves the efficiency of oceanographic data use by broadening both its spectrum of potential users and uses.

Outside of the IOOS example, this method of utilizing the internet as a tool for creating a community of data users is beginning to spread to various other fields of interest as well. Nuclear physics, biotechnology, and medicine are some of the few areas where it is already well established [3]. Another area moving in that direction is fisheries research.

Over the years a number of different drivers have pushed fisheries researchers to begin taking steps towards implementing this new strategy of web-based collaboration and communal data sharing. One of the biggest drivers has been technology. Due to recent advancements in computer and digital technology, fisheries researchers are now equipped with the necessary resources to be able to use the internet as a platform for enabling multiple users the opportunity to access and utilize research instruments, as well as the data that they produce.

Another driver motivating this new phenomenon has been fisheries management. Over the years ineffective management practices have led to overfishing, stock depletion, and other devastating consequences that have plagued the world's fisheries. This harsh reality has forced managers and researchers to seek out solutions. As a result, several new management approaches are now in the process of being developed, many of which depend greatly on the internet and other associated digital technologies for their successful implementation. One such approach, calls for the use of interactive websites

as well as advanced digital data recording devices to provide managers with the ability to access and utilize real-time data towards making in-season regulatory decisions. Another new approach, known as Ecosystem Based Management, requires managers to collaborate with scientists from a variety of different disciplines to manage fish stocks based on their interactions with their surrounding ecosystems. This type of collaborative effort necessitates the use of the web as a key tool for facilitating the extensive communication and data exchanges that are required by this management strategy.

The other major driver contributing to the growth of web-based collaboration and communal data sharing in the area of fisheries research has been the public's increasing demand for fisheries information. In the past, most fisheries research was conducted, utilized, and maintained within the traditional manager-scientist circle. However, recently this trend has changed. For a variety of reasons numerous parties have become interested in accessing fisheries data, a reality which has emphasized the need for websites and web-based communities to enhance the data sharing capacity of fisheries researchers. One of the more prominent groups interested in accessing more fisheries-related information has been the fishermen themselves. Due to recent declines in fishery performance worldwide, fishermen have become increasingly interested in obtaining additional data for the purpose of utilizing it towards improving their productivity and efficiency on the water. Conservationist organizations are another group with a growing interest in fisheries research. Their interest has been fueled by their desire to ensure that threatened fish species are being adequately protected, especially in light of the nation's dwindling fish stocks, the ESA's (Endangered Species Act) strict provisions towards

protecting both species and distinct population segments, as well as the growing national movement towards resource conservation. Another group demanding access to more fisheries information and data are seafood marketers and consumers. Given the growing consumer preference for fresh, wild, and sustainably harvested fish, marketers and consumers have become much more interested in acquiring additional information about their seafood to ensure that their products are meeting society's heightened standards.

Despite all of the above mentioned drivers, the use of web-based collaboration and communal data sharing techniques are still fairly limited in the area of fisheries research. Although steps have been taken in that direction, progress has been slow. Fortunately, a recent effort known as project CROOS (Collaborative Research on Oregon Ocean Salmon project) is hoping to change all of that.

Project CROOS is a cooperative research effort between scientists and fishermen that uses genetic information along with digital traceability systems to track salmon stocks in the ocean, as well as individual salmon after harvest, for management, science, and marketing purposes. One of CROOS's primary objectives is to develop an interactive website to house all of the project's data and results, as well as facilitate data sharing and collaborative research among multiple user groups. The project CROOS website is expected to be the first of its kind in the area of fisheries research, and as such, it is intended to serve as a template for the future development of other fisheries-related websites.

The following paper documents the initial efforts made by CROOS to develop this groundbreaking website, focusing specifically on the steps that have been taken to provide the site with a firm foundation. These steps include: establishing expectations to guide the website development process, reviewing relevant literature and existing websites for expert advice and examples, and acquiring user-specific input through the use of focus groups. The paper also discusses future plans for finalizing the websites design and functionality.

The Collaborative Research on Oregon Ocean Salmon Project

Project Background

In 2006, poor returns of Klamath River Chinook salmon forced the Pacific Fisheries Management Council (PFMC) to mandate coast-wide commercial fishing closures [5]. The motivation behind these closures was to minimize the impact on Klamath fish and ensure the return of an adequate spawning population capable of maintaining the run. Unfortunately, due to the limited understanding of the behavior and migration patterns of individual salmon stocks, managers were compelled to institute large time/area closures, which spanned nearly 700 miles of Oregon and California coastline. These strict regulations severely limited fishing on both weak and healthy salmon runs, resulting in the loss of hundreds of jobs and millions of dollars in coastal income. These losses were largely attributed to inadequate science regarding the management of multi-stock ocean salmon fisheries.

In an attempt to overcome these inadequacies and prevent this salmon disaster from repeating itself, the faculty of the Coastal Ocean Marine Experiment Station (COMES), in collaboration with the Oregon Salmon Commission and federal and state scientists, developed a proposal for a research project known as CROOS (Collaborative Research on Oregon Ocean Salmon). It involved using genetic information to learn more about offshore schooling behavior and stock composition of salmon in the Pacific Ocean.

Project CROOS was approved in June 2006 by the Oregon Legislature Emergency Board and implemented shortly thereafter.

Since its initiation, project CROOS has relied on a cooperative partnership between fishermen and scientists. The fishermen (1) collect salmon samples during their normal fishing operations; (2) record information on oceanographic conditions, time, and location of harvest; and (3) collect tissue, scales, and other biological samples. Meanwhile, the CROOS scientists assume the responsibility of analyzing this data. Through their analyses, researchers are able to age salmon, identify the different environments that they have been exposed to prior to capture, and most importantly, determine the river basin from which the salmon originated. This ability to trace salmon origins is achieved through Genetic Stock Identification (GSI), a process by which tissue samples are genetically compared with a database of existing genetic signatures of fish from over 100 river basins from California to Alaska [5]. By utilizing GSI techniques, researchers are able to accurately identify salmon stocks within a 24-48 hour period, making the results available in near-real-time.

With the availability of these results, coupled with the other data collected and generated by project CROOS, researchers are expecting to improve their understanding of the distribution and movements of salmon stocks in the ocean, especially in relation to temporal, spatial, and oceanographic factors. This improved understanding is also anticipated to benefit salmon managers as well by providing them with the necessary information to implement in-season regulatory measures capable of protecting weak

salmon stocks, while managing to avoid coast-wide fishing closures. By isolating threatened runs and providing fishermen with the necessary information to more effectively target healthy salmon stocks, project CROOS is expected to improve the overall performance of Oregon's salmon fishery.

In addition to improving science and management, CROOS research is also intended to enhance the fishery's economic value. Through the use of barcoded tags and a digital traceability system, project CROOS is expected to provide market channels and consumers the ability to track each salmon used in the study from harvest to dinner table. This will enable seafood buyers to verify that their fish is wild caught, fresh, and handled properly. It will also allow them to acquire specific information regarding their fish, such as where it was caught, by whom, and from which river basin or hatchery it originated. By branding salmon with this additional information, researchers are optimistic that consumers will be given the opportunity to associate favorable characteristics with certain varieties of CROOS caught fish, which in turn will enhance the products value and allow both consumer demand and profits to increase significantly.

Website Background

The ability to achieve these goals and objectives of project CROOS is largely dependent upon the accessibility of the research. Consequently, one of the project's major areas of focus has been the development of an interactive website capable of facilitating multi-user access to CROOS-generated data and information.

Without an effective gateway into the project, the public's ability to access CROOS research and benefit from its use would likely be very limited. For this reason, efforts to develop such a site have been underway since the onset of the project. Within a few months after the first round of data was collected and analyzed, the first prototypes for the project CROOS website were developed. They consisted of two temporary sites, which were designed primarily to test the feasibility of the project's web-related objectives. The first site, which was designed by Beartooth Creative Group, served as a starter homepage. Its objective was to provide the general public with a description of the project and the significance of its research. The second site, which was designed by Chris Romsos at Oregon State University, was geared primarily toward data display. It utilized GIS web mapping software (ESRI's ArcIMS and Arc GIS) to display the full range of data collected in the project and allow for manipulation and interpretation by different user groups, specifically fishermen, scientists, and consumers. The development of this site was critical for demonstrating the feasibility of providing multi-user access to near-real-time data.

Given the success of these early prototypes, project CROOS has continued to build on their efforts to develop a permanent website capable of providing all potential user groups access to relevant data and information in formats that best satisfy their specific interests, preferences, and needs. The following chapter documents these efforts, focusing specifically on the steps that have been taken towards developing a foundation for the website.

Website Development: Laying a Foundation

The first steps taken in the development of the project CROOS website involved laying a foundation upon which the site could be built. This entailed establishing expectations to guide the website development process, reviewing relevant literature and existing websites for expert design advice and examples, and acquiring user-specific input through the use of focus groups.

Establishment of Website Expectations

To ensure a unified and directed approach, the development of the project CROOS website initiated by establishing expectations. This required identifying specific goals and objectives that could be used as a guide during the developmental process. The following is a description of the expectations that have been generated thus far.

The first expectation of the project CROOS website is to educate and inform the general public concerning the project and its associated research. In order to achieve this objective, the site is expected to offer information on project CROOS's background, its purpose, its participants, and its progress.

Another expectation of the website is to provide multi-user access to the data generated by the project. Compliance with this objective is critical for allowing all interested parties the opportunity to benefit from CROOS research. In order to realize this

objective, the website is expected to feature user-specific pages or portals. Each portal will present project data and information in formats that best suit the users' preferences, interests, and needs. The user groups that we intend to target are managers, scientists, fishermen and seafood-buyers/consumers.

Managers. The manager portal is expected to feature a geographic display of the genetic stock identification (GSI) results of the sampled fish, in real-time. Access to this data is intended to allow for near-real-time assessment of harvest impacts, thereby providing managers with the potential to implement in-season regulatory measures aimed at protecting weak stocks, while allowing the harvest of healthy ones.

Scientists. In the scientist portal, GSI results coupled with atmospheric and oceanographic data are expected to be compiled for analysis by fisheries researchers. This will allow scientists the opportunity to identify temporal and spatial variations in stock composition, and to identify distribution patterns associated with oceanographic conditions.

Fishermen. The fishermen portal is also anticipated to provide access to genetic stock identification (GSI) results and oceanographic data. However, for privacy reasons, their access is likely to be limited to aggregate information, as well as their own individually generated project results. Their ability to retrieve this information is expected to allow them the opportunity to identify and avoid weak stocks, as well as help them plan fishing and marketing operations.

Seafood-Buyers/Consumers. Finally, the seafood-buyers/consumers portal is expected to benefit both salmon marketers and consumers by providing access to project CROOS data through a traceability feature. This feature is expected to provide users with the opportunity to track salmon purchases from harvest to dinner table. It is also anticipated to provide consumers with the ability to access specific information about their purchase, such as when and where it was harvested, by whom, and from which river basin or hatchery it originated. This dissemination of information about origin and catch history is intended to demonstrate sustainability, reduce fraudulent marketing behavior, and support marketing strategies aimed at increasing the value of locally harvested salmon.

Literature Review

Once consensus was reached concerning expectations for the website, the next development issue that was addressed involved the site's design. Creating a website without a well-conceived design, regardless of the information or services being provided, often results in an ineffective site. The design is what draws users in, maintains their interest, and encourages them to return. It's what shapes a website into an attractive, functional, and easy to use resource. Without a proper design, a website's valuable content is vulnerable to being overlooked, underappreciated and unused.

In an effort to help create an effective website for project CROOS, an extensive review of web-design literature was conducted. The objective was to identify key elements

associated with quality website design. The results of the review revealed that despite numerous opinions and conflicting viewpoints, several design commonalities do exist among highly rated websites. These design aspects generally fall into the following categories: content, page layout, navigation, interactivity, responsiveness, and credibility.

Content. According to most web design literature, there is a trend toward simplicity when it comes to content [6,7]. "Revolving wingdings, flashing banner ads, grotesque background colors and textures, and meaningless multimedia effects that require endless plug-ins are headed towards extinction. Users no longer want glitter—they want content and service, and they want it fast" [7]. To meet this growing demand for simplistic quality, the literature offers several recommendations.

Beginning with the actual information and services provided by the website, Leavitt and Shneiderman [8] recommend limiting content to material that is engaging, relevant and appropriate to the targeted audiences. They further suggest presenting that material in the most useful and usable format possible. This would imply that the entire website's content be displayed in the user's language and converted or summarized into its most concise, understandable, and salient form [9, 10]. For content designed with inexperienced and/or first time users in mind, this may require the assistance of an FAQ (Frequently Asked Questions) or a help link [8]. Similarly, in scenarios where multiple users are involved, there may also be a need to provide content in multiple formats and at different levels of detail [8, 10].

Regarding website text, the consensus among the literature is that less is more. Well-designed websites tend to use clear and concise text, paying close attention to spelling and grammar [11]. Text that is characterized as promoting effective communication generally uses only a few familiar fonts that are at least 9-points in size, dark, and placed on plain, high-contrast backgrounds containing colors that are subtle and few in numbers [8, 9, 10, 12, 13]. The text is usually restricted to brief sentences, bulleted lists, highlighted keywords, colorful and descriptive paragraph headings, and any other format capable of promoting scanning [8, 10, 11]. When paragraphs are necessary, they are kept small, containing one major idea with the most important point included in the first sentence [8, 11].

Similar to website text, the literature also recommends a minimalist approach when it comes to graphics, images, and multimedia. The idea is that this type of content, when used excessively and inappropriately, hinders efficiency by reducing loading speeds [8, 10, 12]. To avoid efficiency issues, Bevan [10] recommends using graphics sparingly, as well as using small images, interlaced images, and repeat images whenever possible. Similarly, Ivory and Megraw [12] suggest not only minimizing the number of images, but also avoiding certain types, such as images that contain text (content graphics), images that are used for navigation, and images that are animated. They further discourage the use of applets, controls, scripts, video, sound, and plug-ins. Leavitt and Shneiderman [8] argue that video, animation, and audio only be used when the anticipated benefits greatly outweigh the potential risks of distracting the user or slowing download times. They also

recommend using background images sparingly, as well as providing users with thumbnail images when the viewing of full-sized images is not critical.

Page layout. Quality websites are structured and organized to facilitate both ease of comprehension and use [8]. To achieve this objective, several design strategies are often implemented. Among the many strategies, one of the most commonly cited is consistency. Many web experts advocate for the consistent use of design elements (e.g., the size and spacing of characters; the colors used for labels, fonts, and backgrounds; and the locations of labels, text, and pictures) throughout the site [8, 9, 12]. This approach is believed to improve user performance by eliminating the mental strain associated with constantly reinterpreting numerous page layouts within a single website [9].

In addition to consistency, the use of page space is also an important component of a website's layout. According to the literature, well-designed web pages tend to occupy space in a manner that is neither cluttered nor empty [8, 9]. Instead they reflect a healthy balance of both content and white space that allows users to locate desired information, without being overwhelmed by visual and functional paraphernalia [9].

The organization of website content is another important area of page layout. In the literature, many web experts agree that content should be organized to both facilitate usability and avoid timely distractions. To achieve this objective, several recommendations exist. Leavitt and Shneiderman [8] recommend visually aligning page elements, either vertically or horizontally, to avoid the confusion that is sometimes

associated with random design. They also suggest organizing content to avoid scrolling both horizontally and through numerous screenfuls of information. Other web experts, recommend arranging content in an order that reflects its relative importance, meaning the most relevant material is placed toward the top and center of the page [14]. They also suggest improving the users' scanning capability by grouping related elements, using descriptive headings generously, and highlighting important items that require user attention [8, 9, 10].

Navigation. Incorporating efficient and user-friendly navigability within a website is one of the most critical elements of successful web design. Without the ability to move freely and accurately throughout the website, users are likely to get confused, lost, or frustrated and eventually leave the site [11]. To avoid such navigation breakdowns, there are several guidelines that need to be considered.

The ability to effectively navigate a website requires that users be aware of their location and their destination options within a site's information architecture [9, 10, 12]. To achieve this objective, web experts recommend the use of site maps and effective location feedback [8, 10, 12, 14]. A simple, but popular, feedback method is to apply distinct, visible page titles throughout the website that are capable of signaling the users' whereabouts [12]. Another recommendation for improving navigation is to differentiate navigational elements (e.g., buttons, bars, tabs, etc.) by grouping and placing them in consistent and easy to find places on each page [8, 9, 14]. This allows users to increase

their performance efficiency by reducing the amount of time spent searching the website for navigation aids.

The effective use of links is another way to enhance a website's navigation capacity. Links have the ability to transport users quickly and efficiently throughout a website. However, when utilized incorrectly, they can very easily lose a user in hyperspace. To ensure that links are used appropriately, web experts recommend using descriptive, text-based links, which are easy to view and accurate [8, 11, 14]. They also suggest providing links to the local contents and home on every page; using multiple links to access significant information; avoiding links that open up new browsers or pop-up ads; highlighting important links; and differentiating between links that are used, unused, internal, and/or external [10, 11, 14]. In larger web sites, where links and other traditional navigation aids are not sufficient, search engines with clearly defined scopes are also recommended [8, 10, 11, 14].

Interactivity. To be considered interactive, a website must facilitate exchanges with its users [15]. These exchanges are intended to engage the site's visitors and enable them to complete whatever process or experience is offered by the site [16]. To conduct these interactions, users usually require the use of screen-based controls, sometimes known as widgets [8]. Web experts recommend using only familiar screen-based controls in a conventional or commonly used-manner [8]. They also suggest making them easily identifiable to the users by placing them on the site in a manner that clearly distinguishes them from other web features [9]. The most commonly used screen-based controls

include pushbuttons, radio buttons, check boxes, drop-down lists and entry fields [8]. The literature provides several pointers on using each of these ‘widgets’ to maximize a website’s interactive capabilities.

Beginning with pushbuttons, Leavitt and Shneiderman [8] recommend using only those that are clearly labeled and easily identifiable. They also suggest prioritizing them using location and highlighting to facilitate their proper use. In addition to pushbuttons, Leavitt and Shneiderman [8] also advocate using radio buttons when selecting from among two or more mutually exclusive selections, check boxes when binary choices are required (e.g. yes or no), and drop down lists when selecting one item from among many.

Entry fields are another interactive option recommended by Leavitt and Shneiderman [8], especially in scenarios where website users are required to complete forms and enter text into search boxes. According to web experts, well designed entry fields share the following user-friendly characteristics: they are clearly and consistently labeled, they are easy to use, they distinguish between required and optional data, they show default values when appropriate, and they minimize the amount of information entered by users [8, 9].

Responsiveness. The general consensus among web-experts is that users are impatient. They don’t like wading through busy, overstuffed websites and they certainly don’t tolerate slow page-loading speeds [14]. Recent studies suggest that users begin to lose patience within seconds [14]. Consequently, websites must be designed to respond rapidly in order to ensure user satisfaction.

To achieve rapid responsiveness, web experts agree that designers must determine appropriate bandwidth, connection speed, and server requirements for their site's content and users [14]. They also suggest trading off fancy graphics, applets, audio and video clips, and other slow-loading elements for quicker download times [11, 14]. Their viewpoint is that content should be kept simple, meaningful, and immediately accessible. However, the literature does recognize that some circumstances call for the use of more advanced and often less responsive design elements. In such scenarios, process indicators capable of informing users of download progress are recommended as a means for improving a website's usability [8, 14].

Credibility. Given the lack of standards regarding internet content, numerous websites have surfaced containing incorrect and misleading information [17]. This trend has forced web users to become more skeptical of the information they find online. As a result, web designers now face increasing pressure to enhance the credibility of their sites [17]. Fortunately, the literature provides numerous design strategies for improving web credibility.

Fogg et al. [17] recommend incorporating design elements that convey the real world aspect of a website. This can mean displaying a logo, listing a physical address and phone number, and/or showing employee photographs [8, 11, 17]. Including these features is recommended because it increases user-confidence by communicating the legitimacy and accessibility of the organization behind the website [17].

Another strategy is to ensure that the site looks professionally designed [8, 17]. This requires eliminating all functionality errors, minimizing commercial elements, and ensuring that all information is as correct and up to date as possible [8, 9, 16, 17]. Other highly recommended methods for optimizing web credibility include: stating a policy on content; providing author credentials, citations, and references; and ensuring that the site is frequently linked by other credible websites [8, 17].

Website Review

In addition to reviewing web design literature, another important step in developing a quality website involves learning from the existing sites themselves. This process of reviewing websites allows designers to visualize both the strengths and weaknesses that make up the competition. By learning from their mistakes and building upon their successes, web designers can utilize the efforts of others to enhance their own chances of creating an attractive, usable, and useful website.

In an effort to develop such a website for the CROOS project, an extensive website review was conducted. The review process involved identifying and analyzing both websites and web pages from three distinct categories, which were selected based on their relevance to the goals and objectives of the CROOS website. They included: multi-user sites with user-specific access portals, web pages featuring access to geographically displayed real-time data, and web pages featuring traceability. The websites and web pages selected from these categories were identified using common search engines (e.g.

Google, Yahoo, etc.) and then analyzed using the design criteria identified by the literature review. The analysis consisted of rating the web-material's content, page layout, navigation, interactivity, responsiveness, and credibility based on the presence or absence of certain design qualities. Websites and web pages found to possess the literature-derived qualities from each of these categories were awarded high ratings of 3, while those who did not were subject to lower ratings of 1-2. The objective behind this quantitative review process was to identify model web-examples capable of inspiring the development of the project CROOS website. The results of the review are shown below.

Table 1. Website and webpage ratings. Ratings based on the design qualities identified in the literature review. See website review notes in the Appendix for details on rating scores.

	Content	Page Layout	Navigation	Interactivity	Responsiveness	Credibility	Total
Multi-user websites with user-specific access portals							
http://www.cosi.org/ (AAWM gold award)	2	2	2	2	2	3	13
http://www.weeklyreader.com/ (AAWM 2005 site of the year)	1	2	1	3	3	1	11
http://www.smithsonianeducation.org/ (2007 People's Voice)	3	2	1	3	3	3	15
http://kidshealth.org/ (2005 Webby Award)	2	1	1	3	3	2	12
http://www.aqua.org/ (2005 People's Voice Winner)	2	3	2	3	3	2	15
http://www.stopwaste.org/home/index.asp?page=1 (2006 Webaward)	3	2	2	3	3	3	16
http://www.stormwaterauthority.org/default.aspx (2006 Webaward)	2	2	1	1	2	2	10
http://www.adelphi.edu/ (2006 Webaward)	3	2	1	3	3	2	14
http://www.bluecrossca.com/	2	2	1	3	3	3	14
http://www.wbmd.com/index.shtml	3	2	1	3	2	2	13
Webpages featuring geographically displayed real-time data							
http://las.pfeg.noaa.gov/TOPP_recent/index.html (2006 Webaward)	3	1	1	2	3	2	12
http://www.cefas.co.uk/data/wavenet.aspx	1	1	1	1	1	2	7
http://waterdata.usgs.gov/nwis/rt	2	1	1	1	3	2	10
http://nowcoast.noaa.gov/	1	1	1	1	1	2	7
http://www.gomoos.org/data/recent.html	1	1	1	3	2	3	11
http://www.cormp.org/indexreal.php	2	2	1	2	2	2	11
http://www.skio.peachnet.edu/research/sabsoon/tower.php	1	1	1	2	3	2	10
http://sdcoos.ucsd.edu/data/CurrentsObjList.cfm	1	1	2	1	3	2	10
http://www.glerl.noaa.gov/res/recon/	1	1	2	1	3	2	10
http://www.ndbc.noaa.gov/dart.shtml	1	1	1	1	1	3	8
Webpages featuring traceability							
http://www.jsorganic.co.uk/trace.asp	1	2	2	3	3	3	14
http://www.linecaught.org.uk/	2	3	2	3	3	3	16
http://www.wheresgeorge.com/	1	1	1	2	2	1	8
http://www.dmv.org/vehicle-history.php	2	1	2	2	3	1	11
http://www.carfax.com/	1	2	1	2	2	1	9

Multi-user sites with user-specific access portals. Among the web-categories that were reviewed, the multi-user sites with user-specific access portals were by far the most abundant. Their relatively high numbers were complimented by a greater selection of quality websites, which most likely contributed to their higher design ratings. The

highest rated site from among this category was Stopwaste.org, an award winning website created to represent the collaborative waste management and resource conservation efforts of the Alameda County Waste Management Authority and the Alameda County Source Reduction and Recycling Board.

Figure 1. Stopwaste.org homepage. Highest rated website among the multi-user sites with user specific access portals.

As the highest rated website from the multi-user category, Stopwaste.org is a model site for inspiring the development of the project CROOS website. Beginning with its content, the website provides user-centered material formatted to meet the needs of its targeted audiences: residents, business and industry, schools, and local government. It also features text that is adequately sized, easy to read, and formatted to facilitate scanning.

The text is effectively complemented by graphics that are simple, meaningful, and relevant to the site's goals and purposes.

The layout of Stopwaste.org is almost equally impressive. Besides a slightly different presentation of design elements on the home page, all other pages are consistently designed to facilitate both ease of comprehension and use. The layout is also benefited by a well-balanced use of page space, which features a reasonable mix of highly organized content and visually appealing background colors. These design qualities along with the site's use of descriptive headings, highlighted text, and grouped elements result in a website that is both attractive and useable.

The ability to freely and accurately navigate Stopwaste.org is another key factor contributing to this site's superior design. This quality is largely attributed to the website's use of clearly labeled and consistently placed navigational aids, which are featured on both the top and the left-hand side of every single page. User-mobility is also supported by the inclusion of several descriptive and well-placed text-based links throughout the site. The website's effective use of both colors and page headings as location feedback devices also contribute to the excellent navigability of Stopwaste.org. Besides missing a site map, the only navigational flaws associated with this website include a lack of distinction between used and unused links, as well as the presence of a few non-descriptive, image-based links.

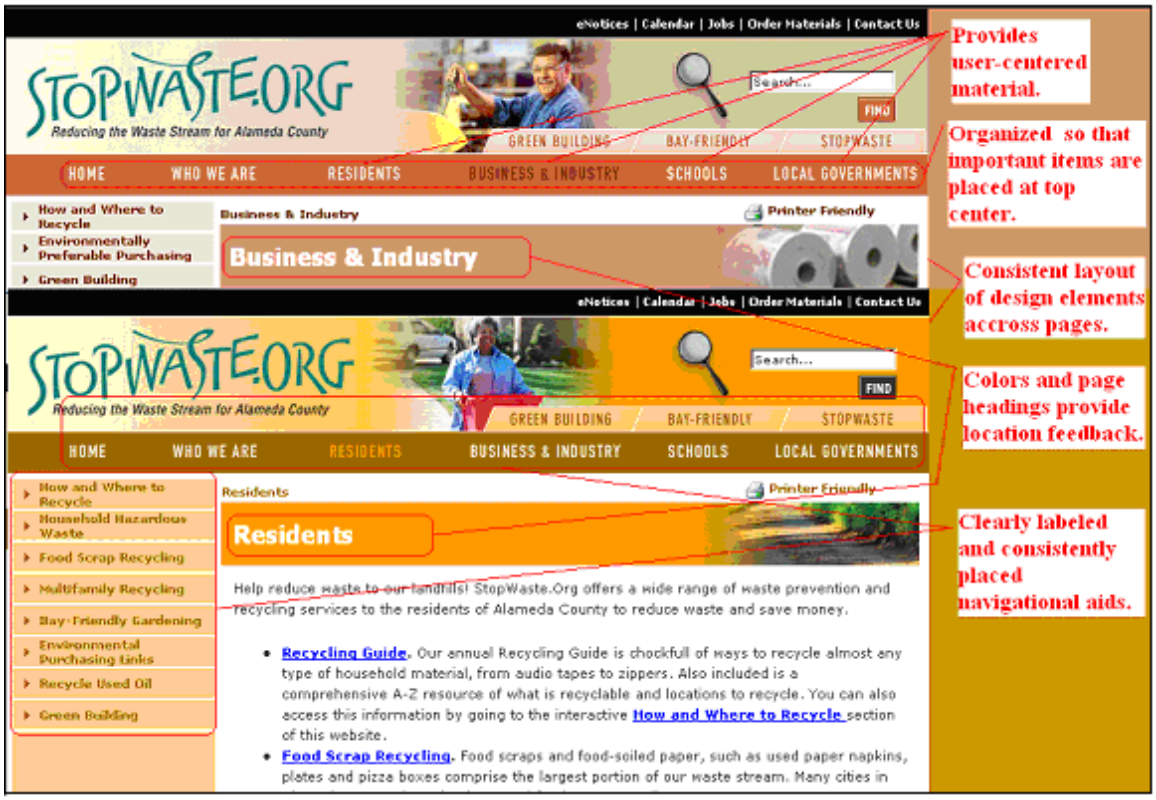

Figure 2. The Business & Industry and Residents pages of Stopwaste.org. Illustrates some of the content, page layout, and navigation design qualities featured on the website.

The interactivity of Stopwaste.org is one of the site's most highly rated design categories. Although limited to a few drop-down menus and entry fields, the site's interactive features are easy to use, they function correctly, and they are utilized in the appropriate circumstances. In addition to interactivity, the responsiveness of Stopewaste.org is also among the site's most highly rated design categories. Its superior responsiveness is the result of rapid page loading speeds.

A strong sense of credibility regarding the information and services provided by Stopwaste.org is the site's final exemplary design feature. This ability to trust in the website is facilitated by the presence of several important features. For example,

Stopwaste.org displays photographs of its personnel and provides a physical address and phone number to communicate a tangible and real presence to the users. It also has a highly professional look, which stems from its accurate, up to date, and functional content. The website's credibility is also enhanced by including numerous articles, reports, and studies containing legitimate citations and references. A policy on content statement is the only significant confidence building feature missing from the site to prevent it from receiving a perfect credibility rating.

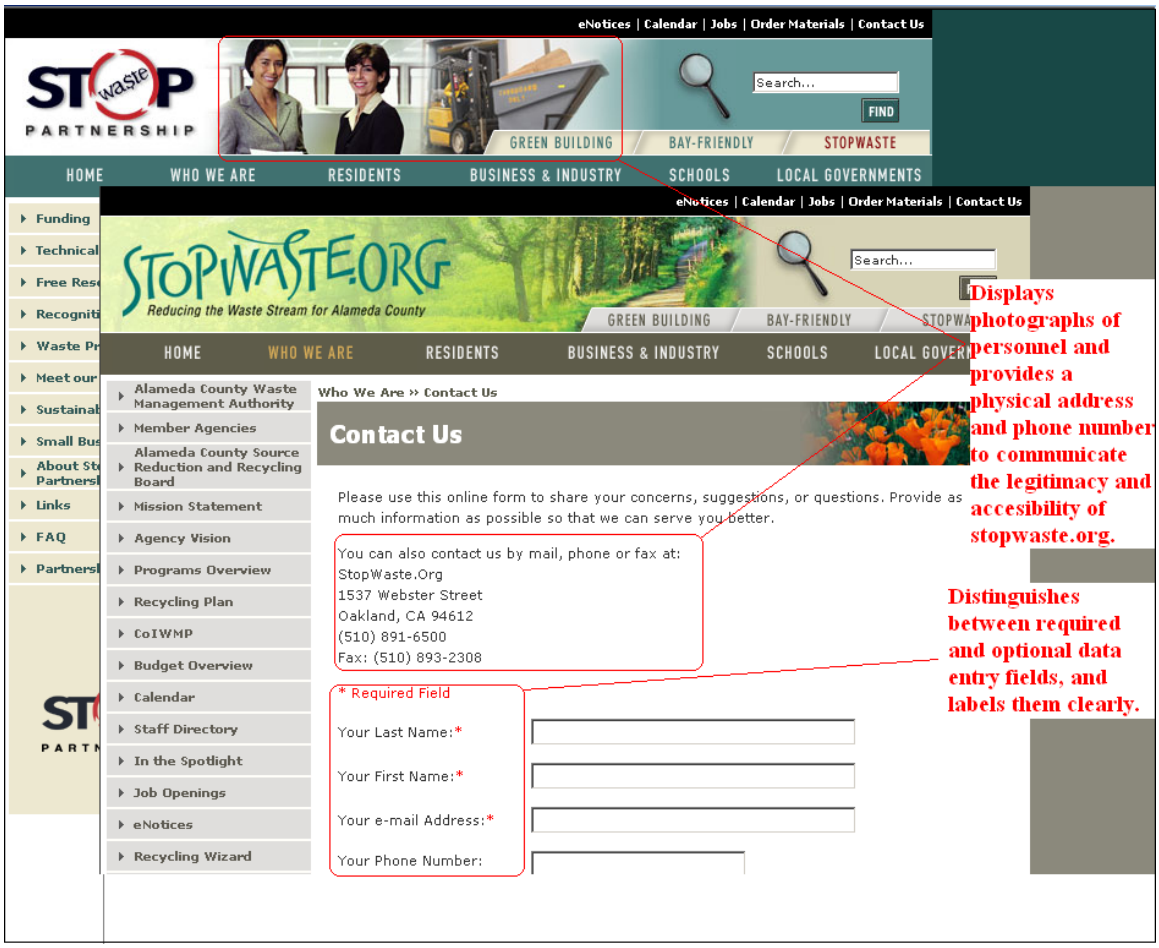

Figure 3. Two pages within stopwaste.org that show specific design qualities associated with the site's interactivity and credibility.

Webpages featuring geographically displayed real-time data. The web-review category with the lowest design ratings was clearly the webpages featuring geographically displayed real-time data. The majority of material reviewed from this particular genre was associated with extremely complex content and highly technical functionality, which made finding attractive, user-friendly webpages very difficult. Among the "real-time" pages that were identified, the one with the highest design rating was that of the award winning TOPP (Tagging of Pacific Pelagics) website. TOPP is a NOAA (National Oceanographic and Atmospheric Administration) sponsored research project, which utilizes specialized tagging devices to collect data on the migration patterns of a select group of pelagic animals living in the Pacific Ocean. This data is housed within the Near Real-Time Animal Tracks page of the TOPP website, where it can be accessed and viewed by the general public.

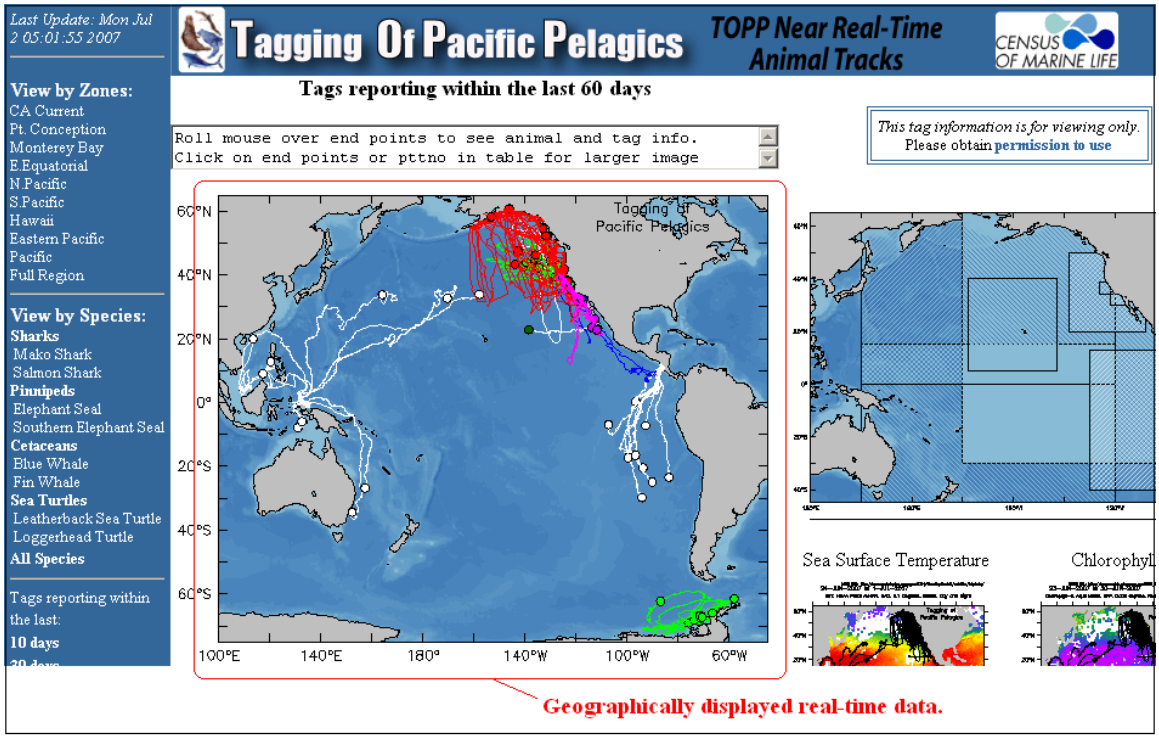

Figure 4. Near Real-Time Animal Tracks page of the Tagging of Pacific Pelagics (TOPP) website. Highest rated webpage among those featuring geographically displayed real-time data.

Although clearly lacking in comparison to the model web-examples from the other review categories, the TOPP webpage still features several qualities capable of inspiring the development of certain elements of the project CROOS website. Among those qualities, is the page's content. Unlike most other real-time webpages, TOPP's content is displayed in a format that is both easy to use and understand. The language is not overly technical and foreign, nor are the mapping functions heavily complicated. Instead, the data and information is presented in simple terms that are both meaningful and engaging to a wide spectrum of users.

The ability to interact with TOPP's real-time data is another highly rated quality of the webpage. This high rating is attributed to the advanced usability associated with TOPP's

interactive features. In contrast to many other pages, TOPP's features are kept simple, so they are easy to operate and they don't break down. Users are not required to undergo extensive training to master complicated tools or confusing map layers. Instead, retrieving data for analysis is as easy as clicking on a geographic image or a descriptive link.

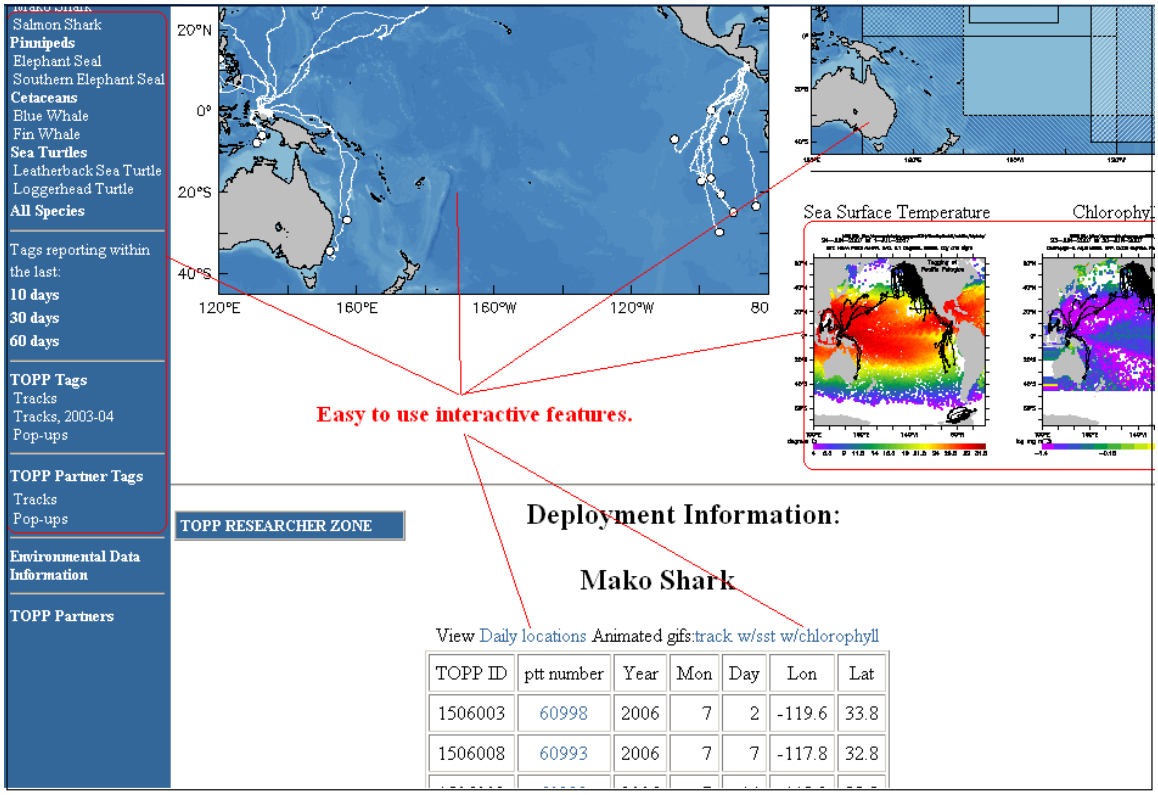

Figure 5. Interactive data retrieval elements featured on the Near Real-Time Animal Tracks webpage.

The other two model-design areas associated with the TOPP webpage are responsiveness and credibility. The page's highly rated responsiveness is the product of rapid page loading speeds, maps and images that download fast, and data plots that are made immediately accessible. TOPP's perceived credibility is attributed to the numerous

scientists, universities, government agencies, and respected sponsors that are listed as being affiliated with the site and its corresponding research.

Despite being the highest rated page within the “real-time” category, the TOPP webpage is not free from design weaknesses. In fact, the page features several flaws that will need to be avoided when developing the project CROOS website. One flaw involves the page’s layout. Due to poor organization and structuring of content, the TOPP webpage requires excessive amounts of scrolling both vertically and horizontally, which can obstruct users from viewing the entire page and make finding information extremely frustrating. It also displays design elements differently than other pages within the site, forcing users to make unnecessary mental adjustments when interpreting the page’s content.

Another weakness of the TOPP webpage involves its lack of navigational aids. Besides a poorly labeled link to the homepage, there are no other means for users to access other areas of the site. In fact the only other links on the page are for retrieving data, but even these hinder navigation by flooding the screen with unnecessary browser windows.

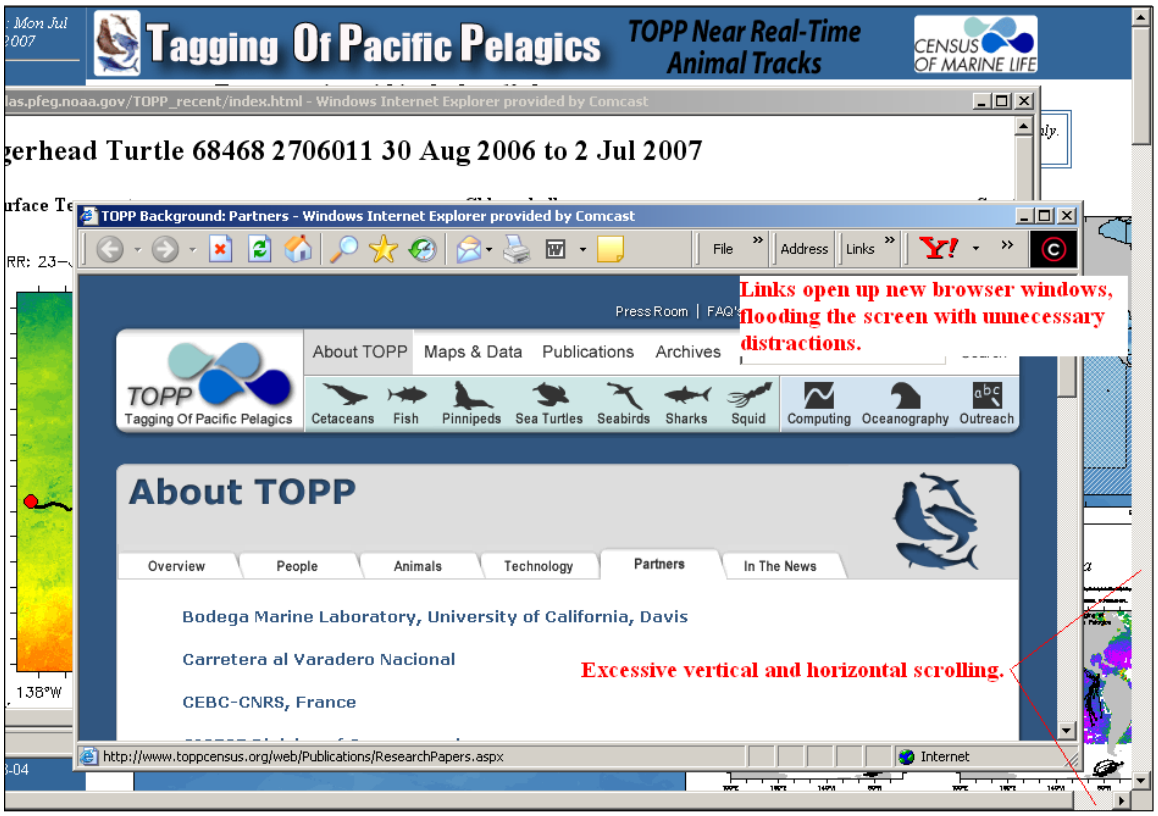

Figure 6. Design weaknesses of the Near Real-Time Animal Tracks webpage.

Webpages featuring traceability. The final web-category reviewed was the webpages featuring traceability. This selection of web-material was the most difficult to review because of quantity limitations. Despite numerous hours of searching the internet, only a few examples of webpages featuring traceability were located. Fortunately, these pages were fairly well-designed and scored remarkably high ratings. The highest rated webpage from among this category was linecaught.ork.uk, the homepage of the South West Handline Fishermen's association.

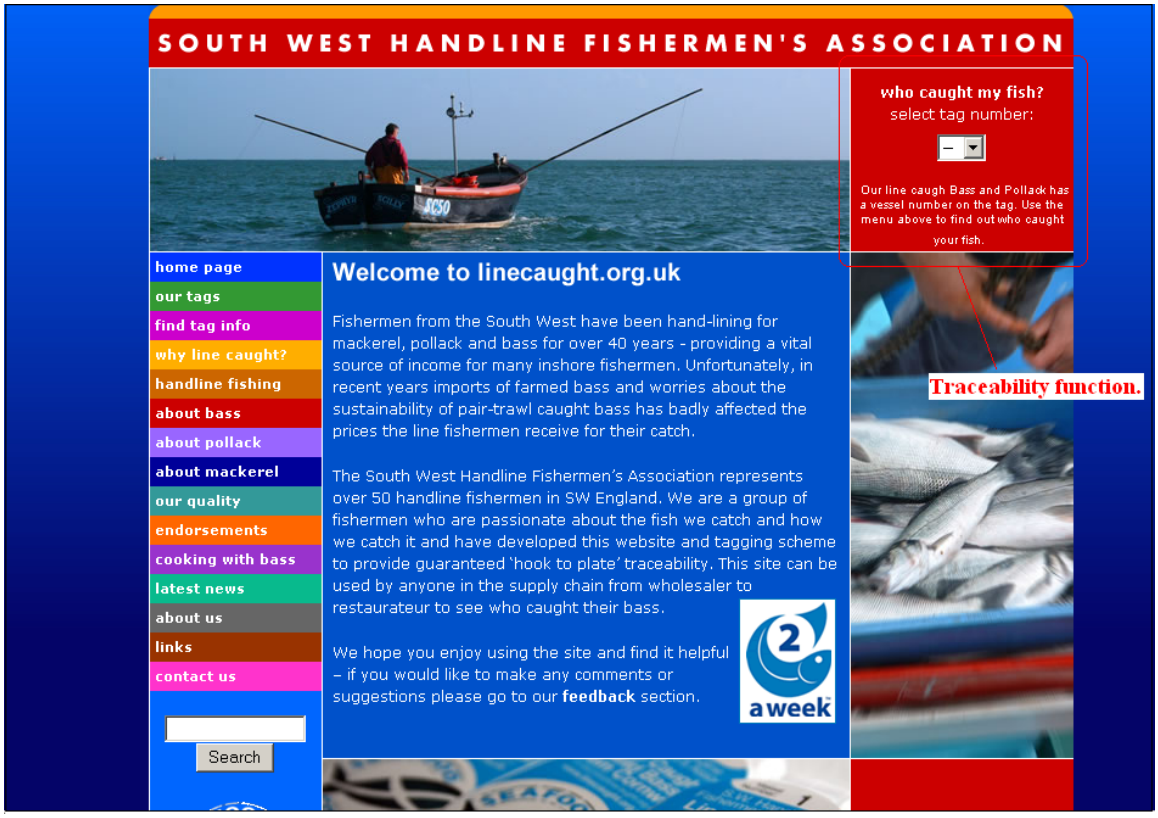

Figure 7. Homepage of the South West Handline Fishermen's association. Highest rated webpage among those featuring traceability.

As a webpage that allows seafood consumers to trace their purchases back to their origin of harvest, linecaught.org.uk serves as a model for the project CROOS website. Besides possessing identical traceability objectives, the webpage also features superior design qualities. One of its key qualities is its content. Similar to the model examples from the other web-review categories, linecaught.org.uk features material that is user-centered and formatted to facilitate ease of use and comprehension. It also provides text that is capable of facilitating scanning, and displays images that complement the site without creating distractions.

Another favorable design feature of linecaught.org.uk is its page layout. By utilizing a consistent, non-crowded, organized presentation of design elements, this webpage provides users with an interface that is both visually appealing and user-friendly.

Interactivity is another strong design feature of linecaught.org.uk. Despite being limited to a search entry field and a traceability drop-down menu, the interactive elements of this webpage are ideal because they are simple, easy to use, and operate without error. Similarly, the responsiveness of linecaught.org.uk is also a strong feature. This is primarily due to the rapid functionality of the page's interactive elements, as well as it's exceedingly fast loading speeds.

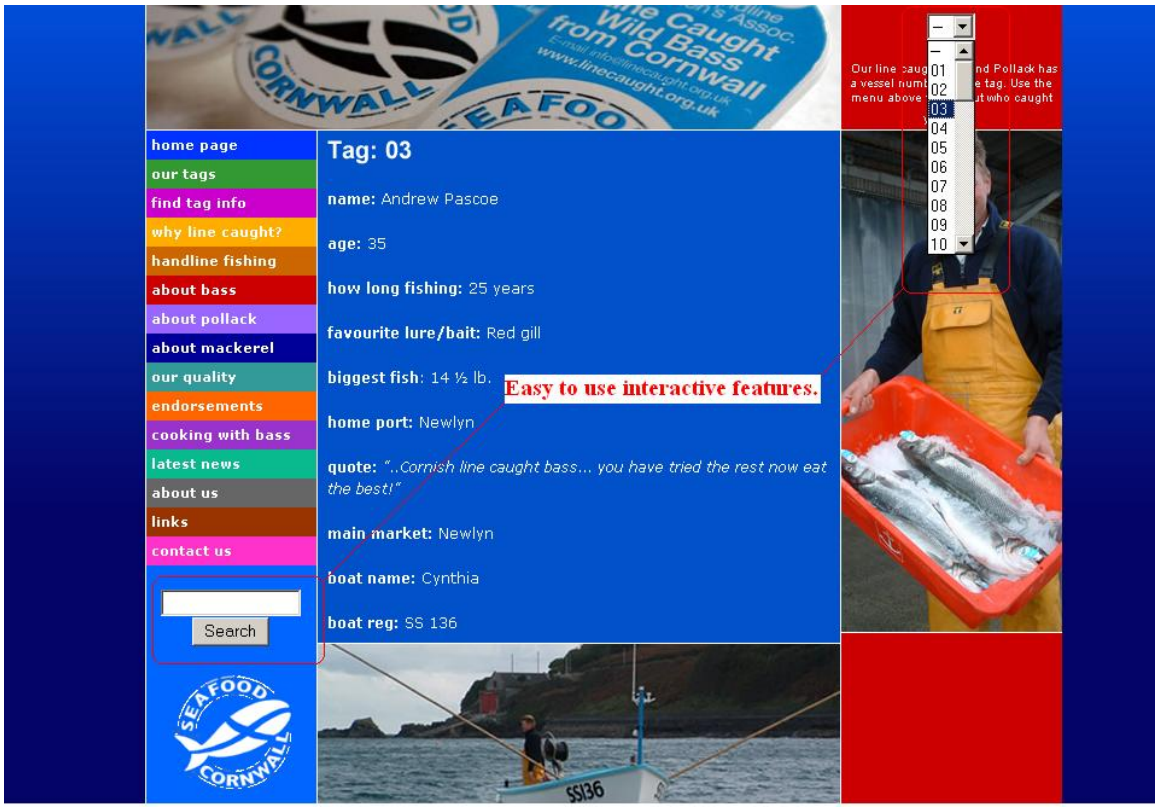

Figure 8. Interactive design elements featured on linecaught.org.uk.

Other desirable qualities of linecaught.org.uk are the various design features it uses to communicate the credibility of its content. Similar to the model examples from the other web-review categories, this webpage utilizes several strategies to promote user-confidence regarding the information and services it provides. Some of these tactics include: displaying photographs and personal information of the individuals behind the webpage, providing links to other credible sites, and maintaining a professional look by ensuring flawless functionality and up to date, accurate information.

The one area of concern regarding the design of linecaught.org.uk is its navigability. Although the webpage does provide descriptive and easy to use navigational aids that are consistent with the rest of the site, it also contains several design elements that obstruct user-mobility. The page's misuse of links is probably the most significant obstruction. Unlike other navigation-friendly webpage's, linecaught.org.uk does not adequately distinguish its links from ordinary text, nor does it provide a distinction between links that have been used and those that have not. In addition, some of the page's links also open up new browser windows, which can disorient users by filling the screen with needless distractions.

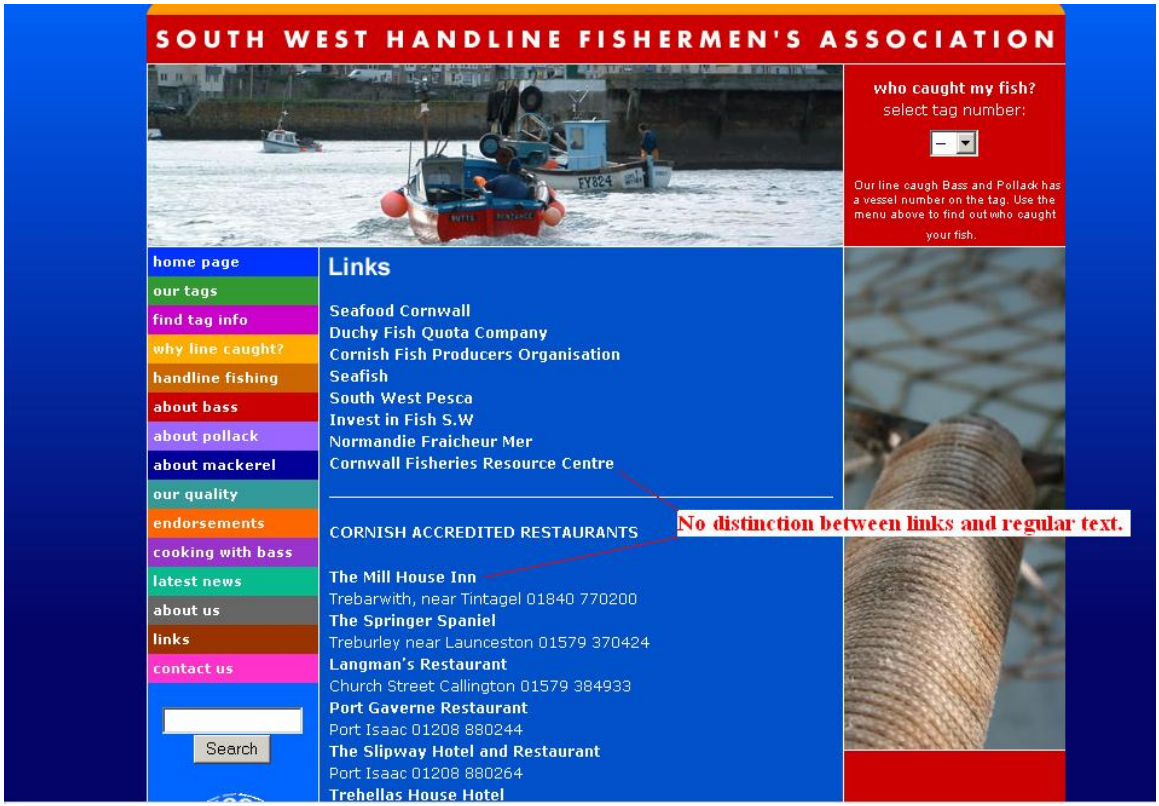

Figure 9. Design weakness of linecaught.org.uk.

User Input

The final step taken during this first phase in the development of the project CROOS website was to acquire user-input, a method commonly referred to as user-centered web design. "User-centered design (UCD) is a broad term to describe processes in which end-users influence how a design takes shape" [18]. It is utilized as a means to ensure that a finished product meets the needs and expectations of its users. This approach helps designers avoid costly post production corrective measures by identifying early on in development what a product requires to be both useful and usable [18]. Early user involvement in the development process is also beneficial in that it facilitates a sense of

ownership over the final product, which often results in higher customer satisfaction and smoother integration of the product into the environment [18].

Gathering user-input to design a user-centered website can be achieved in many different ways. Some of the more common methods include: surveys and questionnaires, interviews, focus groups, and usability testing of prototypes. At this stage in the development of the project CROOS website, a focus group was chosen as the most appropriate option to fulfill our specific input needs.

Focus groups are a somewhat informal technique utilized to assess user needs and feelings both before interface design and long after implementation [19]. In a focus group, users are brought together to participate in a discussion aimed at identifying user wants, expectations and/or perceived needs [20]. Although the discussion is intended to be free flowing and relatively unstructured, a moderator is normally present to ensure that every participant is able to contribute input, that specific issues are covered, and that the goals of the focus group are met [19].

The focus group conducted for the project CROOS website was held on the morning of September 7, 2007 at the Hatfield Marine Science Station. It was structured as a moderated round-table discussion between potential website users. The participants consisted of 5-6 representatives (~15 total) from each of the following user groups: fishermen, fisheries managers, and fisheries scientists. The objective of the focus group was to identify user preferences and expectations concerning the key functions, data

points, and uses of the website. This entailed identifying what information the users wanted to be collected and made available on the site, as well as how this information was intended to be used. The user input provided during the discussion was recorded and analyzed. The results of that analysis are described below.

Fishermen. According to the fishermen, real-time data on atmospheric and oceanographic conditions is critical information that they would like to see displayed on the project CROOS website. They specifically identified weather conditions, current speed and direction, sea surface temperature, and chlorophyll concentrations as being especially important for helping them identify favorable fishing environments. To maximize the use of this information, the fishermen recommended that this data be visualized geographically in relation to the salmon catch data, and that both current and historical records of the data be made accessible. They claimed that by providing the information in this way, the fishermen would be better equipped to identify patterns and trends in fishing performance relative to oceanographic and atmospheric conditions, which would ultimately improve their ability to plan and execute their fishing operations.

The other key suggestions made by the fishermen involved the marketing of their salmon. First, they recommended that the website's consumer traceability function provide salmon buyers with detailed information about their fish, such as when and where it was harvested, by whom, and from which river basin or hatchery it originated. They also recommended that the site emphasize the fact that the salmon are wild caught, harvested sustainably, and most importantly, that they are of the highest quality. To highlight their

product's level of quality, the fishermen also suggested providing consumers with information on the fish's thermal history, as well as a detailed description of the vessel's fish handling practices. They claimed that by taking these extra steps to educate the public concerning the differences in quality that exist between CROOS caught fish and the competition, the consumers would be more inclined to purchase their product, and they would be willing to do so at higher prices.

Another marketing suggestion made by the fishermen was to include tracking information on the website that would enable them to see where their fish is being sold. This would allow the fishermen to identify where their customer base is, and potentially improve their ability to plan marketing operations. In addition to the tracking information, they also recommended that the website be equipped with a feedback option that would enable consumers to communicate comments, complaints, and concerns directly with the fishermen regarding their purchases.

Scientists. Similar to the fishermen, the scientists also identified both historical and real-time catch data, along with corresponding information on oceanographic and atmospheric conditions, as key data points that should be included on the project CROOS website. However, unlike the fishermen, the scientists indicated that they would prefer to see that data in its aggregate form. By viewing the data in this particular format, they claimed that their ability to study ocean fishing performance and salmon distribution patterns would be less likely to be hindered by issues related to the release of sensitive, individual fishing information.

In addition to the harvest, oceanographic, and atmospheric data, the scientists also recommended that the website provide information on age composition relative to stock composition. This recommendation was motivated by their desire to learn more concerning the migration patterns of the different year classes in each salmon population. The scientists also suggested that the site provide data on some of the social aspects of fishing. They felt that by including information related to important coastal issues, such as fishermen behavior and/or fishing-related impacts on surrounding communities, the website would capture the interests of social scientists, which would broaden the site's audience of users, increasing its usefulness as a resource in fisheries research.

The final suggestions made by the scientists during the focus group involved data formatting needs. Their first suggestion was to focus on displaying the data quantitatively, rather than qualitatively. Consequently, they recommended that the data not only be displayed as maps on the website, but also in its raw form. They claimed that by allowing them to query and select information from among the raw data, the scientists would be better equipped to run important statistical analyses to confirm observed trends, as well as make predictions for the future. They also recommended that the website provide scientists with the ability to post their own data analyses results so that others would have the option to view it, test it, and ultimately, refine it. The only other format related suggestion made by the scientists was to arrange the data on the website to facilitate its use in teaching environments.

Managers. Consistent with the other focus group participants, the managers were also in favor of displaying both historical and real-time catch data on the project CROOS website in order to identify and avoid weak salmon stocks. To achieve these key objectives, the managers suggested that only data representative of the entire fleet be used, and that it be displayed in an interactive format, capable of allowing them to query the system and display maps at varying scales of time and area. They further suggested that the maps be designed to not only identify individual fish, but also to provide summaries of the major stocks caught within the given geographic zones and time periods.

Managers also indicated that in the short term the website and its corresponding data and information should not be expected to trigger any large reforms to their current management practices. Consequently, the managers recommended that the website focus on displaying data and information aimed at improving their existing management models. Some of the data points that were suggested included Klamath fish contacts relative to units of effort, CROOS derived stock percentage estimates relative to the traditional preseason estimates, and any data associated with fish possessing coded wire tags.

The final piece of input provided by the managers involved a discussion concerning the credibility of the data contained within the project CROOS website. Their concern was that without formal validation or certification, the data might not be cleared for

management related uses. Unfortunately, the managers were not able to provide any suggestions for resolving this issue at this time.

Conclusion

Based on the information provided in this paper, several key steps have been taken to develop a foundation for the project CROOS website. Goals and expectations have been established with regard to educating the public and providing multi-user access to project data and information. An extensive review of web design literature and project relevant websites has been performed to discover quality design characteristics and model web examples. Lastly, a focus group has been conducted to identify user preferences and expectations regarding the key functions, data points, and uses of the website.

Plans for the Future

Now that adequate guidance and information regarding the development of the project CROOS website have been accumulated, the next phase in the developmental process is to apply that knowledge towards physically creating a functional draft of the website. Plans to do so are already underway. A web design firm called Sparkplug has been contracted to design the project CROOS website according to the input provided in this paper. They are expected to complete a draft of the site within the next few months.

Once a functional draft of the website is completed, the last phase in the developmental process will be to finalize the design and functionality of the site through usability testing. This will involve organizing a series of focus groups for the potential users (fishermen, fisheries managers, fisheries scientists, and seafood buyers/consumers) and

allowing the participants the opportunity to test-drive and evaluate the website. The feedback from this testing will then be utilized to fine tune the site into a finished product. These focus groups are tentatively scheduled to take place in approximately 6 months and the website is anticipated to be completed and launched shortly thereafter.

Expected Outcomes

Upon its completion, the project CROOS website is expected to positively impact the world of fisheries in a number of different ways. By providing a diverse community of users the opportunity to access research, the website is expected to help facilitate entirely new and innovative ways of using fisheries data and information. It is also anticipated to serve as a foundation for promoting further development of entirely new technologies capable of improving fisheries research techniques. The site will also likely help to promote future collaborative fisheries research efforts, while simultaneously serving as a blueprint for utilizing internet and digital technology to facilitate those efforts.

Another expectation for the CROOS website is that it will bring the use of real-time data and in-season regulatory measures into the forefront of fisheries management, supplementing some of the more traditional and often imprecise strategies that are currently used. There is also a hope that the site's potential for enhancing cooperation among fisheries researchers will promote the further development of collaborative management strategies as well, such as Ecosystem Based Management.

In addition to improving management, the project CROOS website is also expected to promote better fish handling techniques through its traceability component. This will likely lead to higher quality and more valuable seafood products. The site is also expected to improve fishery performance, by providing fishermen with the resources to more effectively target healthy fish stocks. It is also anticipated to contribute to the development of more sustainable fisheries, by improving management practices, guiding fishing operations to avoid threatened fish stocks, and providing seafood consumers with the necessary information to make informed purchases that contribute to sustainable fishing practices.

Potential Risks

Despite the overwhelming abundance of favorable impacts associated with the launching of the project CROOS website, there also exist a few significant risks as well. The majority of these risks are primarily concerned with potential management outcomes.

Although the management impacts described in this paper thus far have been mostly positive, there exists a possibility that the CROOS website and its corresponding research could in fact induce unfavorable ones as well. An example of such a scenario involves the issue of micro-management. Micro-management refers to the strategy of managing every single detail of a particular fishery. This can be extremely devastating because it often puts fisheries in a regulatory stranglehold, preventing fishermen from being able to make a viable living. In the case of project CROOS, the threat related to micro-

management involves the possibility of utilizing GSI techniques to not only further break down the Pacific salmon stock into numerous, potentially manageable population segments, but also doing the same in other fisheries as well. By breaking down fish stocks into distinct populations, there exists a risk that additional threatened populations will be identified, leading to an increase in fishery regulation and a decrease in fishing activity. Unfortunately, with fishery performance as low as it is, these additional obstacles could mean economic devastation to countless fishermen and their communities.

Another potentially unfavorable management outcome associated with the project CROOS website involves its actual application in management scenarios. Because this research effort is relatively new and untested, it will likely take time before managers can begin integrating it into their existing management process. Even then there will undoubtedly need to be significant changes in regulatory practices and the laws that govern those practices before CROOS can begin to have a significant impact on fisheries management. In addition to time, testing, and legal considerations, data credibility may be yet another obstacle preventing the CROOS website from becoming a management tool in the near future. This concern regarding credibility stems from the fact that the near-real-time data produced by project CROOS is generated and displayed in a manner that does not allow for a formal validation process.

The last significant management issue associated with the project CROOS website involves its display of salmon stock distribution data. The goal of project CROOS is to

provide managers and scientists with the ability to identify and isolate weakened salmon stocks, so that fishermen can continue fishing the healthy ones. The ability to successfully achieve this goal is largely dependent upon the degree of mixing that occurs between these various stocks during their oceanic lifecycle. If the stock distribution results displayed on the website confirm that a large amount of mixing does occur, there is a strong likelihood that salmon managers will remain in the same helpless situation as before, unable to prevent the coast-wide fishing closures that have plagued our salmon fisheries. In fact, depending upon the extent of mixing found to occur between healthy and weakened salmon stocks, the results could actually facilitate even more extensive closures.

Despite these management concerns, the development of the project CROOS website is expected to continue on as planned. Those involved in the development process are optimistic that solutions to these problems will be found and that the website will be able to live up to its high expectations. Contributing to their optimism is the fact that significant progress has already been made, especially regarding the issue of data credibility. By researching other data-oriented websites, several methods utilizing peer reviewers, automated systems, and/or content disclaimers have been identified and are being investigated as possible strategies for qualifying CROOS data for management use.

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APPENDIX A—Website Review Notes

Multi-user websites with user-specific access portals	Content	Page Layout	Navigation	Inter.	Resp.	Credibility
1) www.cosi.org/	Text <9 pt, home page is all images and no text	Consistency issues with text and background	Trouble getting back home, no difference between used/unused links	Misuse of pushbuttons with donation amounts	Some pages are slow to download because of images	No problems
2) www.weeklyreader.com/	Too many font types, sizes, etc., lots of distracting images, text <9pt	Consistency issues with text, colors, etc.	No site map, lots of non-text links, no difference between used/unused links, easy to get lost at store site	No problems	No problems	No contact info, etc., full of ads, no policy on content
3) www.smithsonianeducation.org/	Text <9pt	Requires a lot of scrolling, a lot of empty white space	Links open different browsers, easy to get lost in this site and in others, no difference between used/unused or internal/extern-al links, no home link	No problems	No problems	No problems
4) http://kidshealth.org/	A lot of text on some pages, especially for kid users, some bizarre fonts used	Requires a lot of scrolling, too much empty page space on each side, home page format inconsistent with other pages	No site map, links in teen portal open up new browsers, navigational aids not consistently present in all 3 portals	No problems	No problems	Functional error- links in teen portal function differently than other portals
5) www.aqua.org/	Text <9pt, a lot of graphics, multimedia, etc., but not too bad because download time is still fast	No problem	No site map, no difference between used/unused links, links to interactive pages open new browsers	No problems	No problems	Scientific info not cited
6) www.stopwaste.org/home/index.asp?page=1	No problems	Home page format differs from other pages	No site map, no differences between used/unused links, some unclear image-based links	No problems	No problems	No policy on content
7) www.stormwaterauthority.org/default.aspx	Some text is difficult to read because of a lack of background contrast	Some pages require a lot of scrolling	No site map, links open up new browsers, navigational aids not on every page, pages lack location feedback, no difference between used/unused links	Some push buttons look identical to non-pushbuttons, two entry fields for questions on same page	A little slow to upload because of graphics on home page, but not too bad	Lots of commercial elements

	Content	Page Layout	Navigation	Inter.	Resp.	Credibility
8) www.adelphi.edu/	Some text <9pt	Home page is a little crowded, a few pages have different layouts	Broken link, no difference between used/unused or internal/extern-al links, some links open up new browsers	No problems	No problems	Functionality error—broken link, no policy statement on content
9) www.bluecrossca.com/	Too text dominant	Pages with new-browsers all have different layouts	Lots of links open up new browsers, two separate clicks required just to enter user-portal, no difference between used/unused or internal/extern-al links	No problems	No problems	No problems
10) www.wbmd.com/index.shtml	No problems	Too much white space	Temporary broken links, home link not on every page, no difference between used/unused links, most links take you off the site	No problems	Some pages are a little slow to download (not sure why because there weren't many graphics)	Functionality errors—broken links (temporary)
Webpages featuring geographically displayed real-time data						
11) http://las.pfeg.noaa.gov/TOPP_recent/index.html	Info could be attractive to multiple user groups which may require different formats to accommodate each of them: education, scientists, etc.	Page doesn't fit on screen, requires horizontal scrolling and a lot of vertical scrolling, links with new browsers have different layouts	To view data new browsers open up, no navigational aids to other areas of site except to home, no difference between used/unused links, some image-based links were tough to identify as links until moused	Interactive push buttons to view daily locations didn't work	No problems	Functional errors- faulty push buttons and broken links
12) www.cefas.co.uk/data/wavenet.aspx	Data text <9pt, some text on data pages is invisible do to lack of contrast with background, needs user assistance for use of complicated data analysis tools	Data pages' layouts are different, data pages also have a lot of empty white space	Navigational aids are invisible on data pages until clicked on, link descriptions don't match destinations	Interactive tools for analyzing data in advanced setting were difficult to operate and didn't seem to work right	Map downloads were very slow, response time after interactions were also very slow	Functionality errors associated with downloading maps (server problems)

	Content	Page Layout	Navigation	Inter.	Resp.	Credibility
13) http://waterdata.usgs.gov/nwis/rt	Overwhelming amount of data, info, etc., could have been summarized more or limited to most relevant material	Background and content organization not visually appealing, some pages require lots of scrolling, different page layout from rest of site, significant info, such as results of data inquiry, need to be centered and placed higher on page ahead of misc. info.	No navigational aids except to home page, some links to interactive pages don't work	Unnecessary entry fields (one for questions/co-mments and another for feedback), Build sequence option doesn't work, data entry fields are numerous and confusing, interactive controls not grouped	No problems	Functionality errors—broken links, and faulty interactive controls
14) http://nowcoast.noaa.gov/	Instruction text appears invisible due to lack of background contrast, some text is <9pt, overwhelming amounts of information in map layers, more instruction and user assistance needed or content needs to be simplified	Page appears cluttered with content, map layers section requires a lot of scrolling, page layout is different from rest of site, significant information hidden in bottom right corner of page	Navigational aids and location feedback hidden in small text in bottom right corner of page, links open up new browsers, no difference between used/unused links, can't distinguish some links from regular text	Map tools and layers are very complicated and confusing to operate	Map downloads very slow and responds very slow to interactions	Rigid functionality
15) www.gomoos.org/data/recent.html	A lot of text <9pt, poor interactive map	Appears kind of squished to the left of screen, pages with new browsers have different layout, not visually appealing	Links open up new browsers, no difference between used/unused or internal/extern-al links, some links look like regular text, graphing pages have no navigational aids	No problems	Data analysis was a little slow	No problem
16) www.cormp.org/indexreal.php	Interactive map could be improved	Some data retrieval links have different page layouts	Most data retrieved from external links that pop up new browsers, can't distinguish between internal/extern-al links	External data retrieval links freeze, making the interactive map non-functional	External data retrieval links freeze and become unresponsive	Functionality issues with the external data retrieval links
17) www.skio.peachnet.edu/research/sabsoon/tower.php	There are visual error in content, data retrieval pages are text only	Background colors and content organization not visually appealing, data retrieval pages have different layouts	Broken links, unclear image-based links, no navigational aid on data retrieval pages, external/intern-al data retrieval links not distinguished	External data retrieval link on interactive map doesn't work	No problems	Errors in content and functionality

	Content	Page Layout	Navigation	Inter.	Resp.	Credibility
18) http://sdcoos.ucsd.edu/data/CurrentsObjList.cfm	Map is really small and tough to see, text is <9pt, data units unclear	Background and content organization not visually appealing, data retrieval pages have different layouts	There are links to lots of pages that are down, data retrieval links open up new browsers	Not many interactive options	No problems	Lots of pages down for maintenance purposes
19) www.glerl.noaa.gov/res/recon/	Real-time data limited to only a few stations, interactive map looks terrible	Background and content not visually appealing, some pages of data plots require lots of scrolling, poor organization of content	Intra-page navigation links hidden on side and too small to be seen, internal/extern-al data links not distinguished	'Remove' pushbutton doesn't work, interactive controls for data plots not easily accessible at bottom of page	No problems	Functionality issues
20) www.ndbc.noaa.gov/dart.shtml	Interactive map is poor, lots of unnecessary data displayed, scale of plots is too small to be useful, text at bottom of page is too light in color to be seen	Lots of empty white space, some pages require a lot of scrolling, visually unappealing, poorly organized	Poorly labeled links, no distinction between internal/extern-al links, some links look just like regular text	'Highlight' pushbutton's purpose unknown, entry fields with too much data that don't serve a purpose	Map and plots take a while to download	No problems
Webpages featuring traceability						
21) www.jsorganic.co.uk/trace.asp	Some text <9pt, A little more info on traceability would be helpful	Seems to be a lot of unused empty white space	Home link needs to be more visible, no distinction between used/unused links	No problems	No problems	No problems
22) www.linecaught.org.uk/	Color scheme for navigation links a little crazy, some text <9pt	No problems	No distinction between used/unused links, some links look just like regular text, external links open up new browser	No problems	No problems	No problems
23) www.wheresgeorge.com/	Text <9pt, lots of unnecessary ad graphics and text, misspelled words, etc.	Displaced content at bottom of page, doesn't utilize space effectively, requires unnecessary scrolling, new browser windows have different page layouts, poorly organized, text layout looks bad	Non-descriptive links, most links open up new browsers, lots of links look like regular text	Some entry fields look terrible and require unnecessary info	A little slow to download because of ad graphics	Lots of ads, text grammar issues, help link doesn't work

	Content	Page Layout	Navigation	Inter.	Resp.	Credibility
24) www.dmv.org/vehicle-history.php	Text <9pt, lots of ads	Lots of scrolling required, lots of empty white space, poor content layout (lots on the side, nothing in the center)	Interactive links open up new browsers, no distinction between used/unused links	No distinction between required/optio-nal entry fields	No problems	States info is not complete or certified, not affiliated with any govt. agency, lots of insurance ads
25) www.carfax.com/	Irrelevant ads, unnecessary audio clips	Lots of scrolling through car info required	Navigation aids disappear on interactive pages, links pop up ad windows, regular text looks like links, some links don't work, some links open up new browsers	No distinction between required/optio-nal entry fields	Audio clips take a while to download	Lots of ads, pop ups, no contact info or other real world elements

APPENDIX B—Sample Focus Group Participant Invitation

Date

Address Block

Dear Sir or Madam,

You are invited to participate in a project being conducted by the Oregon State University Coastal Oregon Marine Experiment Station. The project is titled: Collaborative Research on Oregon Ocean Salmon, or CROOS. It is a cooperative effort between Oregon salmon fishermen and OSU scientists that uses genetic information, data on oceanographic conditions, and digital traceability systems to track salmon stocks in the ocean, as well as individual salmon after harvest. The goal of this research is to improve the science, management, and performance of Oregon's salmon fishery by learning more about offshore schooling behavior and stock composition of salmon in the Pacific Ocean. In addition, the project is also anticipated to create additional marketing opportunities by enabling seafood consumers to track their purchase from harvest to dinner table.

You have been selected to participate in the website development component of this project. The website is intended to house the data and results generated from project CROOS. Given the multiple potential applications of this information, it is our goal to design a website that will allow several different user groups the opportunity to access this material in a format that best satisfies their specific interests, preferences, and needs. In order to achieve this goal, several focus groups composed of fishermen, managers, industry workers, and scientists will be organized as a means to extract ideas, suggestions, and other important input from the various potential website users. The resulting information will than be used to shape the final design and functionality of the website.

As a respected _____ (fishermen, manager, or scientist), you have been selected to participate in one of our focus groups. The focus group is scheduled for _____ (date and time) at (location). Your participation will involve attending a round table discussion with other potential website users. During which time each focus group participant will be provided with the opportunity to contribute input regarding the website's database needs as well as how those needs relate to the presentation of the website's interface. The entire process will take no more than 3-4 hours. Your attendance and contributions to the focus group are completely voluntary, and any input you provide will be used to help guide the final construction of the project CROOS website.

Your participation in the project will be greatly appreciated. If you wish to accept this invitation or have any questions regarding the project, please contact Gil Sylvia by phone at 541-867-0284, or by email at gil.sylvia@oregonstate.edu.

Sincerely,

Gil Sylvia
Superintendent, Coastal Oregon Marine Experiment Station

APPENDIX C—Sample Focus Group Informed Consent Document

INFORMED CONSENT DOCUMENT

Project Title:	Project CROOS: Website Development
Principal Investigator:	Dr. Gil Sylvia, Superintendent, Coastal Oregon Marine Experiment Station
Co-Investigator(s):	Diane Moody, Community Seafood Initiative and Seafood Consumer Center; Jeff Feldner, OSU Sea Grant Extension.

WHAT IS THE PURPOSE OF THIS STUDY?

You are being invited to take part in a focus group regarding the development of a website for the Collaborative Research on Oregon Ocean Salmon (CROOS) project. CROOS is a cooperative research effort between scientists and fishermen that uses genetic information along with digital traceability systems to track salmon stocks in the ocean, as well as individual salmon after harvest, for management, science, and marketing purposes. The CROOS website is intended to provide the general public with information, data, and results concerning this research. Given the multiple potential applications of this information, it is our goal to design a website that will allow several different user groups the opportunity to access this material in a format that best satisfies their specific interests, preferences, and needs. In order to achieve this goal, several focus groups composed of fishermen, managers, industry workers, and scientists will be organized as a means to extract ideas, suggestions, and other important input from the various potential website users. The resulting information will than be used to shape the final design and functionality of the website.

WHAT IS THE PURPOSE OF THIS FORM?

This consent form gives you the information that you will need to help you decide whether to participate in the focus group or not. Please read the form carefully. You may ask any questions about the research, the possible risks and benefits, your rights as a volunteer, and anything else that is not clear. When all of your questions have been answered, you can decide if you want to be in this study or not.

WHY AM I BEING INVITED TO TAKE PART IN THIS STUDY?

You are being invited to take part in this study because you are a _____ (salmon fishermen, salmon manager, or salmon researcher). Your involvement and input is important because the website we are developing is intended to be used by people like yourself.

WHAT WILL HAPPEN DURING THIS STUDY AND HOW LONG WILL IT TAKE?

As a respected _____ (fishermen, manager, or scientist), you have been selected to participate in a focus group being held at _____ (location) on_____ (date and time). Your participation will involve attending a round table discussion with other potential website

users. During which time each focus group participant will be provided with the opportunity to contribute input regarding the website's database needs as well as how those needs relate to the presentation of the website's interface. The entire process will take no more than 3-4 hours. Your attendance and contributions to the focus group are completely voluntary, and any input you provide will be used to help guide the final construction of the project CROOS website.

WHAT ARE THE RISKS OF THIS STUDY?

Your participation is completely voluntary and any input that you may offer will be documented without the use of names or any other identifiers to maintain complete anonymity and confidentiality. As a result, there are no foreseeable risks to the participants of this study.

WHAT ARE THE BENEFITS OF THIS STUDY?

The participants of this study are all considered potential users of the website. As such they have the opportunity to benefit directly from the sites various features, functions, and attributes. Consequently, by taking part in the focus groups, the participants of the study ensure that the website is designed to meet their specific interests, preferences, and needs. Their contributions to the study will not only benefit them as website users, but also anyone indirectly or directly involved in Oregon's salmon fishery. Some of these benefits may include: improving salmon management, advancing science and public education, and creating additional marketing opportunities.

WILL I BE PAID FOR PARTICIPATING?

You will not be paid for being in this research study.

WHO WILL SEE THE INFORMATION I GIVE?

The information you provide during the focus group will be kept confidential to the extent permitted by law. To help protect your confidentiality, we will be documenting all participant input without the use of names or any other identifiers. If the results of this project are published your identity will not be made public.

DO I HAVE A CHOICE TO BE IN THE STUDY?

If you decide to take part in the study, it should be because you really want to volunteer. You will not lose any benefits or rights you would normally have if you choose not to volunteer.

You can stop at any time during the study and still keep the benefits and rights you had before volunteering.

You will not be treated differently if you decide to stop taking part in the study. If you choose to withdraw from this project before it ends, the researchers may keep information collected about you and this information may be included in study reports.

WHAT IF I HAVE QUESTIONS?

If you have any questions about this research project, please contact:
Dr. Gil Sylvia, 541-867-0284, gil.sylvia@oregonstate.edu.

If you have questions about your rights as a participant, please contact the Oregon State University Institutional Review Board (IRB) Human Protections Administrator, at (541) 737-4933 or by email at IRB@oregonstate.edu.

Your signature indicates that this research study has been explained to you, that your questions have been answered, and that you agree to take part in this study. You will receive a copy of this form.

Participant's Name (printed):
_____

_____ _____
(Signature of Participant) (Date)

APPENDIX D—Focus Group Input Notes

Red—data and information needs
Green—intended data use or purpose
Blue—data formatting suggestions

Fishermen:

- One stop access to real-time weather, current, SST, chlorophyll. That data should be visualized geographically and assembled in layers that can be turned on and off. They should be visualized in relation to where salmon are being harvested.
- Data to be used for identifying and isolating weak stocks so that fishermen can stay on the water targeting healthy stocks.
- They want to be able to use the data to identify patterns and trends in oceanographic and atmospheric conditions that correspond to favorable fishing. This will help them fish more efficiently in terms of time spent locating fish, fuel costs, etc.
- Data should be displayed in as close to real time as possible because conditions change so quickly.
- Quota information should be posted so that fishermen are aware what can be harvested, how much, where, etc.
- Need to have access to both historical and current information so that trends and patterns can be identified.
- They want data that not only indicates where to fish, but also where not to. Their reasoning is that when conditions are perfect that doesn't necessarily mean that the fish are going to be there. Thus it is much more helpful to know where the fish definitely are not, then to know where the fish might be.
- They want the site to display tracking information so they can see where there local fish are ending up. This information will help them know where their customer base is, which will help them plan their marketing operations.
- They want the site to provide consumers with information on the boat, the captain, the catch, etc. The goal is to educate the consumers regarding the quality product that they are purchasing and hopefully cause them to associate that quality with the boat from which the fish came. That way the demand for CROOS caught fish will increase and allow fishermen to sell their product at a higher price.
- In addition they would also like information posted for the consumers that emphasizes that the fish are ocean caught and harvested sustainably.
- They also want information regarding the quality of CROOS caught fish to be emphasized. Suggestions for doing so included: providing consumers with the fish's thermal history and describing the vessel's fish handling practices. Their goal is to educate the public concerning the quality differences that exist between CROOS caught fish and the competition.
- Provide a consumer feedback option, so that fishermen can know what the consumer thinks. That way if there are any problems they can be addressed immediately.

Scientists:

- The site should provide historical catch, oceanographic, and atmospheric data for the purpose of identifying patterns and trends in distribution. The data does not need to be presented in a manner that allows individual boats to be identified. Aggregate data and information is all that is needed for researchers to study ocean performance and understand how fish distribute themselves in relation to oceanographic and atmospheric conditions.
- The data on the website can also be used to compare salmon behavior with that of other fish, such as rockfish.
- They want to see the data displayed as maps to get an intuitive understanding of what's happening, but more importantly they want access to the raw data with the option of being able to query and select what types of data they want to look at. This will allow them to run statistical analyses on the data so they can confirm observed trends and behavior as well as make predictions for the future.
- Their focus is on quantitative data rather than qualitative.
- They also discussed the possibility of being able to post their own scientific analyses of raw data back into the site so that others can view it, test it, make comments, and further refine it.
- The site should include enough data to rule out anomalous patterns and behavior.
- They want data on age composition relative to stock composition. This will enable scientist to discover where specific fish populations migrate at different points in their oceanic lifespan.
- They also suggested arranging the data in formats that can be used in a teaching environment.
- The site could also provide data on the social aspects of fishing. This information could be used to study fishermen behavior in response to changes in regulations, management approaches, economic factors, and biological factors, or impacts that the fishing industry has on the surrounding communities.

Managers:

- Data sampling needs to be representative of the fleet if it is to be used to make management decisions.
- Data should be displayed in a manner that is consistent with the goals of managing the fish not harvesting them.
- Data should be displayed in an interactive format that allows managers to query the system and display maps at varying scales of time and area. These maps should not only identify individual fish but also provide a summary of the major stocks that were caught in a particular zone at a particular time.
- An intended use for the data is to be able to identify schools of fish by stock.
- The data needs to be validated/certified for management use, especially with regard to the real-time data.
- The data provided by the website is not likely to trigger any large reforms to the current management practices. Consequently, the most valuable data in their eyes is anything that can be used to improve the existing management models. Data suggestions for meeting this need included: Klamath contacts relative to effort and anything having to do with fish containing coded wire tags.

- They would also like data that enables them to compare CROOS derived stock percentage estimates with their own preseason estimates. This will help them test the accuracy of their current management strategies and hopefully refine them.