Final Report on
Whale Entanglement
Data Systems Design Research

for

OCEAN PROTECTION COUNCIL

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Introduction And Problem Statement

In response to heightened concerns over a sudden increase in reported whale entanglements off the West Coast, the California Department of FIsh and Wildlife (CDFW), in partnership with the Ocean Protection Council (OPC) and National Marine Fisheries Service (NMFS), convened the California Dungeness Crab Fishing Gear Working Group (Working Group) to develop strategies to reduce the risk of whale entanglements in California Dungeness crab fishing gear.

Since 2015, the Working Group has been on the leading edge of developing science-based, collaborative solutions to protect whales, sea turtles, and ocean-based livelihoods. A cornerstone of the Working Group's efforts has been the creation and piloting of the Risk Assessment and Mitigation Program (RAMP) - a first-of-its-kind adaptive management framework to proactively assess and respond to entanglement risk based on a range of indicators, including recent confirmed entanglements, marine life distributions, ocean and forage conditions, and fishery dynamics and socio-economics.

As a near real-time adaptive management system, the Working Group and CDFW regularly meet frequently (monthly or more) before and during the fishing season to review a diverse and expanding array of data, shared as a compilation of charts, maps, and tables. The Working Group seeks to comprehensively assess available data to inform a data-driven recommendation that maximizes consensus across its diverse membership in a short amount of time. To operate in as near-real time as possible, CDFW seeks to share data packages publicly within 1-3 days of the risk assessment date, meaning all parties have little time to review data prior to group deliberations.

For the RAMP to support the Working Group and CDFW in making decisions that achieve the dual goal of maintaining both a thriving commercial Dungeness crab fishery and marine life diversity, it must maximize use of the best available science across the range of data inputs needed to assess risk. However, barriers in the form of a lack of broad shared understanding and agreement on data sources and inconsistency in accessibility of data threaten to limit comprehensive use of best available science in decision-making. There is a critical need and opportunity to remove barriers to ensure data is transparent and accessible at the pace required for near real-time management through the RAMP.

In alignment with both the OPC's Strategic Plan and the OPC Entanglement Strategy's emphasis on advancing collaborative partnerships, leveraging best available science, and specifically developing "a transparent and centralized platform for information sharing," TNC advanced work under an OPC grant to conduct an exploratory assessment of the challenges, needs, and opportunities to integrate key information sources and improve the accessibility of data used to support the adaptive management of entanglement risk. This report summarizes findings from these efforts, providing a situational analysis including recommendations on how to organize and maximize the utility of data to inform adaptive management of entanglement risk through the RAMP program.

Methods

The exploration comprised an iterative set of semi-structured interviews aimed at understanding needs, opportunities, and constraints to maximize understanding and use of best available science in the adaptive management of entanglement risk. Interviews targeted a range of perspectives among Working Group and RAMP participants to ensure recommendations grounded in the needs and constraints of data providers, data organizers and data users. We define data providers as those that provide data to inform the RAMP. Data providers include CDFW staff, NMFS staff, and other experts that often also serve as Working Group advisors and in some cases members. Data organizers primarily refers to CDFW Whale Safe Fisheries staff who request, compile, and share RAMP data packages. Data users refer to CDFW Marine Region staff CDFW Director Charlton H Bonham, NMFS staff, Working Group members and advisors who evaluate data packages to inform Risk Assessment deliberations, recommendations and management decisions. From April 2020 to March 2021, 17 interviews were conducted with individuals representing Working Group members, CDFW, NOAA, and Working Group advisors/data providers. TNC sought regular input from OPC and former Working Group facilitator, Strategic Earth, throughout the project.

The interviews, along with an analysis of existing RAMP data compilations and data sources, established the foundation for a situational analysis and set of recommendations for changes to the RAMP data compilation system to increase the understanding and use of best available science in the RAMP process. In this document, we detail the following through a summary of research activities and resulting recommendations:

- How have Working Group members experienced the existing data packages?
- How have data providers experienced the process of supplying data to those packages?
- How can the data package content and delivery method be improved for data users while meeting the requirements of CDFW and without unduly burdening data providers or data organizers?

We note that certain data types (e.g., whale distributions) and data sources (e.g., aerial surveys) may be highlighted with other data types and sources not mentioned in interview summaries below. This report should not be interpreted as including an exhaustive list of the types and sources of data needed to inform the RAMP. Rather, insights reflect how interviewees prioritized overall data interpretation needs at a high level. The findings detailed and analyzed in this document help define and prioritize the data, features, and visualizations for further iterative development towards a more streamlined, standardized, and accessible data package system to inform the RAMP.

Research Activities

Insights Gathered From The Data User Perspective

To better understand perspectives on challenges and priorities related to the assessment of data in the RAMP program, TNC conducted iterative interviews with Working Group members, advisors, and CDFW staff. A total of ten interviews were conducted from April to December 2020.The interviews were conducted using Zoom, a remote online conferencing tool.

An initial round of interviews were conducted with seven Working Group members and advisors, including one CDFW staff member, two Working Group advisors, and four Working Group members. Interviews were led by TNC staff and Working Group member Jenn Humberstone, and supported by TNC Product Innovation Manager Sue Pollock. Interviewees were asked for their perspectives on data and the overall data compilation used in the RAMP. For a complete list of interview questions, see Appendix 1. Building upon insights gathered in the first round of interviews, TNC led a second round of interviews focused on Working Group members to better understand how members interpreted data and data visualization preferences. Interviews were supported by a set of hypothetical data scenarios, shared with map based and chart based visualizations of fishing effort distribution and humpback whale distribution. Visualizations were streamlined to clearly convey the extent of overlap between fishing activity and humpback whales. Three Working Group members were interviewed, all of whom were fishing industry representatives.

Inconsistent And Lengthy Data Packages Are Hard To Digest

A major pain point discussed in the interviews was that Working Group Members are often presented with data that frequently changes in format, thus making it hard to understand change over time. The current data compilation richly documents information that some consider of small value or extraneous data that makes it harder to find the information they need on the report. Similarly, current visual images used in the reports are considered hard to use for diagnostic purposes.

Lack of standardization makes it difficult for Working Group members to find necessary information, which one interviewee summarized as: “Where are the whales? Where is the gear? And, where are entanglements happening?” Interviews conducted with hypothetical data visualizations suggest that a more streamlined visualization of the overlapping distribution of whales and fishing gear can contribute to a consistent interpretation of relative entanglement risk amongst members.

Agreed To And Transparent Data Sources Are Key To Increase Trust And Common Understanding

Working Group members and advisors shared concerns over lack of agreement on data sources. Some interviewees cited concerns with specific data sources, and that limitations and potential bias are not accounted for consistently across different data sources. There is a general hesitancy regarding the use of models as the basis for management decisions, with observational data viewed as more accurate. Concerns over and lack of agreement on data sources slows and contributes to frustration during the Working Group deliberation process.

These insights underscore a need for explicit agreement on data sources and a shared understanding of the strengths, limitations, and relative contribution of data sources to the evaluation of entanglement risk. One interviewee emphasized that making data streams more transparent and publicly available is needed to foster trust in data. Interview insights underscore that it will be critical for any data accessibility solution to align with an agreed set of data sources and clearly convey relative value and limitations of data.

Data centralization and visualization solutions should be collaboratively designed, and ensure alignment and leveraging of additional efforts to increase understanding of data to inform the RAMP.[1]

Dual Goal To Improve And Expand Data While Also Decreasing Workload

As a near real-time management program, the RAMP is data intensive. The Working Group and agency partners have catalyzed a massive expansion in scientific research and data sources available to inform the RAMP program. While efforts to increase the availability of data is ongoing, it also creates more demands on the process of organizing, sharing and evaluating data. In its transition from a voluntary pilot to regulatory program, the requirements for comprehensive data coverage have increased, contributing to increased workload to compile and evaluate data packages. More frequent risk assessments also place increasing demands on the data compilation system.

There is a common goal to balance interests in improving data streams and filling information gaps, while keeping the RAMP process manageable. While Working Group members cited various priorities and opportunities to improve data and fill additional data gaps, they also cited challenges with the extent and variety of data presentations in use. From a data provider and data organizer perspective, keeping the data package manageable while ensuring sufficient detail and clarity regarding the data sources is a priority moving forward.

Data as a communication tool

In addition to supporting credible, consistent and data driven recommendations, transparent and broadly accessible data can facilitate effective communication of Working Group recommendations to fishery management, peer, and general public audiences. Fishing industry Working Group members in particular need to be able to provide clear and compelling explanations for Working Group assessments and recommendations, and several said that clearer data visualizations would help.

Insights Gathered From The Data Package Assessment

As a first step in understanding the technical and visual characteristics of existing data compilations, GreenInfo Network developed an inventory of recent data packages (also listed in the appendix) and found the following number of unique/different presentations across all data packages (*not including* repeated and updated variants of the same charts/maps):

[1] As examples: a) The Working Group Data Project Team's efforts to develop a process for data source approval, onboarding, and agreed use; b) CDFW has developed a descriptive summary of CDFW-approved data sources; c) The OPC has provided funding to Point Blue Conservation Science to conduct a scientific assessment of California whale abundance datasets to assess the spatial and temporal correlations among them; and d) The West Coast Entanglement Science Workshop Report summarizes emerging science and tools to inform adaptive management of entanglement risk.

Overall	Total
Maps	20
Charts	23
Tables	4

Each data package contained between five and 16 figures, with some repeating with updated data in all or nearly all packets, but others appearing only intermittently or presenting similar data in slightly different ways over time, making comparisons difficult:

Data packages	Maps	Charts	Tables	
Feb 11, 2021*	4	4	1	**9**
June 24, 2020	3	4	2	**9**
June 9, 2020	5	5	2	**12**
May 22, 2020	3	3	2	**8**
May 8, 2020	4	11	1	**16**
April 22, 2020	2	4	1	**7**
April 7, 2020	4	10	2	**16**
March 23, 2020	2	6	1	**9**
March 5, 2020	3	10	0	**13**
February 4, 2020	1	4	0	**5**
Jan 3, 2020	2	5	0	**7**

**Included for review of data associated with new fleet reporting requirements and other changes under RAMP regulations.*

The work to this point suggests that the RAMP process would be best informed by simpler, more consistent data visualizations. But achieving simplicity and consistency can be challenging. Some data sources are automatically updated on websites or data services, some are manually collected and shared, some have confidentiality considerations, others are from proprietary databases, and some are being pulled from existing data aggregation websites. Data integration solutions must be grounded in technical feasibility and practical constraints of data providers and requirements of CDFW.

Insights Gathered From The Data Provider Perspective

In order to assess practical opportunities to increase the accessibility and utility of data streams, GreenInfo Network (GIN) developed a research plan focused on gathering insights from data providers and data organizers. GIN conducted semi-structured interviews with Working Group members and advisors who provide data for the RAMP data package, including a staff member from CDFW's Whale Safe Fisheries Team. GIN sought to assess the available data streams and how to alleviate some of the pain points associated with the data gathering

process. The interview process also offered these stakeholders an opportunity to provide recommendations on the data gathering process.

The interviews were conducted using Zoom, a remote online conferencing tool. From March 5-17, 2021, interviews were conducted with data providers. In total, seven individuals agreed to participate in the interviews.

The following is a synthesis of the key findings from the interviews. These findings are intended to provide a perspective of what was learned over the third phase of the Whale Entanglement Data Systems Design Research. The findings are organized into a series of topic areas to give context.

Data Provider Perceptions Of The Data Submission Process

Currently, Working Group Advisors work within different groups or organizations. They tend to submit all relevant available data from their respective organizations to CDFW as part of the monthly RAMP data package. Our interviews found that all Advisors thought the process for submitting the data to CDFW was easy yet yielded a data package that was challenging to review. Specifically, Advisors believed that the current process for providing data yields a PDF data package that is long and unorganized, making it hard to interpret the content. Across the board, interviewees linked the visualization discussion to the process of providing data.

Interviewees noted that the limitations of proprietary data housed in different databases and submitting the data as JPEG images to CDFW were the top challenges to consistent visualizations. Working Group advisors submit text and images of their data for each monthly data package. Working group advisors believe that compiling and submitting the information they have is easy. On average, advisors spend between 20 minutes to 1 hour placing image JPEG and text-based information on a Word Document provided by CDFW.

For different interviewees, however, the overall guidance provided in the CDFW template is taken to mean different things. For example, some interviewees believed that when prompted to provide their data, submitting a link to a proprietary platform complied with both with data submission expectations for the report and the revised Section 508 Standards of the Rehabilitation Act of 1973. If the linked platform is not itself 508-compliant, then this information is not accessible. When asked what guidance they had received in relation to making the content accessible, such as writing captions for images as alternative text, data providers expressed they did not receive guidance. Some interviewees said they had no knowledge of what alternative text is.

Similarly, they have not received feedback on how the JPEG images are being used, or how to best format the data visually to aid with interpretation for accessibility or otherwise.

Data Visualization Alternatives

When asked whether they believed a different type of content organization was needed to make the data easier to interpret, a majority positively agree.

Layering was consistently identified as a top priority for interviewees. Interviewees believed layering was a good strategy for aiding interpretation of the data available in a single month. Furthermore, interviewees recognized that the risk assessment entails much more than

reviewing a single monthly data package. They believed complementary data that illustrated change over time could have a lasting impact in aiding with interpretation. The broader perspective from interviewees on interpreting risks is that each data package is a snapshot in time and thus it is important to be able to view data from multiple months side-by-side.

For interpretation purposes, interviewees elaborated on how visualizations may be organized in the following ways:

1. Layered Data: Data for where are the whales currently foraging (based on whale sighting data); data for where is the fleet currently fishing (based on zone and depth of traps); .

2. Side-by-side: Monthly side-by-side visualizations for where the whales might be located based on ocean forage information, habitat sustainability models, and whale sightings across multiple years.

A more in-depth look at some of the recommendations shared by interviewees provide additional perspective on layering. They believed layered data needed to be “turn off and turn on” at-will allow for timely interpretation in response to changes in the season. Geographic maps were considered widely used and accepted by interviewees. Specifically, visualizations on top of a geographic representation of the California coast divided by RAMP zones (CCR §132.8, Title 14) would be better for interpretation. Interviewees believed layers with the following information below were important for interpretation:

- Bathymetric map layer with line contours and depth gradients for 70 meter and 200 meter
- Points on a map with lat/long points of sightings for blue whales per zone
- Points on a map with lat/long points of sightings for humpback whales per zone
- Points on a map with lat/long points of sightings for leatherback sea turtles per zone
- Choropleth map layer of whale density per zone

Observational Data And Data Streams On The Horizon: Modeled Data

Interviewees were also asked to think more practically about various data sources to assess risk. Working group advisors evaluated the data sources based on values associated with accuracy, availability, and ease of use. In our conversations, models were mentioned as an important datastream to be used in ways that are complementary, not in lieu of, observational data.

In general, Interviewees expressed hesitancy towards models and believed observational data provided a stronger sense of assurance that whale presence could be demonstrated. Hesitancy towards models was rooted in the perspective that models need to be iteratively tested to understand what questions they can successfully answer. Specifically against new and future data sources, such as the newly established bi-weekly fishing effort reporting requirement and the future Electronic Monitoring requirements expected in 2023.

However, interviewees did not necessarily equate observational data with full trust. In our interviews some participants shared that every dataset has its own limitations, including observational data. One participant cited as examples that visual observation data can only be gathered when people are out on the water or in the air. Other potential observational methods

have their own limitations, such as whale acoustics, which cannot identify whale presence when whales are quiet. Observational data can provide a sense of assurance that might still be incomplete or inaccurate.

Summaries

"Layering" and "side-by-side" were considered important attributes for a strong visualization that could be used to interpret risk. However, ease of use of the data package was also a priority. Working Group Advisors also shared that high level summaries were important for ease of use as complementary to the visualizations. In their opinion, the following topics require text-based summaries to make the data package easy to use for risk assessment:

- Where are the whales currently foraging based on available whale sighting data?
- Where is the fleet currently fishing based on Zone and Depth of traps?
- Where may the whales be based on ocean forage information and habitat sustainability models?

It is important to note that high-level summaries, in addition to the current per-item summaries, were suggested as a minimum to make the data packages more useful. Reflecting on their experience, interviewees saw such text-based summaries as a workaround to the constraint of having multiple individual advisor reports presented in linear fashion. Interviewees were generally consistent across the interview process that summaries should offer high-level interpretations and require that all reports by data providers be considered and aggregated under the topics.

Note, these topical questions for high-level interpretations reflect the input and priorities put forward by interviewees, and are not a comprehensive reflection of all management considerations in the RAMP (e.g., entanglement, socio-economics).

Interviews With Data Organizers

Two CDFW staff were interviewed, with one interview taking place in the data user insight gathering phase, and one taking place in the course of interviews with data providers. In addition to their role as the primary data organizer, CDFW also provides data and reviews all data to inform management recommendations and decisions through the RAMP. Therefore, interviews targeted insights regarding CDFW's experience as a data user, data provider and data organizer. Interviews also sought to develop a more detailed understanding of the process CDFW undergoes to request, compile and share data. While data user and data provider-related insights from these interviews are incorporated into the themes above, the following insights were shared regarding challenges in the organization of data.

Balancing Need For Accurate Up-to-date Data With Quick Turn Around

CDFW staff rely on Working Group Advisors to provide new information on a monthly basis for each risk factor. A common struggle is the lack of consistency in data available for each factor. Some datasets, such as systematic whale surveys, are subject to high variability in timing due to constraints such as weather and sea state, and often delivered past the stipulated date which in turn holds up compiling the data package.

Lack Of Standardization Of Data Deliveries

Inconsistency in the data delivery over time for a risk factor and across risk factors makes it hard to clean the data and present it consistently when the turnaround time is compressed. Overall, compiling, cleaning and processing data is time consuming yet the lack of consistency in data available makes it harder for report readers to visually benchmark or compare the changes over time.

Recommendations

At the highest level, we found that both Working Group members and data providers want to use data and presentations that are true to current conditions, relevant to management decisions, and comparable over time.

Despite a good level of comfort with the current reporting methods, data interpretation demands suggest a strong need to change the reporting process.

While there are some discernible advantages with the existing system, there are serious disadvantages and limitations to data interpretation. The current process provides ease of submission for data providers. However, the current submission process and templated instructions, such as having each individual advisor share JPEG visualizations, makes it hard to visualize layered data for ease of interpretation. Our findings suggest that a dynamic system with greater flexibility to collect all data and "layer" or "turn off and turn on layers" was preferred, which requires the creation of a new data compilation system.

The current staffing and physical layout of the compilation is architected around making data submission as easy as possible for the Working Group Advisors. A new submission process would allow for streamlining the visualization process while addressing relevant accessibility considerations that now fall completely on CDFW staff. Our hypothesis is that implementation of a form submission process will reduce the risks of mistakes while providing greater guidance on how to format the content for compliance with Section 508.

A new submission system should make most content more easily accessible to people of all abilities, including those with visual or cognitive considerations. In the current template, data providers are asked to caption the image JPEGs and submit text-based observations. However, there is no explanation that the caption may be used as an alternative text for screen readers to allow its content and function to be accessible to all users. Validation requirements and information icons with examples can help providers submit the best possible content for accessibility. However, tables and text-based HTML pages will still need to be made available to users in order to compensate for the map-based visualizations.

The process of revamping the visualization will need to consider accompanying changes to the practices around reporting the data.

The scale and diversity of data streams magnify the complexities that come with creating visualizations. Changing how data and visualizations are produced will involve coordination with multiple individuals for most data sources. Data providers expressed willingness to modify or adapt the data they provide, including aggregating predictions up to different geographies, and adding thresholds or other aids to interpretation. They believed modifying or adapting the data is

only possible if CDFW provides guidance on how. Such changes will require interactive discussion about tool features with working group members, advisors and governmental agencies overseeing the RAMP work.

Future System Attributes

We recommend a form-based data submission system accompanied by a dynamic Geographic Information System display. Geographic maps are considered widely used and accepted by interviewees, thus the most important way of displaying information for interpretation. The findings allow us to draw some early specific conclusions in regards to desired requirements for the overall system. It is important to note that not all attributes might be immediately feasible either due to limitations of data sources or because a data stream is not available (e.g., fleetwide vessel movement data).

1. Bathymetric map layer with line contours and depth gradients for 70 meter and 200 meter
2. Points on a map with lat/long points of sightings for blue whales per zone
3. Points on a map with lat/long points of sightings for humpback whales per zone
4. Points on a map with lat/long points of sightings for leatherback sea turtles per zone
5. Choropleth map layer of whale density per zone
6. Map with vessel transit lines (fishing and whale survey)
7. Zoom in to individual RAMP zones and zoom out to view all of the California coastline
8. Import data as a CSV file
9. Export all data in a CSV file

The overall system should give users the ability to visualize data in the following ways:

1. The ability to view on a map points for the lat/long of sighted whales coupled with vessel transit lines on a bathymetric basemap that included line contours and depth gradients for 70 meter and 200 meter.
2. The ability to view on a map where anchovies and/or krill are located coupled with information for whale quantity/density over time for the California coastline
3. The ability to view whale density by zones coupled with fishing vessel tracks on a map
4. The ability to view on a chart quantities of blue whales, humpback, sea turtles per zone
5. The ability to view whale density changes over time
6. The ability to view whale density by Zones coupled with crab landing density by Zones on a map
7. The ability to view economic data such as the market price of crabs over time
8. The ability to submit a narrative text summary using an open field.

A Phased Approach To A Future System

While a system with fully dynamic data is a common goal, it is one that will be achieved only with substantial and iterative effort by a range of actors over an extended period. We see a near-term system that can form a bridge between what's possible now and what we can imagine in the future: Building on the findings in this report, we recommend a combination of human-centered design and development using web standards to improve the way that RAMP data streams are collected, presented, and shared. This approach targets a desired nearterm outcome to maintain

the current level of effort for data providers while substantially reducing the effort required to assemble and disseminate data packages and increasing the accessibility of those packages.

Put simply: The current PDF data packages could be replaced by a form-based submission system and public-facing interface for searching and reading those submissions. The design of such a system should be informed by a user-centered design approach that considers Working Group members, CDFW and other consumers of the data packages, as well as the data providers and CDFW as the data organizer. Input and collaboration with state and federal partners such as NMFS and the OPC likewise remains a priority. By conducting an inclusive, user-centered process, we'll be able to develop a design approach for the data packages that maximizes usability for working group members and other data users, while meeting the requirements and constraints of data providers, CDFW and other key partners.

Next Steps

Findings from user interviews could inform the development of a new web-based system where data providers can submit text, images, and tabular data. We recommend building this system using a fully open source application framework that can power both simple and complex applications.

The approach allows us to start simple. The simple approach would leverage static information: forms to capture text, images, and limited tabular data similar to what is currently in the data Word-based packages. A set of wireframes, or skeletal images which displays the initial functional elements of the system, will need to be fully developed to define the structure and scalability. Below GreenInfo Network has compiled an initial wireframe to illustrate some elements of the recommendations. Further considerations and discussions with Working Group members, Data Providers and Data Organizers at CDFW will be needed to gather feedback and further iterate upon these initial wireframes.

Image 1.1: Wireframe of static Data Package page - desktop version featured below illustrates a potential representation of what the simple approach might look like. Please note that these initial wireframes intend to illustrate the basic architecture, and are not necessarily inclusive of all potential features, style, or language.

The Static Desktop wireframe features a simple navigation with "Data Packages," "New Submission Form," and "About" pages. This system could require a user to log in to submit information, and could also include a publishing/approval workflow for both user accounts and submissions. The page "Data Packages" consists of breadcrumbs, left-aligned title, a filter icon, and a list of data packages. The data packages include a title, the name(s) of who submitted the data, and the organization(s) they belong to. Users would be able to filter data submissions, for example by type of data (e.g., whale surveys), location the data covers (e.g., RAMP zone 1), and/or the organization that submitted the data. Through filters, users would be able to easily navigate to view data submissions over time to assess trends.

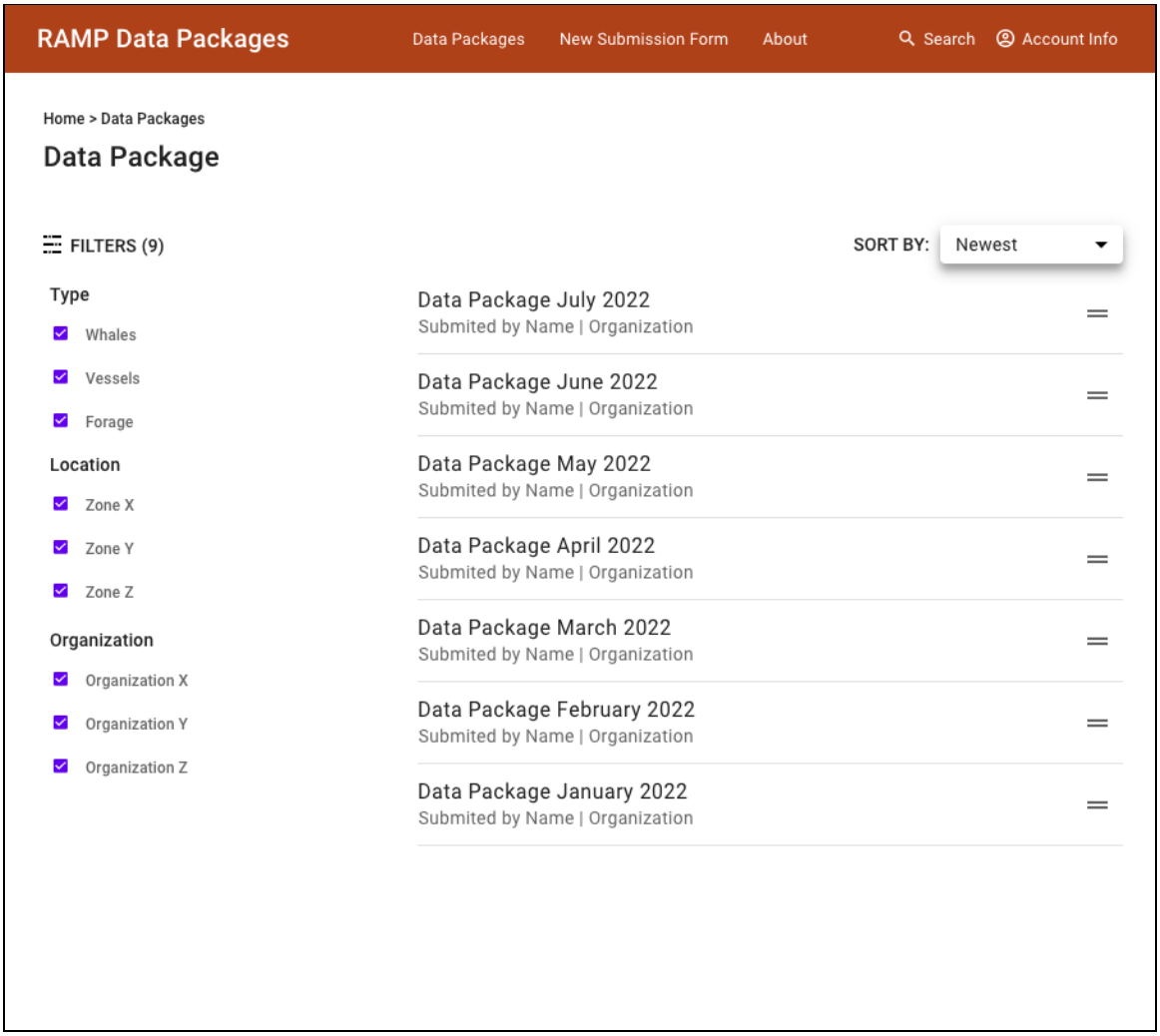

Image 1.1: Wireframe of static Data Packages page - desktop version

The "New Form Submission" is divided into multiple steps and provides guidance through the submission process. *Image 1.2: Wireframe of submission form - desktop version* featured below illustrates a potential representation of what the form might look like. The wireframe features a simple navigation with “Data Packages,” “New Submission Form,” and “About” pages. A user would need to log in to submit information using the form. Data providers can submit a brief title for their submission, choose a category that best represents the data they are submitting and month for reporting. If their submission is an image, the upload section allows them to briefly describe the image and provide an alternative text for Section 508 compliance. The narrative section can be used to provide complementary information. If their submission is text-based, they can use the narrative space to provide that information. For the last step, a data provider can add their name and the organization they represent from a list of pre-populated options. The category, month, and organization selections become filter options on the Data Packages page, making it easier for individuals to find the information they need.

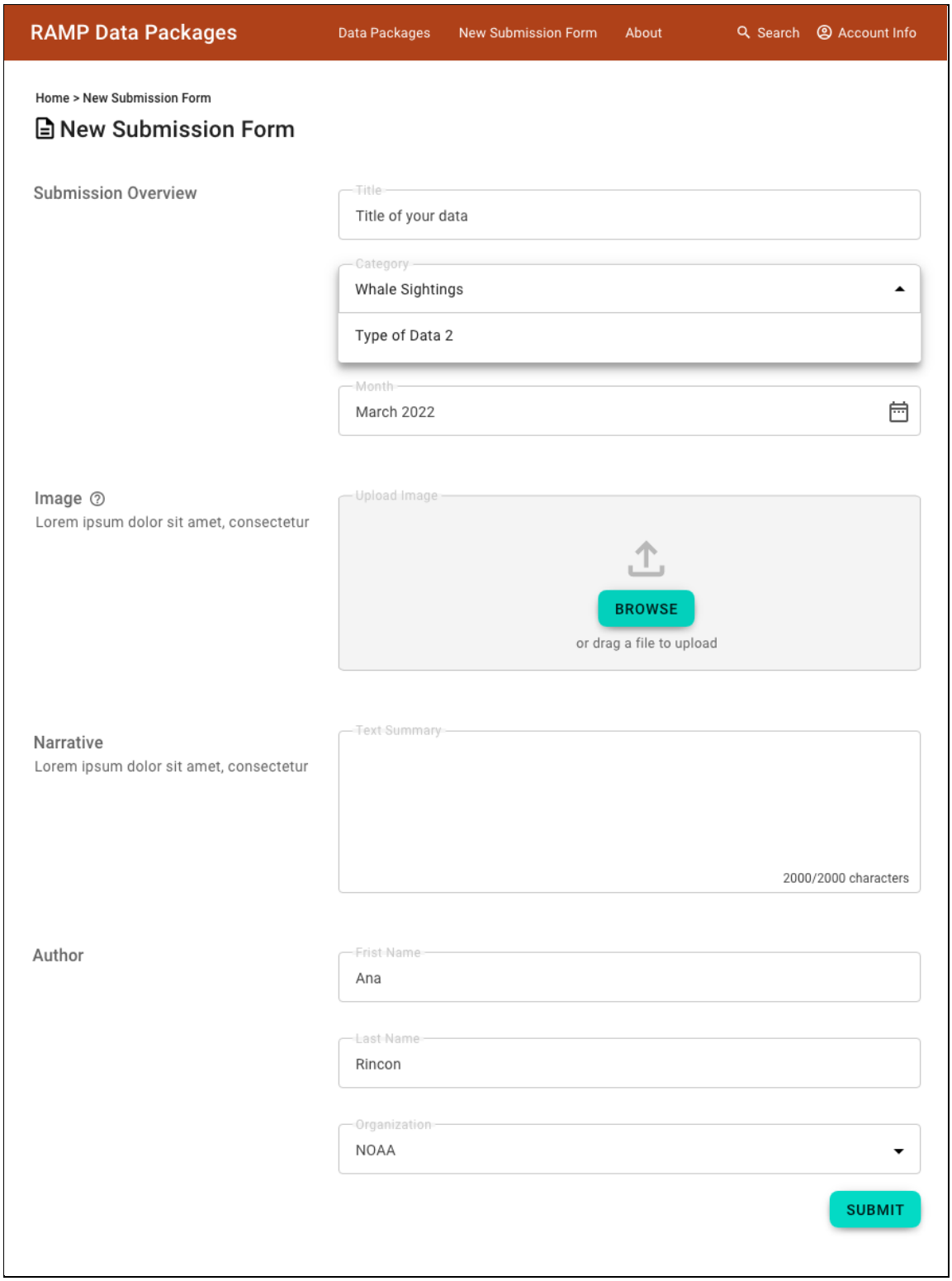

Image 1.2: Wireframe of submission form - desktop version

Through iteration over an extended period of time a system with fully dynamic data would be implemented following a modular approach. *Image 1.3: Wireframe of dynamic Data Packages page - desktop version* featured below illustrates a potential representation of what the modular approach would look like.

The modular approach could allow for a mix of visualizations that support the data streams: Geographic Information or map modules, charts, etc. The wireframe carries over the simple navigation from the previously static interface with "Data Packages," "New Submission Form," and "About" pages. Working Group members could choose to view the data package for a specific month, as with the static version, but they could also look at all instances of a particular chart or map across packages. The dynamic version could incorporate simple search mechanisms and other cross linking within and between data packages.

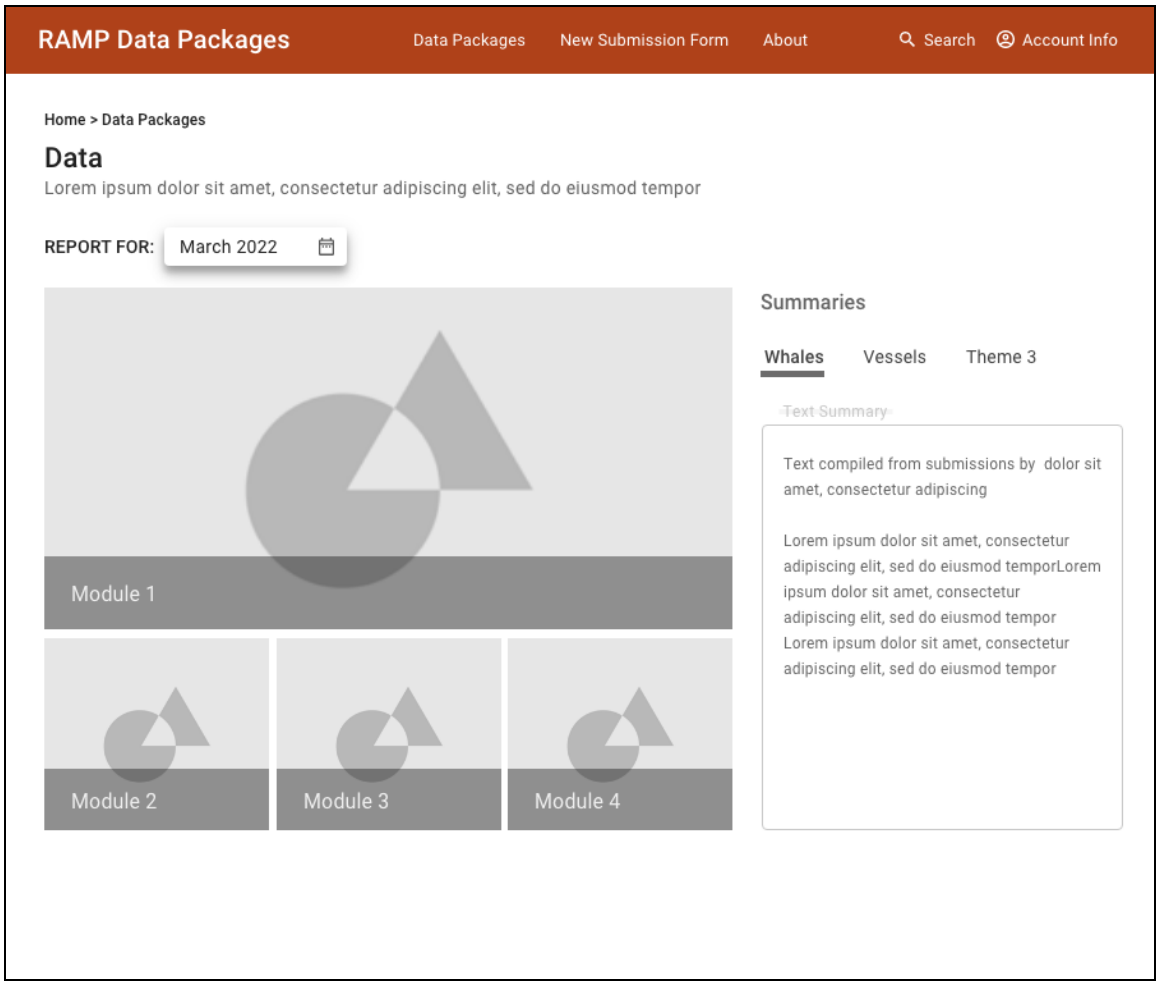

Image 1.3: Wireframe of dynamic Data Packages page - desktop version

Build on and Complement Existing Resources

Working with partners and their existing platforms will be an important aspect to promote collaboration and transparency while ensuring efforts are not being duplicated. For that purpose, and as noted above, all interviewees expressed interest in a form-submission platform with GIS capabilities. In addition to these responses, some interviewees commented about potentially working towards improving and expanding existing platforms, specifically converting the California Current Integrated Ecosystem Assessment platform[2] into a "clearing house" of data that is able to incorporate data from non-NOAA sources and present data at a pace and scale need to inform the RAMP. Others expressed preference and willingness to modify or adapt the data they provide, including aggregating predictions up to different geographies and adding thresholds or other aids for interpretations. Overall, Interviewees looked to CDFW for guidance on how to more effectively work together.

This underscores the importance of a collaborative approach to creating durable, complementary solutions to data integration needs in the RAMP.

It is also important to avoid short-term allocation of resources to a solution that cannot be maintained long-term. Complex web platforms require ongoing maintenance and periodic technical and design upgrades to continue to meet user needs. Investments in new portals should be made with a clear consideration of their full life-cycle cost, not just the cost to get to launch day. The ideal scenario, we believe, is one where open-source solutions draw from machine-readable open data, with clear and well-documented methods for deployment, hosting, and maintenance.

For these reasons, we recommend a flexible and modular approach to maximize opportunities to leverage partnerships toward a shared goal of increasing the accessibility, understanding, and comprehensive use of best available science to inform entanglement risk monitoring and management. The data needs of the Working Group can best be met by focusing efforts on enhancing work that's already been done, building new tools where those are needed, and creating systems that are resilient enough to allow for individual parts to change and evolve over time.

Data Integration is One Component of a Holistic Effort

According to interviewees, any new data submission and visualization platform should be flexible enough to accommodate existing and future data streams that enhance interpretation. A new reporting and visualizing system is only part of the picture to achieve greater common understanding and use of best available science in the adaptive management of whale and sea turtle entanglement risk. The findings also emphasized the importance of transparency in the process of reaching management recommendations and the process of developing, prioritizing and agreeing to the use of new data sources.

In general, there is a strong value placed by interviewees on observational data over models yet most expressed that it's important to further develop models. Specifically, interviewees recommended thinking more practically about models and their purpose. Also, they believed that

[2] https://www.integratedecosystemassessment.noaa.gov/regions/california-current/cc-projects-whale-entanglement

there needs to be greater understanding about the management questions that need answering before, during, and after the Dungeness crab fishing season.

This underscores the importance of an ongoing holistic approach to improve and increase understanding and comprehensive use of best available science. Along with efforts to build data integration tools, additional focused engagement of the Working Group may be valuable to build common understanding of the relative value of existing and emerging data, including models. As an example, a more in-depth series of workshops could focus on existing and future models such as the blue whale model and humpback whale model, among others, and how these can be used to answer key questions. Such efforts could help provide a sense of assurance on emerging data sources such as models and agreement regarding their utility to support the RAMP.

Appendix

1. Semi-structured Interview Questions

Data User Perspectives

Round 1:

Key questions for Working Group members:

- What do you consider to be the most valuable data streams in making risk determinations.
- What is the most helpful way to view the data? Charts, maps, verbal summaries?
- What is on your data wishlist and why do you think it would lead to better recommendations?
- What is your perspective on the usefulness of modeled data versus observational data?

Additional question for advisors:

- Does the WG maximize the use of information available in assessing risk? Are there common misinterpretations or incomplete considerations?

Additional question for CDFW:

- What is working well/not working well in the current process of providing data to the Working Group?
- Does CDFW use any additional data in their management decision making?

Round 2:

Working Group members were asked the following based on map-based and chart-based presentation of three hypothetical scenarios and data visualization of fishing effort distribution and humpback whale distribution:

- Could you rank the three scenarios of data (showing fishing effort distribution and humpback whale distribution) from lowest to highest entanglement risk?
- Do any of the three scenarios reflect a 'high risk' scenario in a fishing area?
- How would you explain the visualization in terms of their interpretation of entanglement risk.
- Would a streamlined visualization help you convey risk assessment findings to the Director, peers, and/or the general public.
- Do you find a chart or map-based visual more informative/intuitive, and why?

Data Providers

- Describe yourself in 1-2 sentences.
- Describe to me your day-to-day work in 2-3 sentences.
- Over the course of a month, how often do you collect data for the RAMP work. Why that frequency? Prompt for percentage of time spent, phase of work
    - Changed to: If not them then: Were you actively collecting data or was there a specific team member that did that?

- Thinking about your work for RAMP, walk me through the step-by-step process of sharing the data with CDFW after you've been collecting and working on it? Prompt for: Does the process start for you with her email or before? Who are the people involved in it?
- Have there been presentation forms (maps, graphs, tables) that you would like to use for the data you provide but have not been able to do? Why? For spatial data, follow up about available data formats (shapefile, etc)
- When it comes to representing your data, do you currently use templates to produce your report? If so, how?
- What application are those templates in?
- In your opinion, what visual elements should a graph or visualization have in order to successfully communicate risk to the working group?
- What other content, elements, things could help with digestion and interpretation of the data?
- What guidance have you received in relation to accessibility? Section 508 accessibility? How?
- When it comes to RAMP work, what would help you share data with CDFW more effectively?

For advisors working on emerging data sources:

- You mentioned that, as part of your day-to-day work, you are working on [x] model. Thinking about your work, walk me through the step-by-step process of creating the model? Prompt for: questions trying to answer, timeline, data collection, etc.
- When thinking of models, what other elements or data layers you think are important to help fishermen and working group members use models to evaluate entanglement risk?

Platform specific:

- You mentioned using platform x. If you could turn or add anything to platform x to make it your ideal platform, what would it be?
- You mentioned x elements. One idea that is being floated is a platform that could help with visualization for interpretation. Is that something a platform could do? Better framed, in your opinion, what kind of platform would best support x element? What is your ideal scenario, blue sky here?

2. Data Package inventory

Below is the full inventory of figures in the data packages for 2020.

Source Compilation	Type	Item
Jan 3, 2020	Maps	Point Blue screenshots - 6 in one image
Jan 3, 2020	Maps	Daily SST Anomaly world map
Jan 3, 2020	Charts	Monterey Bay Whale Watch bar/line charts per half-day trip
Jan 3, 2020	Charts	Stacked Bar: Volume of landing in pounds
Jan 3, 2020	Charts	Stacked bar: Maximum potential traps by week and MacroBlock
Jan 3, 2020	Charts	Line chart: NINO3.4 SST INdex
Jan 3, 2020	Charts	Multiline chart: IRI/CPC
February 4, 2020	Maps	California Macro Blocks
February 4, 2020	Charts	Monterey Bay Whale Watch bar/line charts per half-day trip
February 4, 2020	Charts	Stacked Bar: Volume of landing in pounds
February 4, 2020	Charts	Stacked Bar: Volume of landings by Week and Macroblook
February 4, 2020	Charts	Stacked bar: Maximum potential traps by week and MacroBlock
March 5, 2020	Maps	Observations (non-trap gear) and transect lines from March 21, 2020 aerial survey.
March 5, 2020	Maps	California Macro Blocks
March 5, 2020	Maps	Monthly Habitat Compression Index(annual for 5 years)
March 5, 2020	Charts	Monterey Bay Whale Watch bar/line charts per half-day trip
March 5, 2020	Charts	Stacked Bar: Volume of landing in pounds
March 5, 2020	Charts	Stacked Bar: Volume of landings by Week and Macroblook
March 5, 2020	Charts	Multi-Line: Number of active vessels by week
March 5, 2020	Charts	Stacked bar: Maximum potential traps by week and MacroBlock
March 5, 2020	Charts	Line chart: Monthly Oceanic Nino Index
March 5, 2020	Charts	Line chart: Monthly Coastal Upwelling Transport index
March 5, 2020	Charts	Line chart: North Pacific High January - February Area
March 5, 2020	Charts	Line chart: Monthly Habitat Compression Index
March 5, 2020	Charts	Line chart: Winter Habitat Compression Index
March 23, 2020	Maps	Observations (non-trap gear) and transect lines from March 21, 2020 aerial survey.
March 23, 2020	Maps	California Macro Blocks
March 23, 2020	Charts	Monterey Bay Whale Watch bar/line charts per half-day trip
March 23, 2020	Charts	MBWW Column charts with error bars (3 variants)

March 23, 2020	Charts	Stacked Bar: Volume of landing in pounds
March 23, 2020	Charts	Stacked Bar: Volume of landings by Week and Macroblook
March 23, 2020	Charts	Multi-Line: Number of active vessels by week
March 23, 2020	Charts	Column chart/scatterplots: Boxplots of unit price (dollars per pound) of Dungeness crab by week and port complex.
March 23, 2020	Tables	Estimated number of Dungeness crab traps deployed in each MacroBlock
April 7, 2020	Maps	Biologically Important Areas (BIAs) for feeding humpback whales
April 7, 2020	Maps	Point Blue humpback whale point map screenshot (3 different variants with code snippets?)
April 7, 2020	Maps	California Macro Blocks
April 7, 2020	Maps	Monthly Habitat Compression Index(annual for 5 years)
April 7, 2020	Charts	Monterey Bay Whale Watch bar/line charts per half-day trip
April 7, 2020	Charts	MBWW Column charts with error bars (3 variants)
April 7, 2020	Charts	Stacked Bar: Volume of landing in pounds
April 7, 2020	Charts	Stacked Bar: Volume of landings by Week and Macroblook
April 7, 2020	Charts	Multi-Line: Number of active vessels by week
April 7, 2020	Charts	Line chart: Monthly Oceanic Nino Index
April 7, 2020	Charts	Line chart: Monthly Pacific Decadal Oscillation Index
April 7, 2020	Charts	Line chart: Monthly Coastal Upwelling Transport index
April 7, 2020	Charts	Line chart: March North Pacific High Area
April 7, 2020	Charts	Line chart: Winter Habitat Compression Index
April 7, 2020	Tables	Estimated number of Dungeness crab traps deployed in each MacroBlock
April 7, 2020	Tables	Confirmed whale entanglements from California and/or known to involve gear from California
April 22, 2020	Maps	Point Blue humpback whale point map screenshot (3 different variants)
April 22, 2020	Maps	California Macro Blocks
April 22, 2020	Charts	Monterey Bay Whale Watch bar/line charts per half-day trip
April 22, 2020	Charts	Multi-Line: Number of active vessels by week
April 22, 2020	Charts	Stacked Bar: Volume of landing in pounds
April 22, 2020	Charts	Stacked Bar: Volume of landings by Week and Macroblook
April 22, 2020	Tables	Estimated number of Dungeness crab traps deployed in each MacroBlock
May 8, 2020	Maps	Monthly Habitat Compression Index(annual for 5 years)
May 8, 2020	Maps	Sea Surface Temperature Anomaly

May 8, 2020	Maps	California Macro Blocks
May 8, 2020	Maps	Point Blue humpback whale point map screenshot (2 different variants)
May 8, 2020	Charts	Line chart: Monthly Oceanic Nino Index
May 8, 2020	Charts	Line chart: February ONI
May 8, 2020	Charts	Line chart: March PDO
May 8, 2020	Charts	Line chart: Winter Coastal Upwelling Transport index
May 8, 2020	Charts	Line chart: Monthly Coastal Upwelling Transport Index
May 8, 2020	Charts	Line chart: Monthly Habitat Compression Index
May 8, 2020	Charts	Multi-Line: Number of active vessels by week
May 8, 2020	Charts	Stacked Bar: Volume of landing in pounds
May 8, 2020	Charts	Stacked Bar: Volume of landings by Week and Macroblook
May 8, 2020	Charts	Monterey Bay Whale Watch bar/line charts per half-day trip
May 8, 2020	Charts	MBWW Column charts with error bars
May 8, 2020	Tables	Estimated number of Dungeness crab traps deployed in each MacroBlock
May 22, 2020	Maps	California Macro Blocks
May 22, 2020	Maps	Point Blue humpback whale point map screenshot (2 variants)
May 22, 2020	Maps	Point Blue blue whale point map screenshot
May 22, 2020	Charts	Multi-Line: Number of active vessels by week
May 22, 2020	Charts	Stacked Bar: Volume of landing in pounds
May 22, 2020	Charts	Stacked Bar: Volume of landings by Week and Macroblook
May 22, 2020	Tables	Estimated number of Dungeness crab traps deployed in each MacroBlock
May 22, 2020	Tables	Estimated number of active commercial Dungeness crab vessels and traps by port area
June 9, 2020	Maps	Monthly Habitat Compression Index(annual for 5 years)
June 9, 2020	Maps	Sea Surface Temperature Anomaly
June 9, 2020	Maps	California Macro Blocks
June 9, 2020	Maps	Point Blue humpback whale point map screenshot (2 variants)
June 9, 2020	Maps	Point Blue blue whale point map screenshot
June 9, 2020	Charts	Line chart: Monthly Habitat Compression Index
June 9, 2020	Charts	Multi-Line: Number of active vessels by week
June 9, 2020	Charts	Stacked Bar: Volume of landing in pounds
June 9, 2020	Charts	Stacked Bar: Volume of landings by Week and Macroblook
June 9, 2020	Charts	MBWW Column charts with error bars

June 9, 2020	Tables	Estimated number of Dungeness crab traps deployed in each MacroBlock
June 9, 2020	Tables	Estimated number of active commercial Dungeness crab vessels and traps by port area
June 24, 2020	Maps	California Macro Blocks
June 24, 2020	Maps	Point Blue humpback whale point map screenshot (2 variants)
June 24, 2020	Maps	Point Blue blue whale point map screenshot
June 24, 2020	Charts	Multi-Line: Number of active vessels by week
June 24, 2020	Charts	Stacked Bar: Volume of landing in pounds
June 24, 2020	Charts	Stacked Bar: Volume of landings by Week and Macroblook
June 24, 2020	Charts	MBWW Column charts with error bars
June 24, 2020	Tables	Estimated number of Dungeness crab traps deployed in each MacroBlock
June 24, 2020	Tables	Estimated number of active commercial Dungeness crab vessels and traps by port area
Feb 11, 2021	Charts	MBWW Column charts with error bars
Feb 11, 2021	Tables	Biweekly text-based fishing report
Feb 11, 2021	Maps	Solor logger fishing trips (8 maps of trip lines)
Feb 11, 2021	Maps	Whale Watch 2.0 whale habitat predictions
Feb 11, 2021	Maps	Solor logging whale watching (2 maps of trip lines)
Feb 11, 2021	Maps	Point Blue blue whale point map screenshot
Feb 11, 2021	Charts	Stacked Bar: Volume of landing in pounds
Feb 11, 2021	Charts	Stacked bar: Maximum potential traps by week and RAMP Zone
Feb 11, 2021	Charts	Multiline chart: Average Prince by week and port complex
CDFW_RAMP_Data_Sources_Draft_Overview_09.25.2020.pdf	Maps	Fishing Zones
CDFW_RAMP_Data_Sources_Draft_Overview_09.25.2020.pdf	Maps	Upwell and Aerial Survey
CDFW_RAMP_Data_Sources_Draft_Overview_09.25.2020.pdf	Maps	Point Blue humpback whale point map screenshot
CDFW_RAMP_Data_Sources_Draft_Ove	Maps	Pelagic Data systems fishing trip activity

rview_09.25.2020.pdf		
CDFW_RAMP_Data Sources_Draft_Overview_09.25.2020.pdf	Maps	Pelagic Data systems Estimated fishing effort
CDFW_RAMP_Data Sources_Draft_Overview_09.25.2020.pdf	Charts	Monterey Bay Whale Watch bar/line charts per half-day trip
CDFW_RAMP_Data Sources_Draft_Overview_09.25.2020.pdf	Charts	MBWW Column charts with error bars