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William Hanshumaker

It is not unusual to see stranded or washed-up marine animals and birds along any coastline. Various networks nationwide exist to report marine mammals and sea birds, yet, we have been unable to find a network in Oregon or nationally to report other stranded marine animals, namely fish, cephalopods, and reptiles. Existing networks for sea turtles, an endangered species, are incomplete. When a stranded fish, squid or turtle is found in Oregon, calls are frequently placed to a variety of locations because there is not a single publicized location or person to contact. Additionally, the specifics of the information provided by the public are generally unreliable. This paper will describe the creation of a citizen scientist opportunity for tourist or resident beachcombers to participate in an ongoing and necessary marine research project. A protocol was designed and evaluated, in both English and Spanish, that enables “citizen scientists” to identify washed-up or stranded marine reptiles, fish, and cephalopods along the coast. This protocol created a central location in which users can access information to identify species, know what information to record, and where to report it. The Oregon Coast was used as a proof-of-concept of the efficacy, usability and adaptability of the protocol. A This document will further discuss the myriad benefits this protocol provides to the areas of marine research, endangered species protection, researcher cooperation and collaboration, and community involvement in marine science, as well as long-term plans and possibilities for the future.

What's That on the Beach?

Designing a Protocol for the Identification and Reporting of Stranded Marine Fish, Squid, and Turtles Using the Oregon Coast as a Proof-of-Concept

by
Danielle C. Asson

PROJECT PAPER

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PART I. INTRODUCTION AND SUMMARY

1.1 Background and Rationale

It is not unusual to see stranded or washed-up marine animals along any coastline. The frequency and animal types vary by region, but the nature of winds and currents are such that organisms often wash ashore. These organisms are not limited to the well-known mammals and birds: beachgoers often find jellies like *Velella velella*, various seaweeds, eggs, worms, crabs, coral, and other critters. Additionally, the water often brings inanimate objects ashore, like agates, logs, and trash from faraway regions. The lucky beachcomber can stumble upon a treasure from a distant land like a Japanese glass float. These washed-up items are termed flotsam, jetsam, and wrack, and are so common that identification guides have been produced to help the regular beachgoer figure out what they have found, like that published by Oregon Sea Grant (Osis, 2001).

While many things wash ashore, animals are of particular interest, both to scientists and the general public, especially a larger animal like a whale or a sea turtle. Sometimes the animal is still alive when it washes ashore, and efforts are made to rehabilitate it. Occasionally an animal washes up that is from a different region altogether. Sometimes the cause of stranding is known, and sometimes it is not. But

monitoring and tracking animal strandings can reveal patterns in the currents and tides in the ocean, or within the animal populations themselves, and so is of interest to many scientists. Both for research and rehabilitations purposes, many networks have sprung up to allow for the reporting of stranded animal sightings.

1.1.1 Stranded animal reporting networks

Various networks nationwide exist to report stranded, dead, and injured marine mammals, sea birds, and sea turtles. These networks include both governmental agencies and civilian-run organizations, and can encompass all strandings, or focus on a particular animal type (COASST, n.d.; Marine Mammal Institute, n.d.-b; Maryland DNR; NOAA, 2012; NOAA Fisheries OPR, 2013; Save The Whales, 2013). The NOAA Fisheries Office of Protected Resources provides contact information by region to report stranded dolphins, whales, and sea turtles (NOAA Fisheries OPR, 2013). Although it is not explicitly stated, these hotlines also serve to report pinnipeds (seals and sea lions). Save The Whales, founded in 1977, focuses specifically on marine mammals, and provides a detailed list of the networks that can be contacted to report a sighting (Save The Whales, 2013). The Sea Turtle Stranding and Salvage Network (STSSN) is a nationwide network begun in 1980 that includes federal, state, and private partners and exists specifically to monitor sea turtles. They document and record sea turtle stranding data from an eighteen state region from Maine to the Gulf of Mexico (NOAA, 2012). The Coastal Observation and Seabird Survey Team (COASST) program is run by the University of Washington,

and is a citizen science project that monitors sea bird populations in the Pacific Northwest (COASST, n.d.). Oregon has its own marine mammal stranding network, run by the Oregon Marine Mammal Institute (Marine Mammal Institute, n.d.-b).

However, these networks focus primarily on what have been termed "charismatic megafauna," well-known species that are fairly popular with the general public, that are protected through the Marine Mammal Act and the Endangered Species Act (Rice, 2013). Yet these are not the only creatures that wash ashore. Beachgoers will often find many other organisms like fish, jellies, seaweeds, as well as inanimate materials. Thus far we have been unable to find a network in Oregon, or nationally to report some of these other stranded marine animals, namely fish, cephalopods, and reptiles. As previously mentioned, networks do exist to report stranded sea turtles, however these networks are not complete nationally. There are no STSSN coordinators for the west coast on the United States, for example, even though turtles have been found stranded all along the coast, even as far north as Alaska (AP, 1996). Many marine mammal networks also take calls for sea turtles, however this information is not widely publicized. Because of their publicity, many people know sea turtles are endangered, but on the US West Coast particularly members of the general public are not necessarily aware of whom to call in a timely manner.

When a stranded fish, squid or turtle is found in Oregon, calls are frequently placed to the Marine Mammal Stranding Network, the Oregon Coast Aquarium, or various persons at the Hatfield Marine Science Center (Hanshumaker, 2011). There is not a single publicized location or person to contact for stranded fish and squid, although the

Oregon Marine Mammal Stranding Network works with the Oregon State Police to respond to sea turtle strandings. In addition, the specifics of the information provided by the public are generally unreliable. Yet the general public is an invaluable resource for monitoring and reporting animal strandings of all types. A clear, easy to understand, easily accessible guide is needed to allow the public to become full participants in the marine research surrounding animal strandings (further discussed in section 1.3.1).

1.1.2 Strandings in Oregon

The Oregon coast is roughly 360 miles long, with many beaches, bays and inlets, and has seen many strandings throughout its history. Mammals, birds, fish, squid, and many other creatures wash up along the coast. There are several reasons an animal may wash up along the coast. Creatures have been found dead and alive, injured or whole, entangled or free. Often the reason for a stranding is unclear without a necropsy (Hanshumaker, 2011), and even then a definitive answer cannot always be reached (Chaloupka, Work, Balazs, Murakawa, & Morris, 2008). Sometimes species that wash up were by-catch from commercial fishing actions. They get tossed overboard and are brought in by the tides. Animals can also get entangled in trash and become injured or killed, and then they wash ashore. Some strandings are the result of critical periods during the life history of some animals, such as juvenile mortalities, spawning, and old age. During times of downwelling, such as the Oregon coast experiences during winter

months, prevailing currents push water towards the shore. This also pushes floating animal carcasses, or sick/injured animals unable to fight the current, on to the shore.

The currents can also bring in animals that normally are not found along the Oregon coast. For example, most sea turtles are rarely found in the colder waters of the Northern Pacific. No sea turtle species nests on the northern west coast of the United States (Sea Turtle Conservancy, 2011b). Many turtles have long migration paths, however, and will travel long distances in search of food, which can take them into our waters. Leatherbacks have the widest distribution of any sea turtle, and have been seen on the Pacific Northwest coast feeding on jellyfish (NOAA & NMFS, 2010; Sea Turtle Conservancy, 2011c). Leatherbacks can regulate their temperatures, and so can withstand the colder northern waters (Bostrom & Jones, 2007). Loggerheads have also been seen in Northern Pacific waters, even as far north as Alaska's Gulf Coast, albeit rarely (Game, 2013), even though the only known nesting sites for loggerheads in the Pacific Ocean are in Japan and Australia (Bowen et al., 1995). However, even these species cannot withstand the lower temperatures in the Northern Pacific. A sea turtle that fails to move into warmer waters before water temperatures fall, or becomes caught in a cold current, can be susceptible to cold-stunning. Cold-stunned sea turtles are in a state of hypothermia, become lethargic, and often strand on the coast (Anderson, Harms, Stringer, & Cluse, 2011).

Although animals of all shapes and sizes have been found, there are certain species that are more frequently found on the beach, whether stranded or not. Three major types of marine mammals can be found in the Pacific Northwest, represented by

certain species: cetaceans (whales, porpoises, and dolphins), sea otters, and pinnipeds (seals and sea lions) (Marine Mammal Institute, n.d.-a). Not all of the members of these groups will show up on the beach, however. Only a few strand with relative regularity. Sometimes some species will show up on the beach but are not stranded, merely resting, which is why it is important to educate the public about which animals are likely stranded, and which are on the beach for another reason. Pacific harbor seals (*Phoca vitulina richardi*), for example, will rest on the beach, particularly as pups waiting for their mothers to return. Steller sea lions (*Eumetopias jubatus*) also will frequently haul out onto rocky areas, jetties, and buoys, although they will strand sporadically along beaches throughout the course of the year (Marine Mammal Institute, n.d.-a; Rice, 2013). Northern elephant seal (*Mirounga angustirostris*) juveniles are often seen on Oregon beaches, and many times appear to be in distress, with weepy eyes, irregular breathing, and other symptoms. In most situations, they are going through a natural molting process, and are rarely stranded (Marine Mammal Institute, n.d.-a). In contrast, California sea lion (*Zalophus californianus)* individuals are often stranded when they show up on the beach during fall and spring, due to diseases and stress from long migrations, although sometimes they are just resting. Any time a cetacean is seen on the beach, out of the water, it is stranded. Those animals are not adapted for life out of the water. Two common cetacean strandings in Oregon are the harbor porpoise (*Phocoena phocoena*) and the grey whale (*Eschrichtius robsutus*) (Marine Mammal Institute, n.d.-a). Both of these animals are routinely seen near the shore at certain times of the year (Marine Mammal Institute, n.d.-a), which can make stranding happen more frequently, although

grey whales often forage near the shore in relatively shallow waters, and are often erroneously reported to be in the process of stranding.

COASST monitors bird populations on the US west coast from Alaska to California. They have a list of over 100 different bird species that have been found beached over the years. However, most of the strandings are accounted for by a small number of species (COASST, 2013). Examining their lists it is evident that while a couple species change year-by-year, in general the same species account for a majority of beached birds along the US west coast. The common murre (*Uria aalge*) and the northern fulmar (*Fulmaris glacialis*) are usually at the top of this list. Other frequently beached bird species include the rhinoceros auklet (*Cerorhinca monocerata*), glaucous-winged gull (*Larus glaucescens*), Brandt's cormorant (*Phalacrocorax penicillatus*), pelagic cormorant (*Phalacrocorax pelagicus*), and the western grebe (*Aechmophorus occidentalis*) (COASST, 2013).

The primary species of fish, cephalopod, and sea turtle that strand on Oregon beaches are: salmon shark (*Lamna ditropis*), long nose lancetfish (*Alepisaurus ferox*), ocean sunfish (*Mola mola*), rooster fish (*Nematistius pectoralis*), Humboldt squid (*Dosidicus gigas*), clubhook squid (*Moroteuthis robusta*), leatherback sea turtle (*Dermochelys coriacea*), olive ridley sea turtle (*Lepidochelys olivacea*), green sea turtle (*Chelonia mydas*), and the loggerhead sea turtle (*Caretta caretta)* (Hanshumaker, 2011). Because these are the most common and regular strandings for which no network exists, these species are the focus of the protocol. It should be noted that although seven extant

sea turtle species exist, only the four mentioned in our species of interest have been reported as stranding on the Oregon Coast (Bowlby, Green, & Bonnell, 1994).

1.1.3 Project overview

The purpose of this project was to create an opportunity for tourist or resident beachcombers to participate in an ongoing and necessary marine research project. Throughout this report it will be explained how a protocol that enables "citizen scientists" to identify washed-up or stranded marine turtles, fish, and cephalopods along the coast was designed and evaluated. This protocol created a central location in which users could access information to identify species, know what information to record, and where to report it. The Oregon Coast was used as a proof-of-concept of the efficacy, usability and adaptability of the protocol. In addition to a paper version of the protocol, a smartphone application was also created, containing the same information. In order to store and analyze both information and future information garnered to be through the use of this protocol, a database was also created, hosted through the service provider GoDaddy.com, along with a website, www.beachedmarinecritters.org.

In the protocol species names, pictures, and descriptions of identifying characteristics are provided. There are also descriptions of how the targeted species differ from similar and often confused species. The protocol is designed to allow the finder to identify the species and includes instructions on what to do with the animal, the information to be collected, and where, how, and to whom to report that information.

Specifically, crucial information includes the location along the coast the animal was found, identifying longitude and latitude if possible, as well as key landmarks, the time of day, any injuries evident on the animal, if the animal is entangled and if so, what material it is entangled in, and if it is dead or alive. The smartphone application version of the protocol is designed to allow the same level of identification accuracy, reporting accuracy and reliability, and data will automatically be uploaded to the database. Both the English and Spanish versions follow the same format and contain the same information.

The protocol is designed to be adaptive in both languages and formats, so that species may be added or removed as needed, and so it can be used in different locations (i.e. the protocol could be modified to identify animals on the Florida Coast). The protocol was created to become an example for other areas to use in developing their own site-specific protocols, or as a tool that regions could adapt to their specific needs. Both the document and the app are designed to allow for ease of updating and altering.

When designing and creating this protocol several long term goals and benefits were kept in mind, which will be discussed further in section 1.3. Ultimately, this is meant to be more than a graduate project; it is meant to be a long-lasting project, to gather data and promote community participation in marine science. The data collected through user participation in this project has the potential to be used in research in a number of areas, including climate change science, population studies, and building predictive models of stranding patterns.

1.2 Project Goals and Objectives

The goals for this project were divided into primary and secondary objectives, as well as personal goals. Primary objectives were those deemed critical to accomplish in order for the project to be useful after the end of the graduate project. Since the project had long-term use potential but was being created and designed within the finite time frame of work toward master's degree, the primary objectives represented minimum accomplishments necessary, to allow for future use of the project.

Secondary objectives were those not necessary for continued functioning of the project, but would enhance its effectiveness with the public. These objectives were considered useful and would be beneficial to have, but were not critical to ensure maintenance of the protocol after the end of the graduate project. When designing these objectives it was also taken into consideration that the project would likely continue to have development, either by the graduate student or the PI, Dr. Hanshumaker, after completion of the graduate project. As such, some of the secondary objectives were identified as goals for the future that could not reasonably be accomplished within the scope of work of the master's project, while others were goals that the student would complete if possible.

Personal objectives were those specifically for the graduate student. They were goals about skills to master or information to collect that would aid the student in her career as a scientist. These goals were not necessary for the creation of the protocol, but were sought after as important tools that would benefit the student in the future.

1.2.1 Primary Objectives

A total of four primary objectives were identified to allow for a useful and sustainable protocol:

1. Create a protocol that would allow users to identify the stranded marine animals they encountered on the beach. This protocol needed to have clear and accurate information to aid in identification, as well as some means of recording and reporting that information. The protocol was to be created in both English and Spanish and available as a free document for users. The protocol was also created so as to foster community involvement in marine science, by being an easy to use entry into marine research.

2. Perform a preliminary summative evaluation of the protocol once finalized, to evaluate users' ability to identify species correctly and report accurate information.

3. Build a database for past data that have been collected, as well as for future data collected with the protocol. The database, at the minimum, needs to be functional in English to the point where a user can log in, and query for and download specific data, which they can then use for their own comparison purposes.

4. Create an application for at least one of the two major smartphone platforms, iOS or Android containing the same information and identification capabilities of the physical protocol document. The app is also in English and Spanish, and free to the public.

1.2.2 Secondary Objectives

A total of four secondary objectives were identified as well. All of these were deemed noncritical for the protocol to be an effective citizen science project, however, every effort was made to complete these secondary goals. Of the following, goals one and two were able to be accomplished during the course of the graduate project:

1. Design and create a functional website with information for the public as well as a way to retrieve the protocol documents and the smartphone application.

2. Create a portal on the website for the database, to allow users to access the database and download files using the website as the interface.

3. Create a GIS interface with the database, hosted on the website, to allow for visual representation of stranding locations, times, and animals. This interface would be accessible to the general public.

4. Connect the smartphone application directly to the database such that submissions are automatically uploaded and formatted properly for database entry. These submissions would be placed in a "holding pattern" until the gatekeeper, the person managing the data within the database, confirmed species identification and approved the entry.

1.2.3 Personal Objectives

Three personal objectives were identified. These three goals were ones deemed important to achieve in order for the graduate student to gain the maximum benefit from her time creating this project.

1. Gain key social science research skills through the development of this protocol: Use formative evaluation and focus groups in the development process, and perform a preliminary summative evaluation of the finalized protocol.

2. Gain skills in communicating research to other members of the community, both scientists and non-experts.
3. Become proficient in the creation of websites and communicating scientific information to the general public via the Internet.

1.3 Project Significance and Benefits

Although created as a graduate project, the protocol was designed with the expectation that it would be long lasting and relatively permanent, continuing well after the student had graduated. As such, its significance and potential benefits are greatly increased than if it was meant to serve simply as an example of a protocol that could be implemented. Several main benefits and significances are discussed below.

1.3.1 Improved marine research

One major area that will be improved through widespread use of this protocol is that of research into marine strandings. With such complex and ever changing geography due to erosion and other oceanographic properties (Allan, Komar, & Priest, 2003; Shih, 1992), it is simply not feasible, both logistically and economically, for the relatively small group of university, governmental, and research employees to survey the entire Oregon coast with any consistency. Through the use of this protocol, the community of residents and tourists who walk along the beach can significantly increase data collection.

Increased data collection will help significantly with future research. Any research done with the data collected thus far on marine fish and cephalopod strandings along the Oregon coast is subject to a large sample bias. Although a dataset exists that extends back twenty years, analysis of it would suggest that strandings have increased over the past two decades. In reality, beachgoers and organizations such as the Oregon

State Police have become aware that Dr. William Hanshumaker at the Hatfield Marine Science Center wants the data on marine strandings. As a result, calls to him have increased dramatically from earlier years (Hanshumaker, 2011). Widespread distribution and use of this protocol can help significantly reduce this sample bias by increasing the number and accuracy of reports. Within a few years a true baseline can be established.

Additionally, for many species, it is unclear why they strand on the beach. They wash up both dead and alive, and the cause of stranding is often unknown, even if a necropsy is able to be performed on the animal (Hanshumaker, 2011). Perhaps there are patterns that exist in when and where animals strand, or which species strand. Without a robust dataset kept in a single location, it is impossible to identify these patterns. The protocol asks users to report if the animal has any obvious injuries, or appears entangled, and to send in photographs, providing further data that can be analyzed to determine the cause of strandings, for example if fishing gear shows up on most animals along a certain stretch of coastline. Comparing the reported sightings of stranded animals to seasonal variables such as wind direction and sea surface temperature could also lead to a predictive model of when and where a stranding will next occur. This benefit is not restricted to the data collected through the use of this protocol; other stranding networks with good datasets can perform similar analyses, on their own or in conjunction with researchers in other areas.

The research can further be used to help researchers better understand the species in question. For example, researchers studying salmon sharks and lancetfish may be able to piece together currently unknown information on the habits of individuals of a

particular age. By analyzing the data on where and when animals strand, as well as any data that can be recovered from a necropsy of the animal, it is possible to discover new information about migration paths or behaviors of organisms in specific age classes.

The data garnered from this protocol has implications beyond discovering local patterns and models. The coastline is not an isolated system, but rather connected to the global oceans. All data collected for local use can be applied to wider, even global processes, particularly if joined with other areas of research. Patterns in species and stranding locations can inform scientists about coastal and ocean wide current patterns. Patterns, or changes in patterns, in the age classes of stranded animals might lead to a better understanding of the population dynamics of that species and those it affects. For example, Humboldt squid historically do not range as far north as the Oregon Coast (Nigmatullin, Nesis, & Arkhipkin, 2001). However, they have been appearing more frequently along our coast (Zeidberg & Robison, 2007), with initial sightings beginning in 1997, and generally increasing since then (Chesney, 2012), which may indicate a change in seasonal migration patterns, or even a shift in the range of the species. Changes in observed patterns, frequencies, or species, can be indicators of a major process like global climate change (Cleland et al., 2012; Hellmann, Byers, Bierwagen, & Dukes, 2008; Pociecha, 2011; Vickery, 2008). However, without a robust dataset only limited analysis can be performed.

1.3.2 Protecting endangered species

While some of the project species of interest are not yet threatened or listed, others, such as the sea turtles, are endangered (NOAA, 2012, 2013). For all these species it is important to determine what factors may be influencing their stranding behaviors. For some species, if they begin stranding in greater numbers, in addition to other pressures such as over-fishing, it is possible that their populations could be reduced by a significant amount.

This protocol would be particularly useful for time-sensitive species like sea turtles. These animals have the ability to survive outside of the water for an extended period of time, unlike fish and squid, but will die if no help reaches them in time. Often these animals are still alive when they wash up on shore (Hanshumaker, 2011). As with mammals and birds, efforts are made to rehabilitate and reintroduce the sea turtles to the wild. However, this is only successful when the turtle is retrieved relatively quickly, before it has spent too much time in a hypothermic state (Anderson et al., 2011), where it is not only vulnerable to death from the cold, but also to avian and terrestrial predators or scavengers. With the widespread distribution of the protocol, it will greatly increase the number of people who know what to do when they see a turtle. Timely reporting would enable the appropriate response, possibly saving individuals of an endangered species.

In addition, as the climate changes we could begin seeing new species appear on the shores (Chesney, 2012; Zeidberg & Robison, 2007), some of which could be

endangered (Lambert et al., 2011; MacLeod, 2009). As new species appear they will be added to the protocol.

1.3.3 Increased collaboration and cooperation, and unified networks

The protocol provides a means to indirectly lead to increased cooperation between researchers, coastal organizations, and stranding networks. Information garnered through the use of this protocol will be uploaded to a database and made available to scientists. This will allow researchers to have access to larger, more robust datasets to draw from for analysis. As a result, new patterns and results might emerge that would not have with a smaller dataset, possibly lending greater validity to the researcher's results. The database is not limited to data collected through the use of the protocol; it is intended to be a database for many researchers. As well as being able to download data, researchers will be able to provide data to this database to share with others. This process has already begun; Aaron Carlisle, at Stanford University, has both received salmon shark stranding data from Dr. Hanshumaker, and provided his own data for the database.

The protocol is designed to be adaptable to many different areas, allowing for other states, or even other stranding networks to adapt it to better fit their needs. This will allow further compilation of data from around the nation and the creation of a nationwide view of processes, providing better understanding of marine cycles and connections. If data are compiled nationwide, it will also require the various organizations to collaborate, to avoid data replication and to ensure that the data are useful to a wide range of users.

There is also potential to use this protocol as a preliminary step to combining all networks and creating a single nationwide network for all animal strandings. Information for all stranded animals could be collected in one centralized location, enabling ease of access and analysis. While this would require a great deal of effort and commitment nationwide, and is unlikely in the near future, small steps like the creation of this user-friendly protocol could lead to the accomplishment of these larger goals.

1.3.4 Community involvement in marine research

Arguably the most important and significant benefit of this project is that it allows the community to be involved in and connected to the process of marine research. Citizen science is rapidly becoming a common tool both for data collection, and public education (Adams, 2012; Azzurro, Broglio, Maynou, & Bariche, 2013; "Citizen science," 2010; "'Citizen science' helps bird welfare," 2010; Clary, Wandersee, Guyton, & Williams, 2012; Dohrenwend, 2012; Gallo & Waitt, 2011; Green & Medina-Jerez, 2012; Hand, 2010; Henderson, 2012; Koss et al., 2009; Mayer, 2010; Schnoor, 2007; Scripa & Moorefield-Lang, 2013; Silvertown, 2009), and has in fact been in use for decades (Schnoor, 2007; Silvertown, 2009). Connecting the public to marine research was a major driver behind many of the design decisions for this protocol. Since the protocol was created in both English and Spanish, it also allowed for a greater proportion of the community to be involved in the project. The creation of the website allows for greater access to both the information in the protocol and the protocol itself (Wellman, Haase,

Witte, & Hampton, 2001). Because it is critical to reach as broad a user base as possible, it was important that we did not limit the finished product to either a paper document or a smartphone app, but created both. The entire project was designed to allow for ease of use by many different people, in the hopes that it would increase public participation in marine research.

Although many areas of research and policy-making require advanced training, there are other methods including the use of tools like this protocol, in which the public can become involved in research (Dohrenwend, 2012; Gallo & Waitt, 2011; Mayer, 2010; Scripa & Moorefield-Lang, 2013). The concept of connections is a broad and important aspect of Ecosystem-Based Management (EBM) (Leslie & McLeod, 2009), one of the recent forerunners in marine management (Espinosa-Romero, Chan, McDaniels, & Dalmer, 2011), and understanding of concepts is often improved by "doing" rather than simply being told about them. Comprehending the connections between places, people, animals, and the inanimate environment is critical to creating effective and meaningful management policies (Stern, 2008; Viteri & Chavez, 2007). As such, any opportunity in which the public can safely be included in marine research should be embraced whole-heartedly. Certain situations are clearly inappropriate for citizen science projects. For example, too much training is involved with handling dangerous marine debris, or dealing with marine mammal disease research. However, a multitude of research projects exist for which portions can be adapted to utilize the public as a data collection tool and provide an entrance into marine research (Azzurro et al., 2013; Koss et al., 2009; Schnoor, 2007; Scripa & Moorefield-Lang, 2013).

Ultimately, this project will produce data that can also be accessed by the general public, via a website or other interface, so the public and scientists alike may examine the data and identify patterns. The data collected will be used for actual research, as well; Dr. Hanshumaker intends to analyze the data and compare it to sea surface temperatures, wind direction, and other factors, in an attempt to identify patterns and perhaps, with enough data, build predictive models. Because the data are not merely being collected as a feel-good activity for the public, it is hoped that this will foster feelings of ownership of the research ("Citizen science," 2010). Feelings of ownership help foster feelings of legitimacy about practices and policies, which encourage participation and compliance with those policies (Kessler, 2004; Stern, 2008; Viteri & Chavez, 2007). Through the use of this simple protocol, users may begin to feel a connection to the research and the results produced from it. If any policies come into being because of the research accomplished as a result of the protocol, it is possible users will feel connected to those policies as well, and will feel the need to embrace their role as stakeholders in the marine policy-making process.

The fact that this protocol is multilingual is also important (Clabots & Dolphin, 1992; Ofulue, 2011). English is not the only language spoken along the Oregon Coast, and to limit the protocol to English would remove a large pool of potential users. Approximately 15% of the people in Oregon speak a language other than English at home (U.S. Census Bureau, 2013), and 11.7% of the state population identifies as Hispanic or Latino (U.S. Census Bureau, 2010). Each of the counties along the coast has a small but

not insignificant portion of the population that speaks a language other than English at home (Table 1).

Table 1. Percent of population that speaks a language other than English at home for each coastal county in Oregon (U.S. Census Bureau, 2013).

County	% Population
Clatsop	7.5
Tillamook	6.6
Lincoln	6.6
Lane	9.7
Douglas	3.8
Coos	4.9
Curry	4.6

By translating the protocol to Spanish not only are we increasing our pool of data collectors, we are also incorporating a traditionally underrepresented community into marine science and marine research. This benefit is twofold. Often minority communities are poorly represented in the sciences in general within the United States (National Research Council, 2011; National Science Foundation, 2011). This protocol offers another opportunity for minorities to get involved in marine science. This will be particularly true when it is translated into more languages in the future, such as French, German or Russian, for example. In addition to giving this opportunity to minorities, it also introduces new cultures and ideas into the field of marine science and marine research. There are many ways of looking at the world and the various systems and processes within it, a fact which has gained increasing recognition and support in science

education (Brown & Abell, 2007; Chinn, 2012; O. Lee, Luykx, Buxton, & Shaver, 2007; Pollnac et al., 2010; van Eijck & Roth, 2011). To limit research to a single cultural view is a disservice to science.

Another important aspect of this protocol that will allow for increased community participation is the fact that it is free. The protocol is available as a free download from the website, the smartphone app is free, and when workshops are held in the future, such as the ones the graduate student plans to conduct in conjunction with CoastWatch, free copies will be available for participants. Similar to being multilingual, being free allows for economically disadvantaged community members to participate in marine research. For a family trying to save money even $5 on a field guide may seem a frivolous expense, but they might pick one up if one were available at the beach, or a visitor's center, if they went. Although currently the protocols are not available in these locations, it is hoped that in the future a means can be found to provide hard copies at a variety of locations. Coastal organizations may also download and print copies of the protocols themselves for distribution, if they desire. Additionally, cheap is not the same as free, and people are likely more willing to try something new or participate if it does not cost them anything (Evans & Reimer, 2009; "GAO: free lunch, breakfast increases student participation," 2009). This is why the smartphone app is free as well as the hard copy of the protocol.

This protocol provides an important gateway for promoting marine science literacy. As an attendee at one of the project presentations said, he would have a hard time convincing his son to go for a walk on the beach, but if he suggested they go look

for dead stuff his son would be very enthusiastic. This could be a springboard for children or adults, people of all ages, to become involved in marine science (Green & Medina-Jerez, 2012; Scripa & Moorefield-Lang, 2013). The protocol could be altered or adapted to work with a pre-existing curriculum, or specific workshops could be designed as informal education opportunities. Perhaps a user will discover their passion for marine science, or merely feel a small bit of happiness at contributing to marine research. Whatever the outcome, they are getting involved in marine science.

PART 2 - PROTOCOL DEVELOPMENT

2.1 - Literature review

The way in which people learn, process, and utilize information is a major area of research, and there is a large and diverse body of literature on the subject and associated areas (Bransford, 2000; Dirksen, 2012; Glaze, 1999; McWilliam, 2008; Oliver & Carr, 2009; Rieskamp & Otto, 2006; Salmoni & Gonzales, 2008; Simonson, 2012). As such, there is a good amount of research addressing to taxonomy and the methods of identifying species, and the development and use of field guides and identification keys, and teaching students and the general public how to identify organisms and use these guides (Bicknell, Fraser, Sickler, & Taylor, 2009; Corbett et al., 2005; Edwards & Morse, 1995; Gaston & O'Neill, 2004; Hagedorn, Rambold, & Martellos, 2010; Killermann, 1998; Ohkawa, 2000; Randler & Zehender, 2006; Scharf, 2009; Somaweera, Somaweera, & Shine, 2010; Stevenson, Haber, & Morris, 2003). The results of these studies have been utilized for many educational purposes, such as the development of teaching projects and schemes for biology students (Gobalet, 2003; Ohkawa, 2000; Randler & Zehender, 2006; Watson & Miller, 2009), and provide useful information for both formal and informal educators. However, surprisingly little literature exists about the effectiveness of different types of interpretation formats and the ability of persons to use them for accurate species identification, particularly when being used by the average person in a public setting.

Accurate species identification can be a difficult activity to perform with consistency, even for professionals in a controlled laboratory setting. Many species, known as cryptic species, are so morphologically similar that positive species identification can only be made by performing genetic analysis, and in many cases these species were only identified recently (Hebert, Penton, Burns, Janzen, & Hallwachs, 2004; Smit & Van der Bank, 2001; Trontelj & Fišer, 2009). Even if that is not the case, many closely related species are morphologically similar enough that it can be difficult for the layperson to distinguish differences. Regardless of these difficulties, organism identification in general can be difficult simply because of a declining task force of skilled taxonomists (Gaston & O'Neill, 2004; Godfray, 2002; Stevenson et al., 2003). It has been noted that in some instances, data were not collected as thoroughly as possible because the researchers were doing "routine identifications" of organisms already classified, rather than being able to identify novel species (Gaston & O'Neill, 2004). Similarly, there is not a large enough cohort of persons who can identify our species of interest to cover the entire Oregon Coast with any regularity. However, it is becoming increasingly viable to bring in non-experts, educate them, and utilize their abilities, thanks to new advancements in technology, and an increased ability to widely share information (Stevenson et al., 2003). It was hoped that the design phase of the protocol could capitalize on these advancements.

While the use of non-experts can provide a much needed influx of identifiers, there are several problems that can arise. One of the biggest problems is with consistency in species identifications, which are not always widely accepted and recognized. There

are often many different names for species, resulting from being described by various persons over the years. The most popular common name may not be the "type description," the original description of the species (Gaston & O'Neill, 2004; N. Wilson, 1994). This particular problem was especially of concern when it came to creating an ID page for the robust clubhook squid. The current scientific name, *Moroteuthis robusta*, replaced the previous name of *Onykia robusta*, but both are still used. This species also has several common names, including the North Pacific giant squid, or the clubhook squid. This can become a major source of confusion when attempting to develop identification guides if not addressed properly.

There are many formats available for species identification guides. These include dichotomous keys, polytomous keys, multi-access keys, multi-entry keys (Hagedorn et al., 2010), synoptic keys (Ohkawa, 2000) and field guides. These formats vary in complexity and the intended audience; some formats are more suited for use by experts, whereas others are more acceptable for use by the general public. Multi-access, multi-entry, and synoptic keys are more complex than was deemed necessary for the purposes of the project, and so will not be discussed here, but they are explained in greater depth by Hagedorn et al. (2010), Hagedorn (2007), and Ohkawa (2000).

2.1.1 Single-access keys

Dichotomous keys and polytomous keys are both considered a single-access key. This type of key guides the reader through a set of predetermined steps by presenting a

variety of leads, or statements, about the characteristic they are evaluating, from which the reader selects the most appropriate one (Hagedorn et al., 2010; Ohkawa, 2000). For example, a key could have the reader answer the question "What shape are the fins of the squid?," with the leads being "Arrowhead" or "Diamond." Together the leads, or the "answers," for a specific characteristic form the couplet (Hagedorn et al., 2010). In general, a couplet will describe only one characteristic. In the event of characteristics with a great deal of natural variability, however, Boolean statements can be used as leads. A Boolean statement involves multiple characters and words such as "and," and "or," to represent the possible forms of the characteristic in question. In the squid example, this could be a lead such as "Fins are arrowhead-shaped, or long and narrow." This indicates that there are different forms of the fins of that squid species, and a reader might encounter either (Hagedorn, 2007). However, Boolean statements can make the lead seem very complex and riddle-like, and it is generally not advised to use them if possible (Hagedorn et al., 2010).

A dichotomous key, as indicated by the name, provides only two possible leads for each characteristic, where a polytomous key provides more than two (Hagedorn, 2007). Thus, a dichotomous key is a special kind of polytomous key. Regardless of whether a key is dichotomous or polytomous, it can be constructed in two primary formats. The first is when the couplet takes the form of a question, for which the leads are the answers. Choosing one of the leads will direct the user to a different portion of the key for further identification steps. In the squid example, selecting "Arrowhead" as the fin shape will send the reader to step 5, perhaps, while selecting "Diamond" will have

them continue on to step 3. In this format, each specimen is keyed out once, and there is one path to get to it. The second option, the lead style, asks an implicit question, by presenting the couplet as a statement, which needs to be evaluated as true or false. The lead style is more useful than the question style when multiple characteristics are used in a single statement (Hagedorn, 2007).

2.2.2 Field guides

Field guides are one of the more common means of identifying organisms. A field guide is essentially an assemblage of species, and can be in the form of a book, a pamphlet, a single sheet of paper, or many others, depending on the number of specimens and the intended audience. When using a field guide species identification is made primarily by visually comparing a specimen with a photograph or some other image. These images can also be accompanied by a written description and/or identifying characteristics (see Appendix A, Figures 12-16 for examples of various field guide formats).

Modern field guides were created specifically for use by the general public, to replace the more technical identification keys that existed at the time (Stevenson et al., 2003). Field guides are designed to be used by both amateurs and professionals, however (Scharf, 2009). Originally, there were many similarities between field guides and keys, requiring users to follow a series of steps to narrow down their organism. In the case of organisms that were rarely stationary, such as birds, a dead specimen was necessary in

order to identify it (Scharf, 2009). Ornithology and the popularity of bird watching led the way to field guides that resemble modern ones, containing larger, more, and better quality illustrations and doing away with the keys. This enabled users to identify birds from a distance, through binoculars, without needing a dead specimen (Scharf, 2009). Although the intended users of this protocol will not be identifying mobile organisms, and many specimens encountered will in fact be dead, the modern field guide format is more user-friendly than a dichotomous key, particularly to the layperson.

Most field guides will include enough information, along with an image, to aid in identifying the organism of interest. However, there is no standardized method of designing a field guide (Appendix A, Figures 11-14), and written entries accompanying images can range from one or two sentences about key characteristics, to pages of information about the organism, its characteristics, its life history, conservation information and more. The images in field guides can also take many different forms. Some are high-resolution color photographs, some are simple black and white outlines, showing a representative image of the organism, and some images are color drawings. Different field guides will also handle identification of key features differently, either by providing a blown up image for detail, or simply describing the feature in text. Although no studies comparing the accuracy of species identification by the general public by different image styles were able to be located, anecdotal evidence suggests black and white line drawings allow the greatest ability to identify organisms, as they can show a representative species member with all observed morphological characteristics and

variations without taking up a great deal of space (E. Jensen, personal communication, February 3, 2012).

2.2.3 Dichotomous keys versus field guides

Which format of identification guide a person will use depends greatly on who is doing the identifying, the group of species being identified, location of use, and factors such as cost of the guide, size and transportability, ease of use, etcetera. The most likely people to utilize a dichotomous key for identification purposes are experts in the field, namely biologists, ecologists, and those in similar professions. Some researchers have even considered dichotomous keys inappropriate for use by the general public, because they can be complicated for the uninitiated to use (Hagedorn et al., 2010; Stevenson et al., 2003).

However, researchers should not underestimate the ability of the general public to utilize these more complex methods simply because they are less common outside of research circles. While little research has been done comparing the use of field guides versus a dichotomous key, there are some data to suggest that neither method is more effective than the other. When both methods are used correctly, it has been documented that school children posses the ability to understand and effectively use dichotomous keys, and there is no difference in identification accuracy of reptiles (Randler & Zehender, 2006). There are also several lesson plans available for practicing using dichotomous keys in biology classes (Gobalet, 2003; Watson & Miller, 2009). In fact,

using dichotomous keys has been shown to enable students to develop critical skills in organizing, comparing and contrasting, and analyzing information (Watson & Miller, 2009), as well as providing an understanding of some scientific terminology (Randler & Zehender, 2006).

Despite these successes with keys, field guides are easier for the general public to use, as they rely on a simple image comparison to make an initial identification. However, field guides do contain some notable limitations that are absent in dichotomous keys. For example, they generally rely on a single image, or a few images, of a species, meant to be a representative member. Often members of the same species can exhibit a wide array of morphological differences, and these images cannot properly display that variation, which can lead to misidentification (N. Wilson, 1994). The portability and affordability of field guides is also a concern, and has been since their creation (Scharf, 2009). Because the usability of field guides depends on the quality and variety of pictures, detailed pictures are generally needed of all the known organisms of interest in the region, category, or group. This can lead to cumbersome, bulky books that are not suitable for someone to take on a day trip. A large field guide would not be appropriate for the average beachgoer, for example, to take on a pleasure trip to the coast. Thus, field guide publishers, and other organizations trying to create some kind of guide, must weigh the trade-offs between illustration quality and quantity, how much intra-species variation to show, the amount of written information accompanying images, and much more (Stevenson et al., 2003).

2.2 - Methodology

When designing the protocol a variety of different resources were investigated and considered. As was discussed in the previous section, there are many types of identification guides. Multiple sources and examples were utilized and combined in the creation of the protocol. During protocol creation we were specifically interested in looking at both dichotomous keys and a field guide-like format.. Protocol development took place in three primary steps: the initial development of the format, focus group testing of the format and information, and the finalization and distribution of the protocol.

2.2.1 - Development of the format

While a dichotomous key can lead to more detailed information retention and is a straightforward method of species identification, it was ultimately decided it was not appropriate for use in identifying most of the species of interest. Specifically, there is neither a wide enough variety in the species of fish and squid of interest, nor a large amount of similarity in species morphology, to justify using a dichotomous key, when simple comparison identification of an image will suffice. Squid identification might present some difficulty because of similarities in overall body structures, however there are some distinct morphological characteristics to allow for identification. In addition, despite the findings that children can effectively use a dichotomous key (Randler & Zehender, 2006), this was only after some brief instruction on how to use said key. While

trainings are potentially a future use for this protocol, the target audience of the general public is not going to be trained at every location where protocol distribution happens, nor when they download it from the website. Thus, it was decided that for the fish and squid, at least, image and specimen comparison was more appropriate.

Turtles represent a slightly different problem when it comes to identification. Most often turtle identification is made using the shape, number, and color of their scutes, the plates that make up their carapace. These features can be difficult to visualize with a photograph if it is not of high enough quality. Because many species of turtle can look similar in color and scute shape, it was considered that it might be easier to use a dichotomous key, rather than comparisons with an image, because the key is a systematic method of identification, ideal for turtle identification characteristics. In fact, a dichotomous key is already being used by some to help people identify sea turtles; the Sea Turtle Conservancy has an interactive online sea turtle identification program, available at http://www.conserveturtles.org/seaturtleinformation.php?page=species_id, which guides the user through identification steps similar to a dichotomous key (Sea Turtle Conservancy, 2011a). For this protocol, however, it was decided that it would be sufficient to maintain the picture comparison method of identification. Given that only four of the seven sea turtle extant species are likely to strand along the Oregon coast, and one of them, the leatherback, is already highly distinctive, it was determined that the similarity in turtle species was not significant enough to warrant the additional complication of including a dichotomous key and instructions on how to use it. In addition, it was decided that consistency in the method of identification would allow for a

more cohesive protocol, and provide less confusion for users. Although no published research has been done on this topic, results of a class project that acted as a pilot study confirm this supposition: when given both a photograph and a dichotomous key method of identifying species, there was no significant difference between the two methods (p-value > 0.05) (Asson, 2012, available from author).

It was also hoped that the design phase of the protocol could capitalize on the advancements that have been made in technology and information sharing (i.e. smartphone technology). The protocol benefited from the fact that our species of interest were not so similar as to need genetic analysis for positive identification. Indeed, only a couple species closely resembled the others in the protocol enough to make identification between those species difficult, but they still had noticeable morphological differences.

Given these considerations, the initial idea was to have the protocol follow the same general style as that of Oregon Sea Grant's publication "Flotsam, Jetsam, and Wrack (Osis, 2001)." In that publication the species or item name is given, along with pictures and identifying information. The project protocol also includes descriptions of how the species differ from similar and often confused species if necessary, although to avoid confusion it was decided to not include identifying pages for those species unless they too stranded along the coast. The point of the protocol design was to allow the finder to identify the species and to know what information to report to whom. Thus, instruction pages were also included at the beginning and end of the protocol on what to do with the animal, the information to be collected, and where, how, and to whom to report that information (Figures 17, 18 and 20, Appendix B). Specifically, crucial information

included the location along the coast the animal was found, identifying longitude and latitude if possible, as well as key landmarks, the time of day, any injuries evident on the animal, if the animal is entangled and if so, what material it is entangled in, and if it is dead or alive (Figures 21 and 22, Appendix B). A glossary of terms was included near the back of the protocol as well, to clarify scientific terms (Figure 20, Appendix B).

A major concern was what type of image to use for identification purposes, a black and white representative drawing or a high quality photograph. Ultimately, a combination of both drawings and photographs was selected. For the identification images it was determined that a line drawing would be preferable to a photograph. Since this protocol was designed for printing, there is limited space and thus limited room for multiple photographs showing morphological variation. In addition, the size of the photos would be limited, making it difficult to accurately depict some smaller features. A further consideration was that many species exhibit large variations in color and pattern, which, if a photograph is used for identification, can only be represented with a photograph of each variation. This is not space efficient. In contrast, a line drawing can depict a "representative" member of the species, with some or all of the morphological variations possible, as well as different angles of key features, in less space than trying to do the same with photographs (Jensen, 2012). However, a representative line drawing, while useful for highlighting identifying characteristics, does not depict what real specimens look like. To solve this problem a line drawing was used for identification purposes, accompanying photographs of example specimens were also provided, to give users a

visual of what real specimens could look like. Each image was also given a caption that explained what the photograph was showing (Figure 19, Appendix B).

When creating the reporting forms, the goal was to make them as easy and user-friendly as possible to fill out. Rather than have the user write in every piece of information, check boxes were used when it was possible. This was done both for ease of filling out the form, and to eliminate some variation in reported information. For example, some users might refer to rope as "rope," "ship rope," "fishing rope," or some other variation. To eliminate that possibility, a check box was provided for general categories, "rope," "fishing line," "net," and a category for other, if none of those options seem appropriate. Additionally, on the back of each form is the address to which users can report the information (Figures 21 and 22, Appendix B).

2.2.2 - Focus groups

During the development phase, "focus groups" were consulted to allow for formative evaluation of the protocol. Formative evaluations differ from summative in that they occur during the development of a project, to allow for alteration and improvement, rather than after project completion (Scriven, 1991). This method is often used for evaluating ongoing projects without a set end date, such as online courses (Stewart, Waight, Marcella, Norwood, & Ezell, 2004). Although at the end of the graduate project a brief summative evaluation was performed, which is presented in section 2.5, in truth

the protocol is always undergoing a formative evaluation, because it is meant to be adaptive and changeable as necessary.

Strictly speaking, actual focus groups were not used for the formative evaluation process. Focus groups are structured discussions with a relatively homogeneous group of individuals who have been selected for their expertise or other desirable trait in the study. They generally take place face-to-face, either physically or virtually, and have some form of guided discussion with a moderator (Liamputtong, 2011; V. Wilson, 2012). They are used to collect data about a group or situation, and those responses are analyzed to allow for some conclusion about the question of interest (Liamputtong, 2011; Morgan, 1996). The interaction among focus group members is a key part of this process, in that it allows for the discussion to become dynamic, highlighting different issues (Liamputtong, 2011; V. Wilson, 2012). During the process of protocol development, several of these key features were not met. The focus groups used for this project were not homogenous groups of experts, but groups of convenience, comprised of both "experts" and everyday people. In addition, no structured discussion with focus group members was held, either in person or virtually. The focus groups were not consulted to analyze their answers for patterns, or to answer a question. Rather, what are called focus groups in this document were groups of people whose opinions were wanted on the efficacy of the protocol. There was no study on their responses, because their responses were only useful in that they helped guide the development of the protocol, similar to asking friends or family to edit a paper or give suggestions on how to decorate a room. For this reason it was also unnecessary to receive Institutional Review Board (IRB) approval for the research, which

was confirmed by the IRB Office within Oregon State University's Office of Research Integrity; the focus groups did not meet the definitions of Research with Human Subjects. Their responses were used to guide the development of the protocol, but there was no analysis done on the responses (for example, preference of one format over another). For convenience however, these groups will continue to be referred to as focus groups for the remainder of this document.

Culture has been known to affect the outcome of evaluation groups such as focus groups (Billson, 2006; Brown & Abell, 2007; J.-J. Lee & Lee, 2009), and it is very important to consider culture and other group dynamics when utilizing an evaluation group (Toseland, Jones, & Gellis, 2004). It is also well known that culture influences how various user groups view and utilize communication and instructional tools (Brown & Abell, 2007; Hall, de Jong, & Steehouder, 2004). For this reason two focus groups were created, one whose primary language was English and another whose primary language was Spanish, to evaluate each version of the protocol and ensure its appropriateness for the target users. It was important that the evaluators of the Spanish protocol were native Spanish speakers, not merely English speakers who were fluent in Spanish. Growing up as a native Spanish speaker will shape your views on instructional materials and what formats are most effective, differently from a native English speaker (Hall et al., 2004). It is true that the Spanish-speaking community is not a homogeneous group, but rather a variety of cultures that share a common language. However, due to time constraints and feasibility, a focus group comprised of individuals from a variety of backgrounds was selected instead of multiple groups for each Spanish-speaking culture.

The English-speaking focus group was comprised of members of the group CoastWatch and other volunteers. Specifically desired were those involved in the CoastWatch Adopt-a-Mile program, as they would be the most likely users of this protocol. Volunteers were initially recruited at the Sharing the Coast conference, hosted by the Northwest Aquatic and Marine Educators (NAME), in March of 2012. Further volunteers were recruited from the Hatfield Marine Science Center volunteer pool, consisting of members of the community who frequently volunteered at the science center. Later volunteers were recruited as samples of convenience - friends and family from whom feedback was requested throughout the process. Because the focus groups were not being used as part of a study, there was no danger of results being biased. Rather, continually acquiring volunteers allowed us to see on a small scale how the general population might react to the protocol.

The Spanish-speaking focus group was primarily built of samples of convenience. Several former Spanish professors were asked for assistance, all of whom were born and grew up in Latin American countries, and were native Spanish speakers. Before providing the protocol it was translated it into Spanish, with some assistance from a fluent Spanish speaker. This was primarily to check for grammar, since the Spanish-speaking focus group's assistance was wanted to analyze the format, and not to worry about correcting the grammar. The fluent Spanish speaker also assisted in finding persons to evaluate the protocol, reaching out to several native Spanish speaking coworkers for assistance.

2.2.3 - Finalization

For both language versions, after an initial draft of the protocol had been completed, it was communicated via email to all volunteers, and feedback was requested. For the English version several volunteers responded with basic comments of "looks good," or along similar lines. Four volunteers responded with significant feedback about the information presented and offered suggestions on information to include, such as a glossary for scientific terms. A member who consults with clients on the best layout for their products, the founder of Vela Technologies, offered many suggestions on the overall layout, such as putting the basic information on the species at the top of the page, followed by the identification image and then the key features. He also offered suggestions on how to format the reporting page to make it clear what the various categories are. After making the suggested changes a draft was again sent out, asking for further suggestions. No one had any further suggestions, so after a final review the final version was declared, keeping in mind that the protocol can be modified at any time as needed.

Finalization of the Spanish version happened in a similar manner to the English version. Initially the protocol was translated into Spanish. It was then turned over to the fluent Spanish speaker to assist in correcting grammar and syntax errors. Once those corrections were complete, the protocol was given to our Spanish-speaking focus group. Several people were approached, but only three respondents were able to examine and provide feedback on the protocol. However, it was decided that this was sufficient, as

only four responses of significance were received from the English-speaking focus group. Additionally, since the protocol is meant to be adaptive, if further feedback is received in the future after distribution had been increased, about either language version, the protocol can easily be adapted as needed. Each of the Spanish-speaking respondents provided feedback primarily about grammar. They suggested more appropriate terms and words that better represented the concepts and implications present in the English version. No comments were given about the layout and format of the protocol. As a result of this feedback it was determined that the format was acceptable in Spanish. After making the necessary grammar edits, the Spanish version was declared finalized and posted on the website.

2.3 - App development

The smartphone application was developed after the protocol version was finalized. Vela Technologies programmed the app for the Apple iOS operating system. The app, called Beached Marine Critters, was designed to include the same information and images as the hardcopy. Essentially, the paper version of the protocol was converted into digital form. Like the paper version, the app is designed to be adaptive, allowing for addition or removal of species as needed. The app is also available in both English and Spanish, designed to detect the language on the user's phone and select the appropriate language.

2.3.1 Smartphone application walkthrough

The smartphone application opens with a screen listing the categories of animals within the protocol (Figure 1). Currently the application opens directly to this page. In the future, as the protocol is adapted to other regions, a further opening page can be included allowing the user to select the state or region as well.

Figure 1. Opening screen of smartphone application

From the initial screen users can select a category of animal. Each category then leads to another screen, with all the species within that category. For example, if users

select the sea turtle category, they will be taken to a page listing all of the turtle species that strand on the coast, along with icons of each species as well, to aid in selecting the correct option (Figure 2).

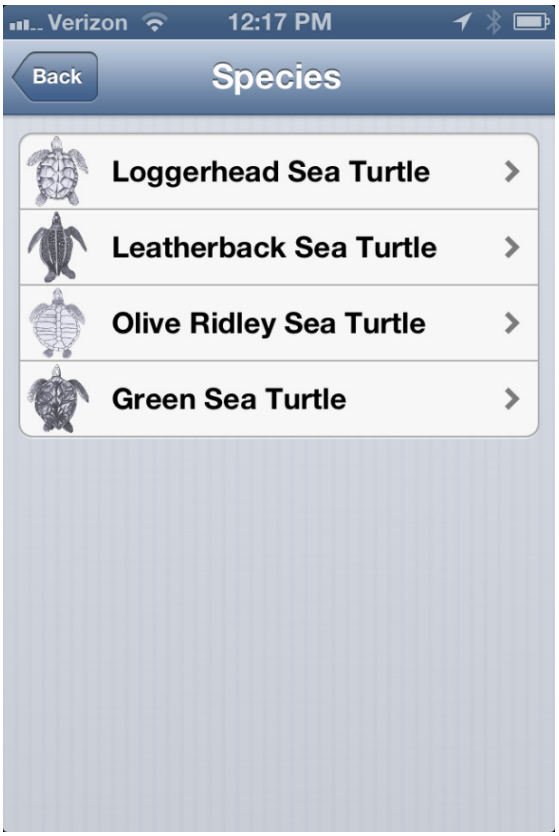

Figure 2. Screenshot of the sea turtle screen, showing the possible species options to choose from.

Once users choose a species, they are taken to the identification page. This contains the same image as in the hard copy of the protocol, with all the arrows pointing to the key features. The user is able to zoom in on the image to see the identifying features more clearly (Figure 3). Beneath the image, the user can scroll through the key features and the general information about the species. If the user wants more images, they can click the button at the bottom and be taken to the example images. These are the

same images as in the hard copy of the protocol, along with the same captions (Figure 4). By clicking on an image the user can enlarge each photo to get a closer look at the example.

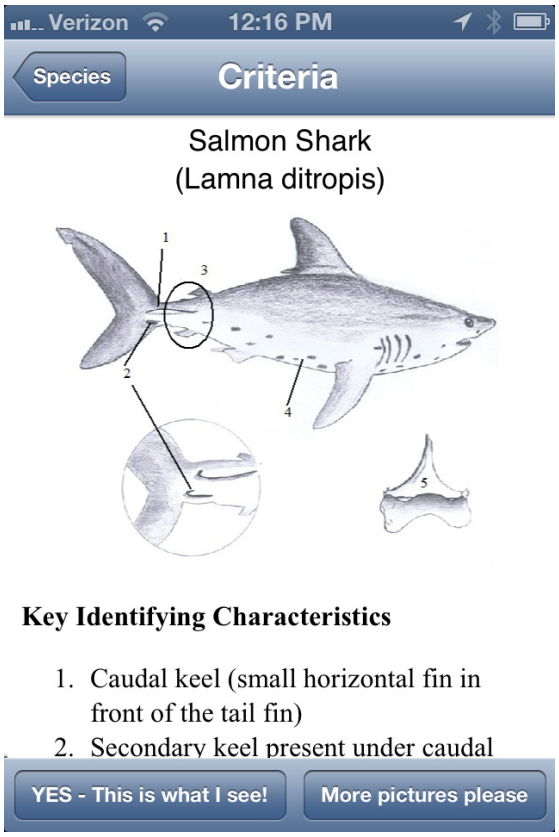

Figure 3. Identification screen

Figure 4. Example images

After determining which species their specimen is, the user can click the button at the bottom of the ID screen (Figure 3) to be taken to the reporting form. The app automatically inserts the species name into the form. In addition, if the user has GPS on, it automatically inserts the latitude and longitude into the form as well. There are text

boxes, dropdown menus, and selection buttons for the remainder of the form, for the user to fill out. Additionally, the form allows users to take and attach photos before submitting (Figures 5-7). When a user is ready to submit the form, it is sent as an email to info@beachedmarinecritters.org, for entry into the database.

Figure 5. Beginning of reporting form

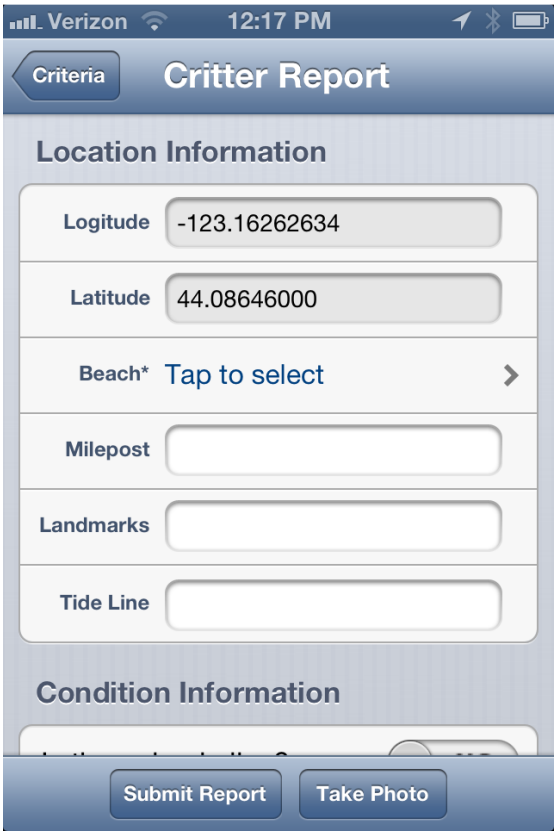

Figure 6. Location information portion of reporting form

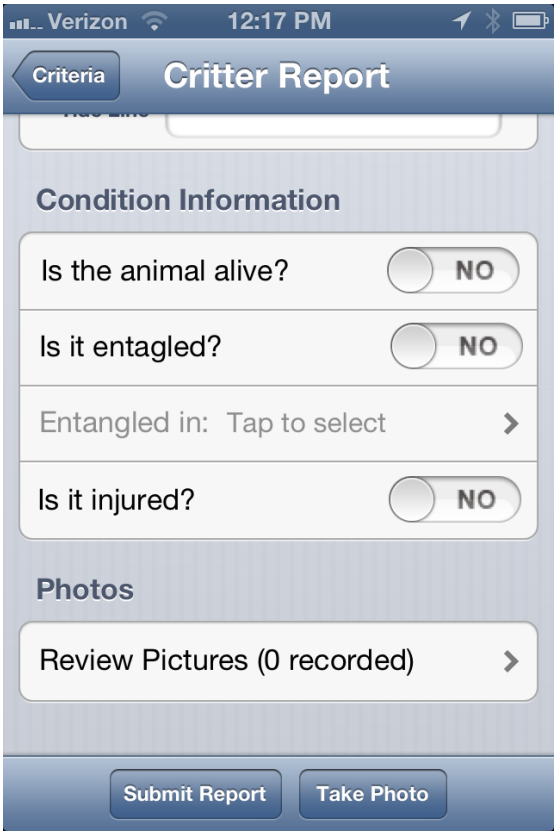

Figure 7. Condition information and photo attachment portion of the reporting form.

2.3.2 Future smartphone application plans

Currently there is only an Apple iOS version of the Beached Marine Critters app. Future plans include converting the app to run on an Android platform as well. If funds become available, the app will also be converted to the Blackberry and Windows smartphone operating systems. However, these systems are not as widespread as Apple or Android (Bostic, 2013), and so it is not as critical that an app exist on these platforms.

Additionally, the reports are sent as an email to info@beachedmarinecritters.org for the time being, which is moderated by the database curator. In the future the app will

be connected directly to the database. Reports will be submitted and the data automatically input into the correct area within the database. The data will then remain in a "holding pattern" until the person running the database can check the data for accuracy and approve the entry.

2.4 - Initial Distribution

After finalization of the protocol several initial steps were taken to distribute the protocol. Approximately 200 copies were printed and distributed to fellow students, faculty, and staff at Oregon State University, namely in the College of Earth, Ocean and Atmospheric Science. It was also announced that the protocols were available on the website the presentations done since finalization (Asson, 2013a, 2013b), and to family and friends. Once the app was available an announcement was posted on Facebook and the website. The post on the website contained a link to the Apple AppStore page for the app.

2.5 - Summative Evaluation

Although no reports have been received from the use of the protocol, the initial outlook for the future of the protocol is positive. The protocol was presented at the 2013 Sky 2 Sea conference hosted by the Northwest Aquatic and Marine Educators, in Vancouver, BC, and received much positive feedback. Part of the presentation included

the audience actually using the protocol to identify photos of squid and turtles. The audience said that this activity was a lot of fun, and were actively identifying the animals based on the key features presented in the protocol. Many comments were also received on other organizations to contact, to work with, and assurances that the educators who attended the presentation would definitely show the protocol to their colleagues and use it in the future. At a workshop done on August 13, 2013, in Coos Bay, OR, for the CoastWatch Shoreline Sciences Workshops series, further comments were received on how this protocol could benefit many persons, not only of the younger generation, but also older community members, who are retired, who want to get into marine science because they did not when they were younger, or want to return to the field.

As of yet, distribution has been limited. The protocol is available on the website, but it will take more time before word really spreads that it exists. It may take a few years to determine whether the format is effective, and the true benefits of the protocol. However, initial reactions and feedback are positive, boding well for the future.

2.6 - Future distribution plans

There are many options for distribution of the protocol in the future, including connecting with the Oregon State Parks to discuss the possibilities of putting some kind of signage up at various beaches. Continual outreach to various websites and coastal organizations for help in promoting our protocol will occur. Not only will the organizations include those such as the Hatfield Marine Science Center, the Oregon

Coast Aquarium, and similar businesses, but those focused on tourism or information sharing will be targeted as well. The possibility has already been discussed of future workshops with CoastWatch, and one is planned for September 20, 2013, in Netarts, OR. For the foreseeable future those workshops will continue to happen. It is also hoped to develop a presentation suitable for children, to introduce them to the protocol. This presentation could be given at a number of elementary, middle, and high schools across the state, likely by the graduate student, introducing students both to the protocol and to marine research. Feedback about possible connections is also continually being collected. The possibility of expanding the project into other states via scientific and coastal communities is high. Although distribution has been limited thus far, there is great potential for the future.

PART 3 - WEBSITE AND DATABASE CREATION

3.1 - Purpose

The website and database were created for two different, but overlapping reasons. The purpose of the website is to provide a portal for the general public to access the protocol. It has information about the project, the species of interest, and the documents. From the website, http://www.beachedmarinecritters.org, users can find out why we created the protocol, can access the protocol in English and Spanish, and can even report a sighting. The website also contains a portal to the database. The database was created for researchers, as a place for all of the data to be contained, queried, and shared. Although it was created for the researchers, the data is accessible to the public through the website. Additionally, new data can be entered from the website portal, making it easy for authorized persons to share their data and increase the overall data pool.

3.2 - Website creation

3.2.1 - Logistics

The website is located at http://www.beachedmarinecritters.org. The website is hosted through a GoDaddy server. The graduate student owns both the domain names beachedmarinecritters.com and beacehedmarinecritters.org. This ownership will last for three years. After this time there are many possibilities for future ownership of the

website and database, including transferring control to Oregon State University, Hatfield Marine Science Center, or Oregon Sea Grant. Beachedmarinecritters.org is the primary site, and the .com site redirects to that one. The website was built using a Wordpress engine, but it is not a Wordpress blog. It is a fully functional, multipage website, available in both English and Spanish.

3.2.2 - Overview/walkthrough

Currently there are ten main pages on the website, and seventeen subpages. The ten main pages include Home, Project Information, Species of Interest, Documents, About Us, Contact Information, Report a Sighting, Animal Stranding Networks, Blog, and Data. There are subpages underneath the Project Info and Species of Interest tabs. Users can navigate to these pages from a top menu bar (Figure 8).

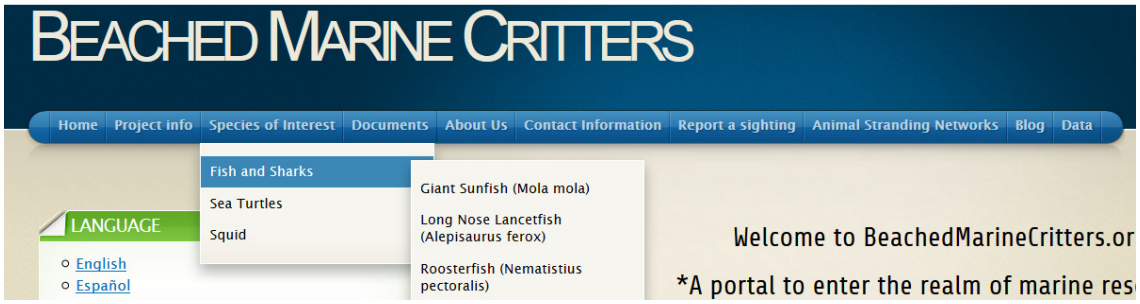

Figure 8. Screenshot of the webpage, with the subpages under Species of Interest highlighted

The Home page is an introductory page. It contains the same introduction that is in the first pages of the protocol, as well as an announcement about the availability of the

app. The Project Info page is about the process of the graduate project. It contains the information about our rationale, our primary and secondary objectives, and our thoughts about the importance and benefits of the project. Users can navigate these pages to learn more about the process of creating the protocol. The Species of Interest pages have identification information about each of our species. The first subpages, Fish and Sharks, Sea Turtles, and Squid, provide the line drawings of each of the species within that category (Figure 9). Each drawing is a link to the identification page for that species. The ID pages for the species are the same as in the protocol, with the same words, layout, and example images. In addition to the links from the pictures, the ID pages can be accessed from a dropdown menu of subpages under the Species of Interest tab (Figure 8).

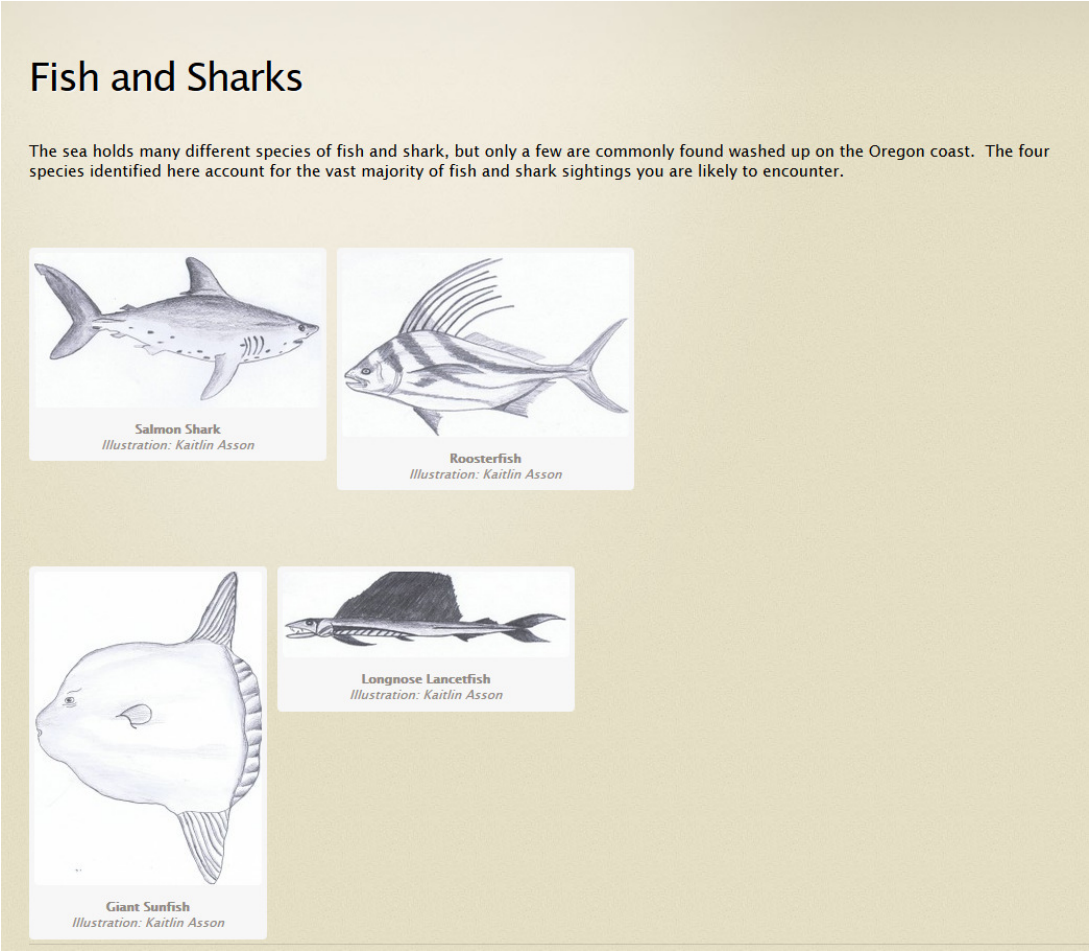

Figure 9. The subpage for Fish and Sharks

The next three pages are straightforward. The Documents page contains pdfs of the protocol in two forms: one that prints out into a four page booklet spread, and one that prints out as a two page spread, ideal for those without a double sided printer. The About Us page contains information about the project members, namely Dr. Hanshumaker and Danielle Asson. The Contact Information page contains the address to which the reporting forms should be mailed, as well as our email address. It also contains a notice

that users should immediately contact the Oregon Marine Mammal Stranding Network tip line if they find a stranded mammal or sea turtle.

The Report a Sighting page is the most complex of any of the pages. It contains a form that users can fill out to report a stranded animal, if they do not want to mail in the paper form and do not have the app. The form on the website is the same layout and format as the one in the protocol. It contains text boxes, dropdown menus, and radio buttons to allow for the most user-friendly situation. It also allows for users to attach photos.

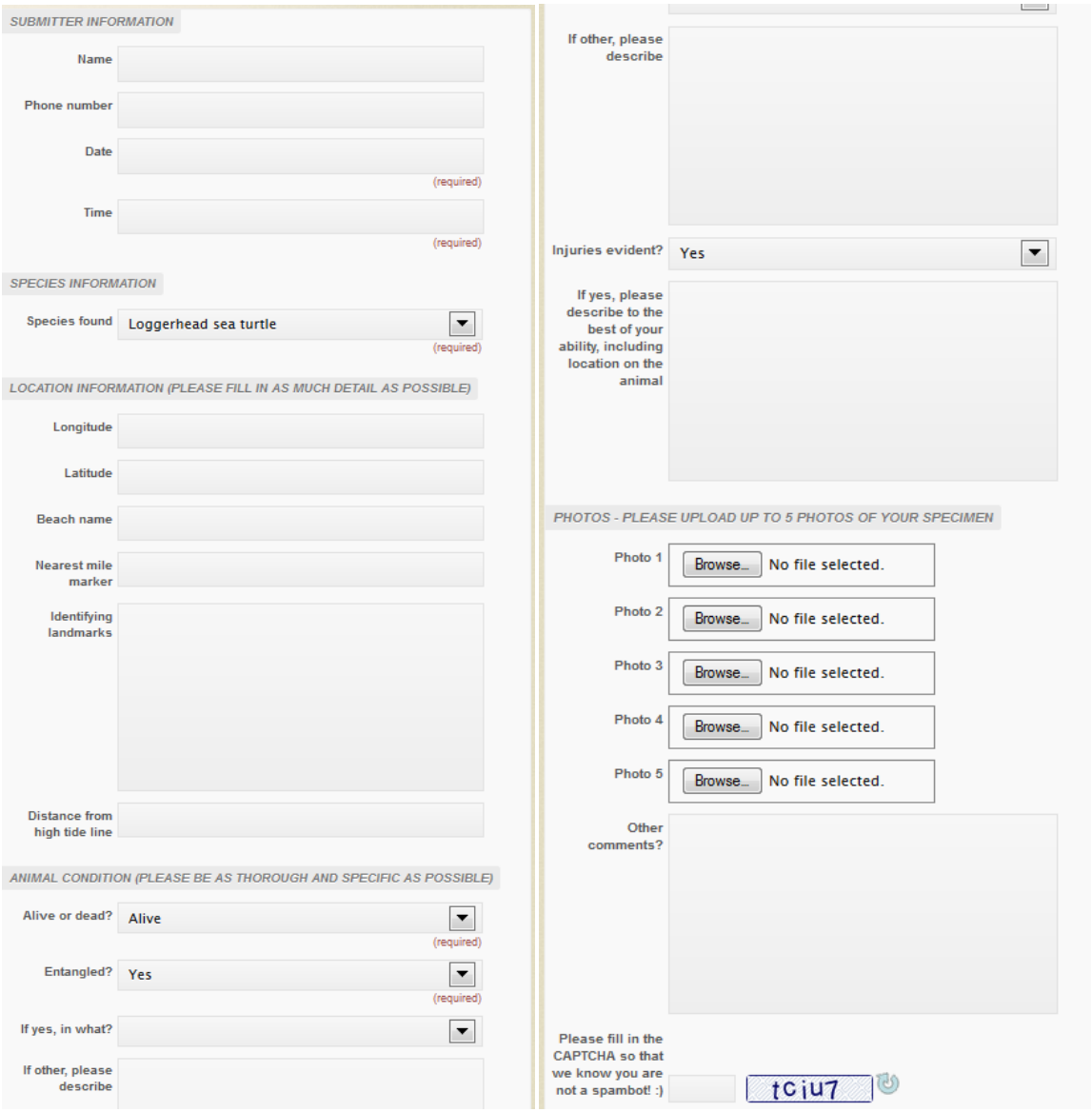

Figure 10. The reporting form on the website. Note that in the image the form is in two shots, but on the website it is a continuous scroll.

The final pages on the website are the blog and data pages. The blog page is meant to provide for updates about new material, changes in the protocol, announcements about workshops, and any miscellaneous information about the project. The data page contains the portal to the database. This will be further explained in section 3.3.1. All

pages on the website except the blog and data pages are in both English and Spanish. Users can toggle between the languages using buttons in the Languages menu on the left sidebar of the website.

3.2.3 - Research/public use opportunities

The website has great potential both for research and for public use in general. Because the data are hosted on the website, anyone can download and use them. This includes members of the general public. Thus, not only will researchers around the world be able to utilize the data, but the general public will as well, and they may see results that others do not. In addition, the author intends to continue work in the future with this project, for the next few years at the least. One of the secondary goals not yet accomplished is the addition of a GIS-based map interface for the data. In the future this goal will be achieved once the necessary skills are gained. This will allow for further public interaction with the data, and allow for website viewers to visualize the data.

The website also has great potential because the protocols are available for free, and because there is a reporting form built into the site. Anyone with access to a printer can download the protocol. In addition, even users who do not have an iPhone can still have a digital copy of the protocol through the website. They can access all the identification information for the various species from the website, and will be able to fill in and send a report to info@beachedmarinecritters.org, as long as they have internet access. This will allow for increased versatility, because even after the app is converted

into the Android operating system, there are other smartphone operating systems that are less common.

3.3 - Database creation

3.3.1 - Logistics

The graduate student developed the database, with the assistance of a computer scientist for some of the coding. It was created using MySQL, and completely built using the program MySQL Workbench. Both the website and the database are hosted on the same GoDaddy server. MySQL workbench connects to this server using Standard TCP/IP over SSH, allowing for edits and alterations without having to access the physical server on which the database is located. The database contains all the past data that has been collected by Dr. Hanshumaker. It will also contain any future data collected through the use of this protocol, or otherwise.

The database portal on the website is accessible through the data button on the top menu bar (Figure 8). Selecting this button will take the user to a page where they can access and search for the data (Figure 11).

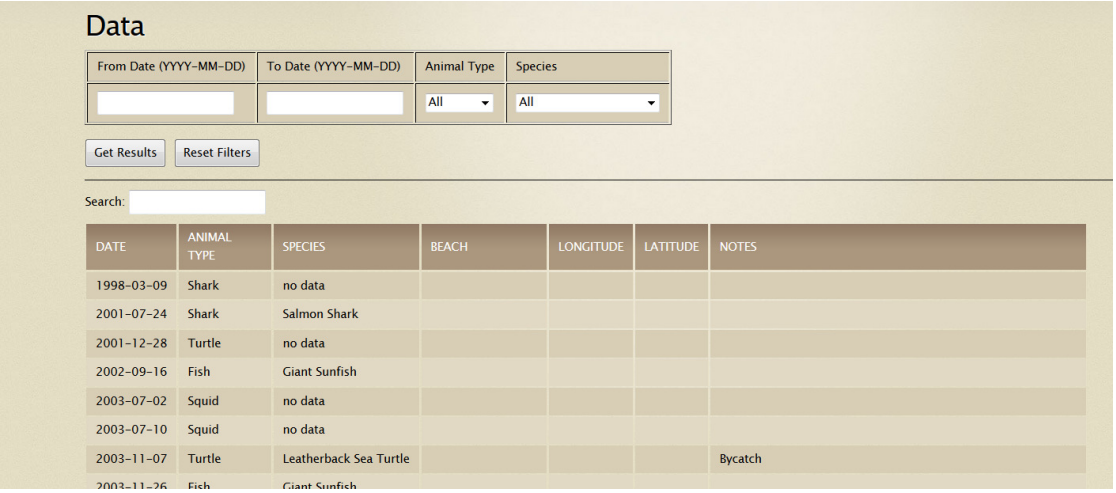

Figure 11. The default data page, before any search parameters are entered.

From this page users can either view all data, or search for a specific type of data. For example, they can search for data from a specific date range, or for a specific species. For the moment, the variety of fields a user can search for is limited. This is primarily for ease of programming and viewing on the site. If a user wants to download the data to analyze it, they can download a CSV file using the button at the bottom of the data. When downloaded, all of the data fields will be provided. If a user wants to view data on a specific entry, they can click on that entry. They will be taken to a new page showing the data detail for that entry (Figure 12).

Figure 12. The data detail page for an Olive Ridley sea turtle that stranded near Seal Rock, OR, in 2012.

3.3.2 - Future plans

For the moment the database only contains data from Oregon, California and Washington. However, as the use of the protocol grows, we hope to increase connections with other states and regions. As these connections are made, additional data will be added to the database. If future connections are made with other stranding networks these data can also be incorporated into the Beached Marine Critters database, or the data within that database can be incorporated into another, to create a cohesive unit for all stranding data.

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APPENDIX A

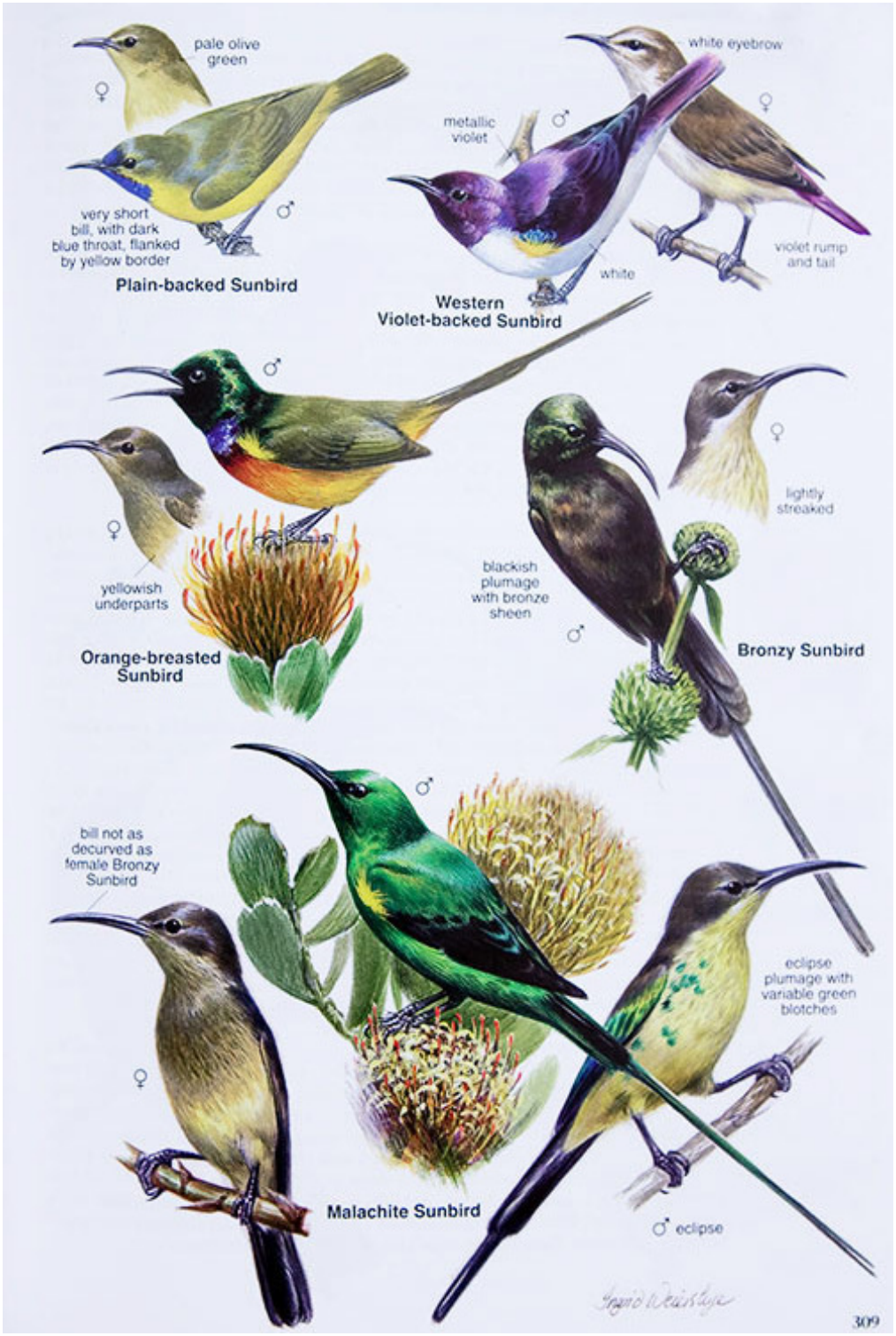

Figure 13. Page 309 from the Roberts Bird Guide, 2007 edition. Photo retrieved from the Roberts Field Guide website, http://www.birdinfo.co.za/birdnews/38_new_roberts_fieldguide.htm

Figure 14. Field guide page to reptiles and amphibians, published by Rainforest Publications, as part of the Belize Field Guides series. This is an example of a common guide type used in educational materials. Retrieved from http://www.nhbs.com/belize_field_guides_reptilesamphibians_tefno_128680.html.

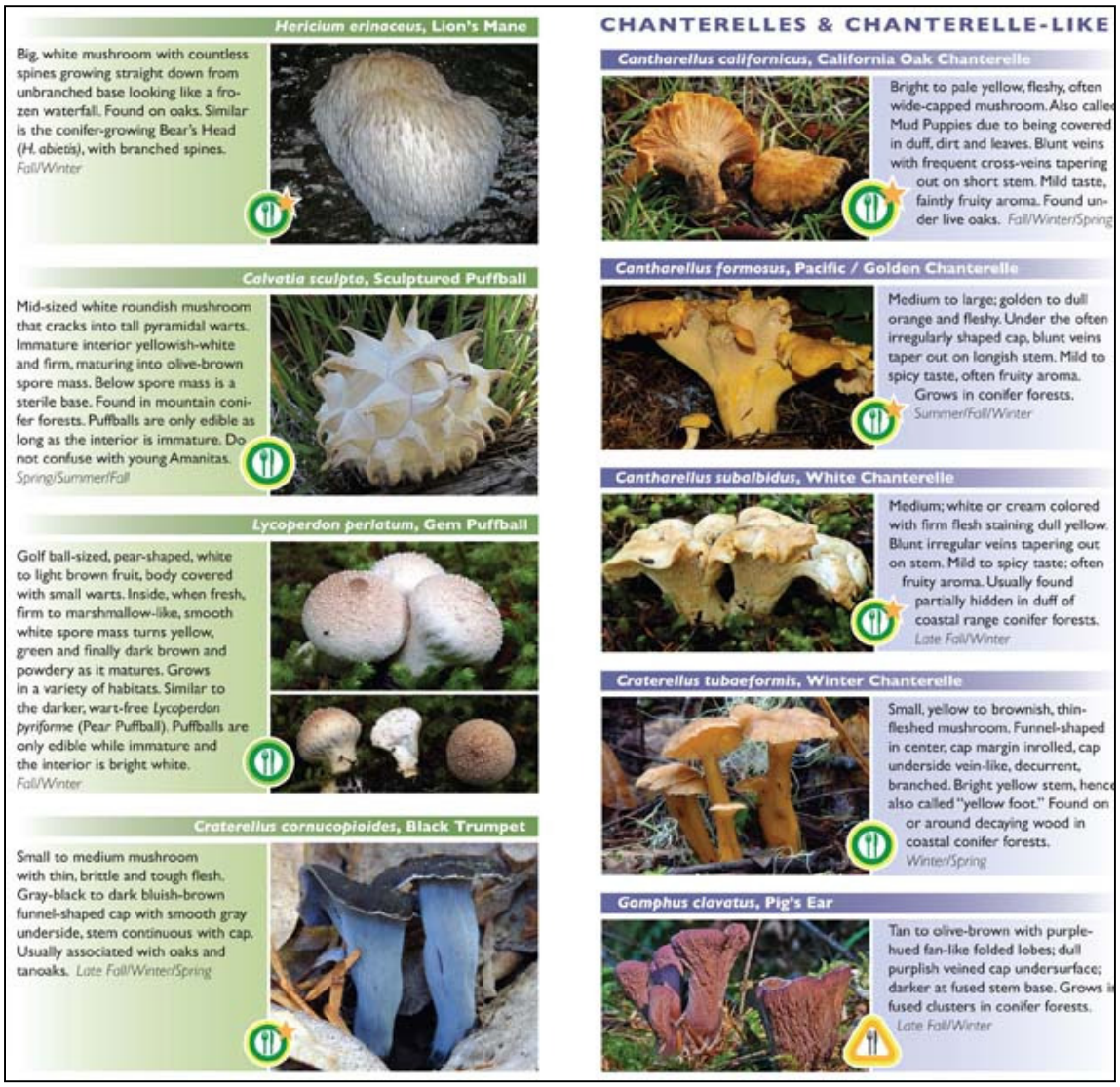

Figure 15. Sample pages from the Field Guide to Edible Mushrooms of California, by Daniel Winkler, published by Harbour Publishing. Retrieved from http://mushroaming.com/Field_Guide_to_Edible_Mushrooms_of_ California.

SCALLOPED SALLOW
Eucirroedia pampina 93-2609 (9952) Common
TL 21–25 mm. Orange FW has bold rusty AM and PM lines that converge toward inner margin. Large orbicular and reniform spots are purplish. Outer margin is boldly scalloped. Typically rests with its angled wings and abdomen raised. **HOSTS:** Deciduous trees and plants, including cherry, oak, and poplar. **NOTE:** May be flushed from leaf litter during the day.

BICOLORED SALLOW
Sunira bicolorago 93-2616 (9957) Common
TL 18–20 mm. Peppery pale orange FW typically has wavy lines bordered with purplish bands. Scalloped PM line is accented with faint black dots along veins. Reniform spot has a blackish dot in inner half. Some individuals (bicolored) show dark shading across apical half of wing. **HOSTS:** Deciduous trees and low plants, including cabbage, cherry, elm, maple, and tobacco.

DOTTED SALLOW *Anathix ralla* 93-2619 (9961) Common
TL 17–21 mm. Orange FW has slightly scalloped, double AM and PM lines. Angled brown median band is often conspicuous. ST and terminal lines are rows of black dots. Orbicular and reniform spots have diffuse blackish dots in inner halves. **HOSTS:** Aspen.

PUTA SALLOW *Anathix puta* 93-2620 (9962) Uncommon
TL 14–15 mm. FW is variably grayish brown to pale orange, typically with contrasting pale gray veins. Double AM and PM lines are filled with pale gray. Angled median line touches blackish spot in inner half of reniform spot. Midpoint of inconspicuous ST line is accented with black dots. **HOSTS:** Trembling aspen.

APPROACHABLE SALLOW
Anathix aggressa 93-2621 (9963) Uncommon
TL 15–17 mm. Similar to smaller Puta Sallow, but FW is usually paler grayish tan with contrasting whitish veins. Scalloped AM and PM lines are often inconspicuous. Angled median line touches grayish spot in inner half of reniform spot. **HOSTS:** Poplar. **RANGE:** W. Canada and U.S., also sw. ON.

PINK-BARRED SALLOW
Xanthia tatago 93-2622 (9965) Uncommon
TL 16–17 mm. Bright yellow FW is boldly marked with purplish brown shading and spots. ST line is a row of blackish dots. Terminal line is checkered. Fringe is pinkish. Slightly crested golden yellow thorax has wide purplish collar. **HOSTS:** Willow.

474 SWORDGRASSES, PINIONS, AND XYLENINE SALLOWS

SWORDGRASSES, PINIONS, AND XYLENINE SALLOWS

actual size

typical

SCALLOPED SALLOW

BICOLORED SALLOW

bicolored form

DOTTED SALLOW

PUTA SALLOW

APPROACHABLE SALLOW

PINK-BARRED SALLOW

475

Figure 16. A page from the Peterson Field Guide to Moths of Northeastern North America, by Seabrooke Leckie. Retrieved from http://seabrookeleckie.com/the-new-peterson-moth-guide/.

APPENDIX B

Introduction

So many miles of coastline...

So many stranded critters...

Here's a way you can help!

Tracking the species and locations of stranded marine animals is important for understanding many aspects of our coastal environment. With enough data, we can begin identifying stranding patterns of various species. We can also begin to build predictive models to identify where animals will strand in the future and how the patterns could change. This data can also be used for research into important topics, such as climate change. Now you can help Oregon scientists gather this critical data using this new protocol.

Many things, animal and otherwise, wash up on our beaches, but we are primarily concerned with sea turtles, squid, sharks, and specific types of fish. This protocol will help you identify these key animals. Each species of interest has a specific identification page that includes a representative illustration and several key characteristics that distinguish that animal. When you find a specimen, turn to the page that describes what you think the specimen is, then use these characteristics to confirm your identification.

4

Included for each species are example photographs of the animal. These photographs are intended to be examples only! Some of the images were taken of live, healthy animals, some are of stranded animals, and still others are of animals being prepped for dissection. Any specimen you find may or may not resemble the images, as many species have a lot of color variation and the specimens you find may be in different stages of decomposition. Use the images as examples of what actual specimens may look like, but use the key identification characteristics to confirm your species identification.

Once you have confirmed your identification, fill in the form at the back of this protocol and send it off! You can mail in the form and pictures, or email the form and pictures to info@beachedmarinecritters.org. A fillable pdf is available on our website. Please fill out the form in as much detail as possible, being clear with descriptions. Along with your form, we ask that you send in at least three photos of the specimen you found as well. If you cannot take photos, please send in your form anyway, but if it is at all possible please send in images. Include at least one image of the entire specimen with an object of known size next to it, such as a quarter or a pencil, so that we have a size reference.

With your help we can greatly increase our knowledge and understandings about animal strandings along our coast.

5

Figure 17. The introductory pages to the protocol.

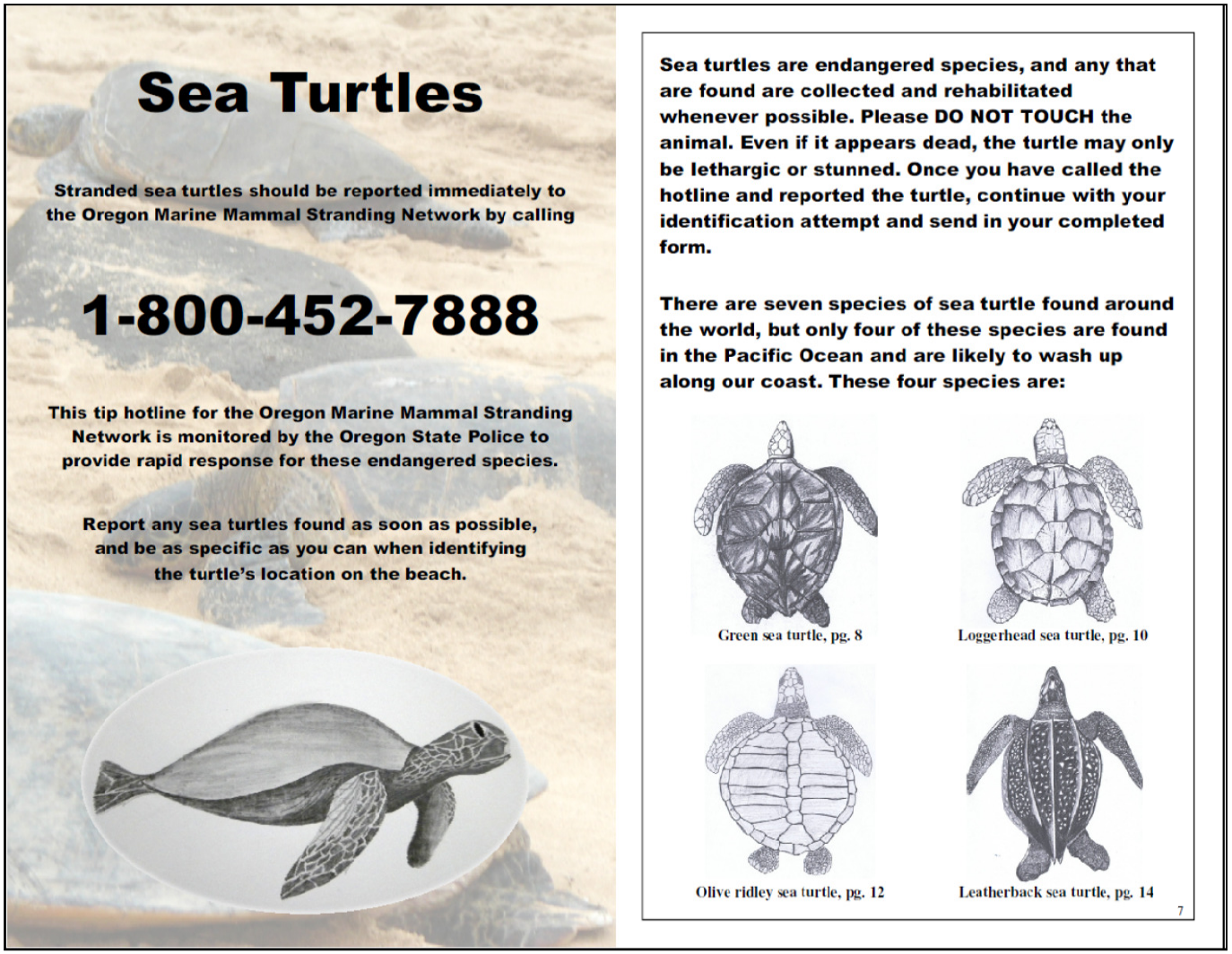

Figure 18. The introductory page for sea turtles. Each group of animals has an introductory page like this. For sea turtles, there is extra information on what a user should do, because they are endangered species.

Salmon Shark *(Lamna ditropis)*

Salmon sharks can live between 20 and 30 years and reach a maximum of 4m (12ft) in length. They are often mistaken for great white sharks when found on the beach, but can be easily distinguished by the presence of a secondary caudal keel and their smooth, narrow, non-serrated teeth.

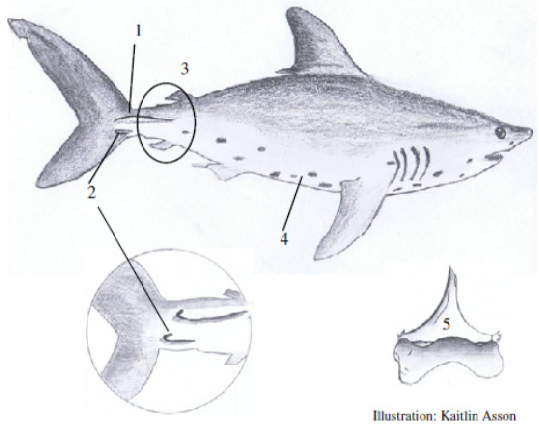

Illustration: Kaitlin Asson

Key identifying characteristics

1. Caudal keel (small horizontal fin in front of the tail fin)
2. Secondary keel present under caudal keel
3. Secondary dorsal fin directly above secondary ventral fin
4. Some individuals have dark splotches on white underside
5. Teeth narrow and non-serrated

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Example Images

A salmon shark stranded on the beach near Twin Rocks, OR. *Photo credit: Dr. William Hanshumaker*

A dead female salmon shark on a dissecting table, being prepped for a necropsy. *Photo credit: Dr. William Hanshumaker*

A stranded salmon shark with a piece of plastic protruding from its mouth. *Photo credit: Dr. William Hanshumaker*

A close-up view of the caudal keel and secondary keel of a salmon shark. *Photo credit: Dr. William Hanshumaker*

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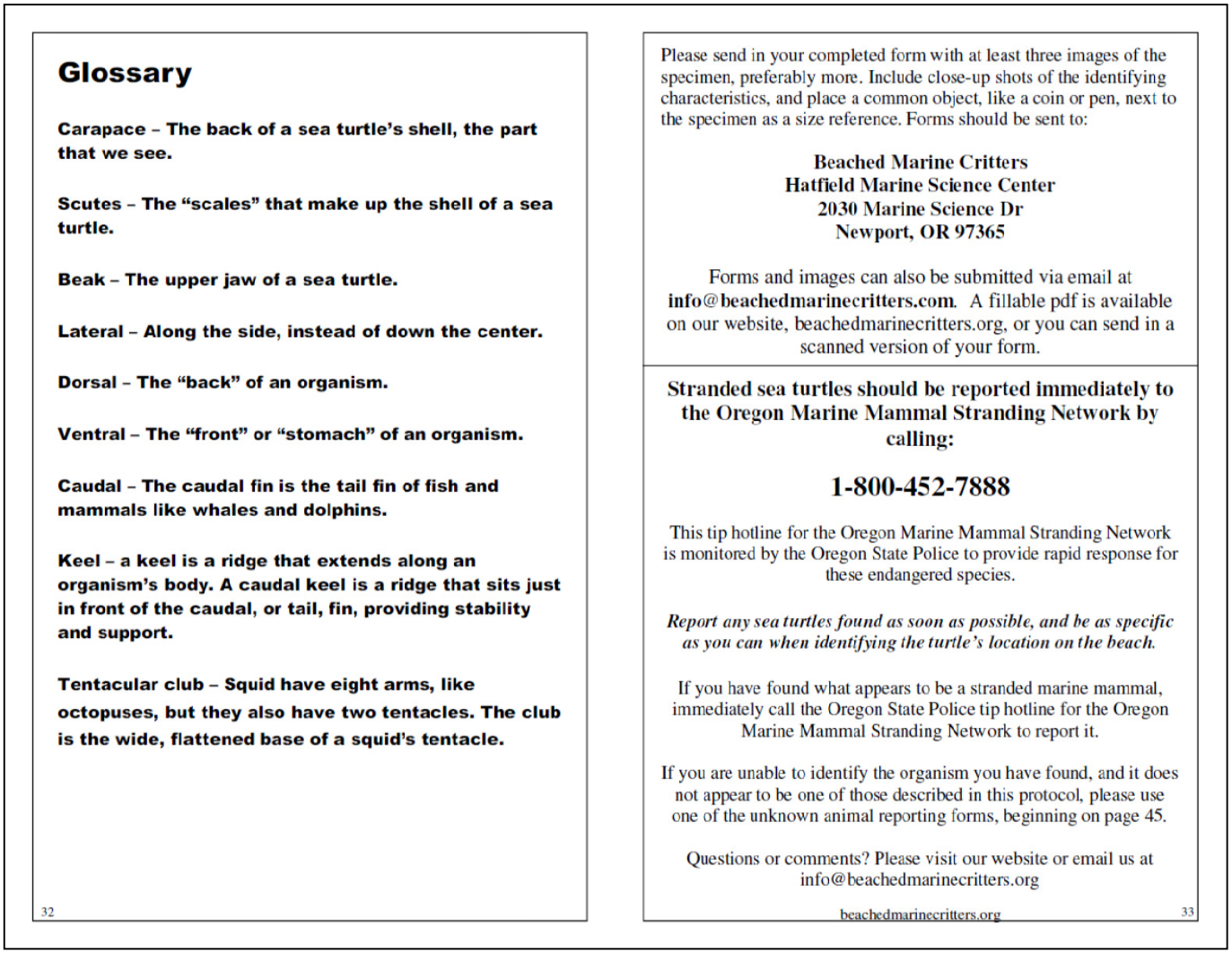
Figure 19. An example identification page. This one is for the salmon shark. In the text it mentions some characteristics that distringush the salmon shark from the oft confused species, the great white.



Glossary

Carapace – The back of a sea turtle's shell, the part that we see.

Scutes – The "scales" that make up the shell of a sea turtle.

Beak – The upper jaw of a sea turtle.

Lateral – Along the side, instead of down the center.

Dorsal – The "back" of an organism.

Ventral – The "front" or "stomach" of an organism.

Caudal – The caudal fin is the tail fin of fish and mammals like whales and dolphins.

Keel – a keel is a ridge that extends along an organism's body. A caudal keel is a ridge that sits just in front of the caudal, or tail, fin, providing stability and support.

Tentacular club – Squid have eight arms, like octopuses, but they also have two tentacles. The club is the wide, flattened base of a squid's tentacle.

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Please send in your completed form with at least three images of the specimen, preferably more. Include close-up shots of the identifying characteristics, and place a common object, like a coin or pen, next to the specimen as a size reference. Forms should be sent to:

Beached Marine Critters
Hatfield Marine Science Center
2030 Marine Science Dr
Newport, OR 97365

Forms and images can also be submitted via email at **info@beachedmarinecritters.com**. A fillable pdf is available on our website, beachedmarinecritters.org, or you can send in a scanned version of your form.

Stranded sea turtles should be reported immediately to the Oregon Marine Mammal Stranding Network by calling:

1-800-452-7888

This tip hotline for the Oregon Marine Mammal Stranding Network is monitored by the Oregon State Police to provide rapid response for these endangered species.

Report any sea turtles found as soon as possible, and be as specific as you can when identifying the turtle's location on the beach.

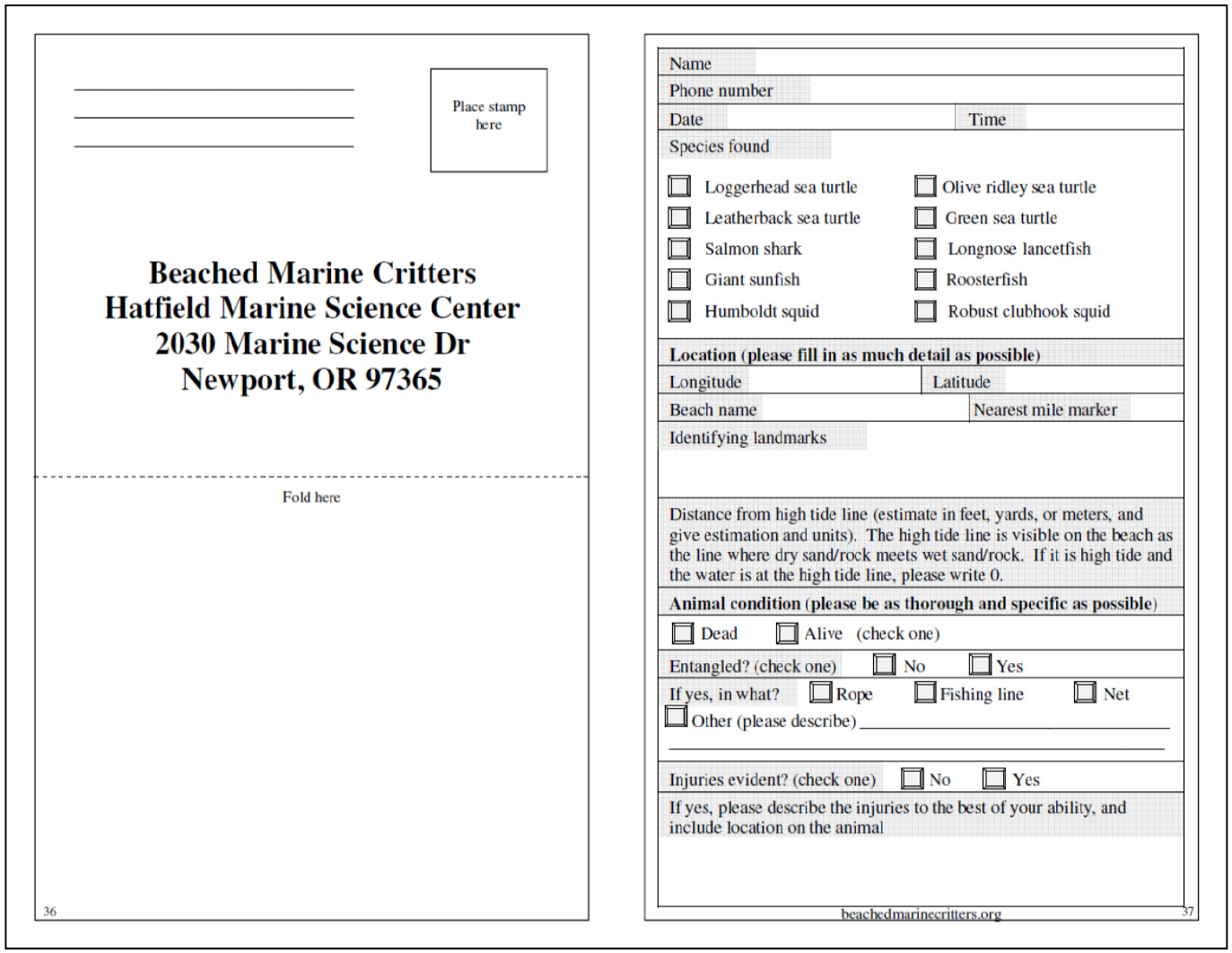
If you have found what appears to be a stranded marine mammal, immediately call the Oregon State Police tip hotline for the Oregon Marine Mammal Stranding Network to report it.

If you are unable to identify the organism you have found, and it does not appear to be one of those described in this protocol, please use one of the unknown animal reporting forms, beginning on page 45.

Questions or comments? Please visit our website or email us at info@beachedmarinecritters.org

beachedmarinecritters.org 33

Figure 20. The glossary and form submittal instruction pages.



Place stamp here

Beached Marine Critters
Hatfield Marine Science Center
2030 Marine Science Dr
Newport, OR 97365

Fold here

36

Name

Phone number

Date | Time

Species found

- ☐ Loggerhead sea turtle
- ☐ Olive ridley sea turtle
- ☐ Leatherback sea turtle
- ☐ Green sea turtle
- ☐ Salmon shark
- ☐ Longnose lancetfish
- ☐ Giant sunfish
- ☐ Roosterfish
- ☐ Humboldt squid
- ☐ Robust clubhook squid

Location (please fill in as much detail as possible)

Longitude | Latitude

Beach name | Nearest mile marker

Identifying landmarks

Distance from high tide line (estimate in feet, yards, or meters, and give estimation and units). The high tide line is visible on the beach as the line where dry sand/rock meets wet sand/rock. If it is high tide and the water is at the high tide line, please write 0.

Animal condition (please be as thorough and specific as possible)

☐ Dead ☐ Alive (check one)

Entangled? (check one) ☐ No ☐ Yes

If yes, in what? ☐ Rope ☐ Fishing line ☐ Net
☐ Other (please describe) _____

Injuries evident? (check one) ☐ No ☐ Yes

If yes, please describe the injuries to the best of your ability, and include location on the animal

beachedmarinecritters.org

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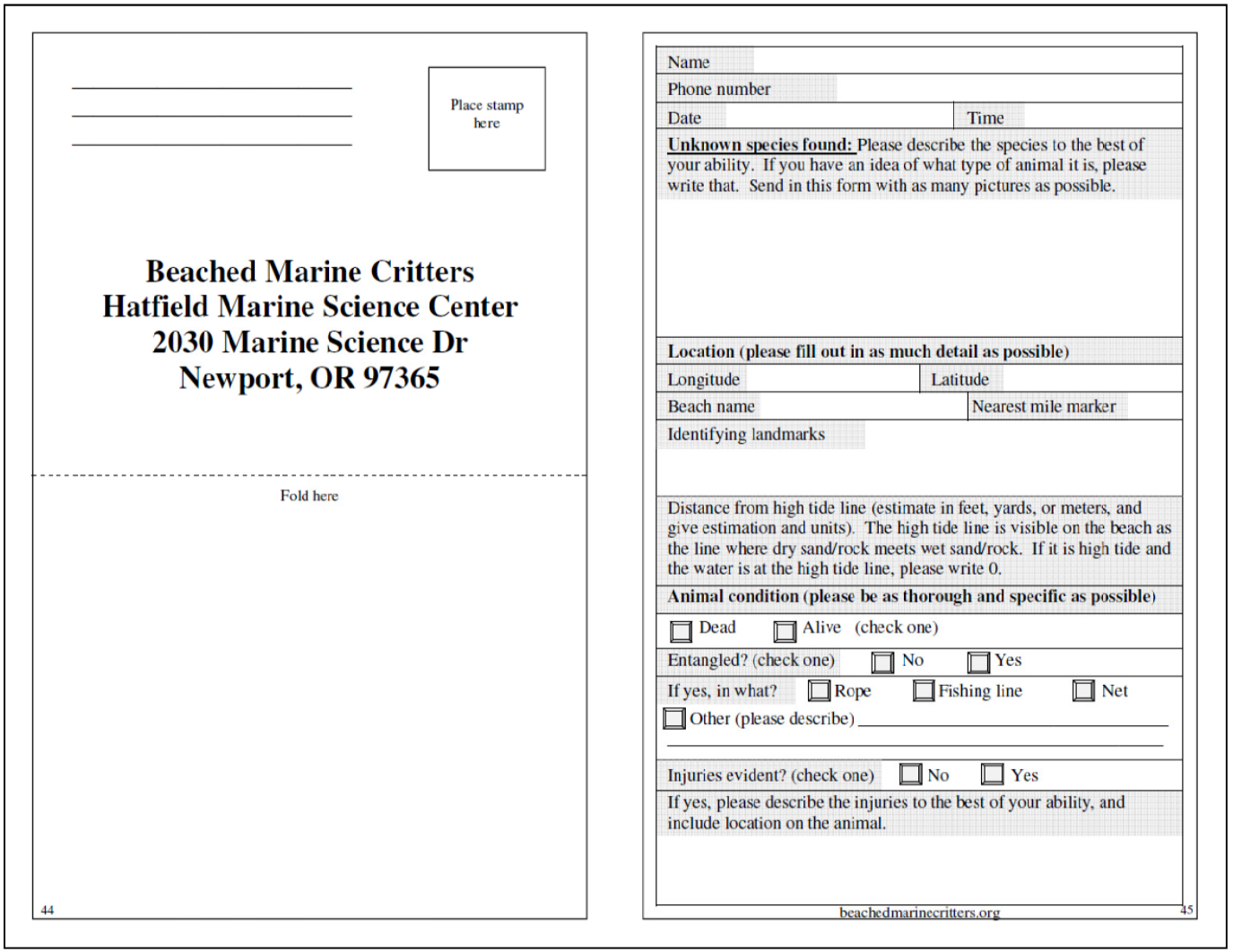
Figure 21. The reporting form on which users record information.



Place stamp here

Beached Marine Critters
Hatfield Marine Science Center
2030 Marine Science Dr
Newport, OR 97365

Fold here

44

Name

Phone number

Date | Time

Unknown species found: Please describe the species to the best of your ability. If you have an idea of what type of animal it is, please write that. Send in this form with as many pictures as possible.

Location (please fill out in as much detail as possible)

Longitude | Latitude

Beach name | Nearest mile marker

Identifying landmarks

Distance from high tide line (estimate in feet, yards, or meters, and give estimation and units). The high tide line is visible on the beach as the line where dry sand/rock meets wet sand/rock. If it is high tide and the water is at the high tide line, please write 0.

Animal condition (please be as thorough and specific as possible)

☐ Dead ☐ Alive (check one)

Entangled? (check one) ☐ No ☐ Yes

If yes, in what? ☐ Rope ☐ Fishing line ☐ Net

☐ Other (please describe) _____

Injuries evident? (check one) ☐ No ☐ Yes

If yes, please describe the injuries to the best of your ability, and include location on the animal.

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Figure 22. The reproting form when the species encountered is unknown.