The Ocean Health Index Conceptual Guide

Contents

1 Phase 0 - Introduction

1.1 What is the Ocean Health Index?

> The Index is the first assessment framework that provides a common platform for scientifically combining and comparing key elements from all dimensions of the ocean to measure how sustainably people are using the oceans.

The Ocean Health Index (OHI) measures ocean sustainability. It offers the metrics needed to find the balance of priorities to ensure that oceans can continue to sustainably deliver their range of benefits to people now and in the future. The framework itself is structured around clearly defined **goals** coupled with findings of how the **likely future state** is affected by social and ecological **pressures** and **resilience**. The scores are calculated using the best available science, data, and indicators that can be applied to the chosen geographical scope. Scores reflect how well coastal regions are using their ocean benefits in a sustainable way, where a score of 100 means that the evaluated system achieved its defined target, and a score of 0 mean no benefits were achieved or they were achieved in an unsustainable manner.

As a composite index, the Ocean Health Index integrates the results across disciplines and sectors and expresses them through broadly-held public goals:

- **Food Provision** from sustainably harvested or cultured fish stocks
- **Artisanal Fishing Opportunities** for local communities to engage in sustainable practices
- **Natural Products** that are sustainably extracted from the ocean
- **Carbon Storage** in coastal habitats
- **Coastal Protection** from inundation and erosion
- **Sense of Place** from culturally valued iconic species, habitats, and landscapes
- **Livelihoods and Economies** from coastal and ocean-dependent communities
- **Tourism and Recreation** opportunities
- **Clean Waters** and beaches for aesthetic and health values
- **Biodiversity** of species and habitats

1.2 The Benefit of OHI+

The Index is a highly tailorable approach ready to meet the needs and priorities of those who wish to use the ocean sustainably. The OHI framework is repeatable, transparent, quantitative, and goal-driven, and because of this it now being expressed through independent Ocean Health Index+ (OHI+) assessments. The inputs to the OH+ assessments use the same overarching framework while consisting of data and indicators specifically relevant to the local context. Such a flexible framework allows OHI+ assessments to adapt to local conditions while still being comparable within its scope and across time.

> Outside partners are now using the Index framework to conduct their own independent assessments, called Ocean Health Index+ (OHI+) assessments. OHI+ assessments are local interpretations of the original Global Assessments conducted for the first time in 2012 (Halpern *et al.* 2012). The methods have improved since then, and researchers have changed the goals, models, and data in their assessments in an ever-evolving process that characterizes the Index.

The Index is the first assessment tool that provides a common platform for scientifically combining and comparing key elements from all dimensions of the oceans health — biological, physical, economic, and social – to measure how sustainably people are using the ocean. By allowing for a comprehensive and integrated view of marine systems as a way to understand the trade-offs and synergies among these goals, the Index represents a significant advance over conventional single-sector approaches to assessing sustainability as communicated through other kinds of index efforts.

The OHI supports the growing need for marine management to establish comprehensive objectives that maximize the ocean-derived benefits delivered to people while at the same time keeping oceans healthy. As a management tool, the Index can inform decision-making by helping stakeholders identify geographic and thematic priorities for management, which increases the cost-effectiveness of actions taken. At the same time, it addresses the desire for policymakers to increase environmental performance in the face of budget constraints for natural resource conservation, and galvanizes efforts towards ecosystem-based management.

1.3 The Process of OHI+

TIP: The amount of time required to do an OHI+ Assessment will vary.

The OHI+ process consists of four distinct phases. In the first phase, you will learn about the OHI and understand the philosophy behind it and the motivation for conducting your study. In the second phase, you will actively plan to conduct an OHI+ Assessment. In the third phase, you will engage with the science of finding the data, preparing the goal models, and taking the necessary steps to learn the software and produce the results. In the final phase, you will communicate the results of your OHI+ Assessment in order to inform stakeholders who will use its findings.

- **Phase 1: Learn** about the OHI
- **Phase 2: Plan** an OHI+ Assessment
- **Phase 3: Conduct** the OH+ Assessment
- **Phase 4: Communicate** and Inform

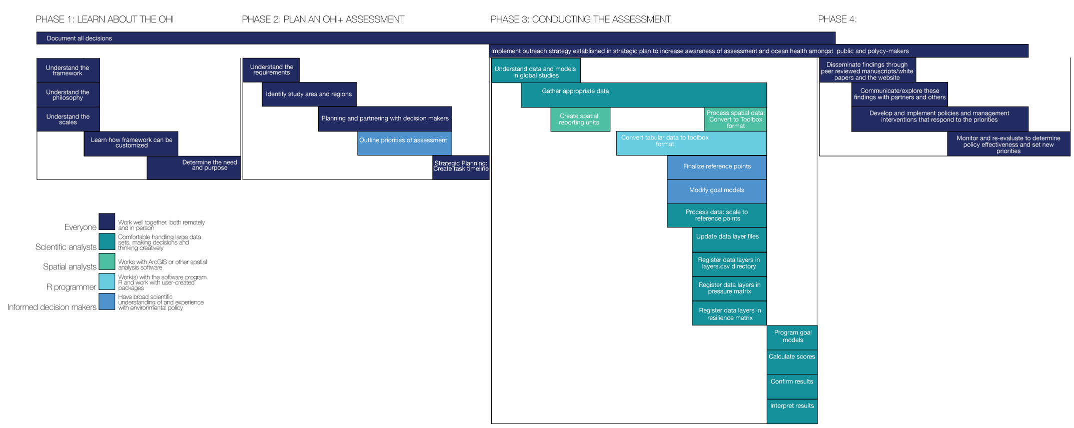

Figure 1: The Task Timeline shows the steps recommended in conducting Ocean Health Index assessments. It gives an overview of the **Phases** of the project and the colors offer recommendations for the types of skills needed at different stages of the process.

When conducting an assessment, is it useful to use our timeline as a guide, knowing that the amount of time required to do an assessment will vary. It is important to keep in mind that the process of conducting the assessment requires collaboration and iteration among your team to arrive at the best results possible. The process of conducting an assessment is a scientific one and good documentation to track the decision-making along the way will support the validity of the results.

- For more information, visit: http://ohi-science.org.

1.4 Natural Products

> The **Natural Products** goal describes how sustainably people harvest non-food products from the sea.

1.4.0.1 Philosophy

Natural Products evaluates the levels of sustainability for all ocean-derived goods that are traded. These include shells, sponges, corals, seaweeds, fish oil, and ornamental fishes, among other things. It does not included products that are consumed for only nutrition, but may in some cases include products that are consumed as medicine. In the Global Assessments, the goal model calculates overall status by weighting the status of sustainable harvest of each extracted marine product by its proportional value relative to other harvested products. Higher scores reflect sustainable extraction of non-food ocean resources with little to no impact on surrounding habitats, marine species, or human well-being.

1.4.0.2 Ideal Approach

Ideally, quantity, value, and a sustainability rating of the harvest method would be available for every marine and coastally-derived natural product within the regions of a study area. This would include a wide range of products, including corals, shells, seaweeds, aquarium fish, mangrove wood, or any non-food marine product that is harvested within a region. The ideal reference point would be derived from a functional relationship of the sustainability of the harvest for each product relative to the amount of product available in the ecosystem, informed by scientific studies.

1.4.0.3 Keep in Mind

This goal does not include non-living items such as oil, gas, and mining products, because these practices are not considered to be sustainable. They are also done at such relatively large scales that including them would essentially make an index for those sectors specifically. This goal also does not include any valuation of things like bioprospecting for medicines through genetic discoveries, which has an unpredictable potential value occurring in the future rather than measurable value now.

The activities that drive this goal can interact with other goals and sub-goals when unsustainable harvesting practices are used. Because so little is known about some of the functions relationships between the amount of natural products taken and the effect of harvest on their quantities in the ecosystem, assumptions often have to be made to set the reference points in the calculations.

Assessment	Model Description and Reference Point
Global 2012	For the status of each product, we assessed the most recent harvest (in metric tons) per regio
Global 2013	The goal model and reference point had the same approach as Global 2012, although the data
Brazil (2014)	The goal models and reference points used the same approach as Global 2012
U.S. West Coast (2014)	Not included in this assessment. Scores were not calculated because there are few data availal

1.4.0.4 History of the Approach

1.4.0.5 Practical Considerations

1.4.0.6 *Ideal Approach*

Ideally, quantity, value, and a sustainability rating of the harvest method would be available for every marine and coastally-derived natural product within the regions of a study area. This could include a wide range of products depending on what is harvested in the study area, including corals, shells, seaweeds, aquarium fish, mangrove wood, or any non-food marine product that is harvested within a region. The ideal reference point would be derived from a functional relationship of the sustainability of the harvest for each product relative to the amount of product available in the ecosystem, informed by scientific studies. Without such information, assumptions and expert judgment will need to be made to set the reference point.

1.4.0.7 Ready to start on Natural Products? Whether you use the approach from the global assessment or are developing your own new model entirely, there are a few tasks that will remain the same because are key to the philosophy of this goal.

The first is to identify **identify which products are in your study area.** For example, does your study area have corals, ornamental fishes, sponges? Does your area yield medicines from the sea, that are not used for nutrition under **Food Provision**? Does your area harvest drinking water from the ocean through desalination plants? Is there a kelp or seaweed industry in your area?

Study	Natural Products considered	Data Source
Global 2013	aquaria fishes, corals, sponges, shells, seaweeds, fish oil	UN FAO database
U.S. West Coast (2013)	kelp considered, not included	NA
OHI+ China	seasalt, medicine, chemicals	China Statistical Yearbook 2014
OHI+ Israel	desalinated water, not included	???

The second task is to think about **where these products are harvested and how much of them are harvested** in these areas through a period of time. You should find spatial representation of these products, which can be done by knowing where they are derived from. Do they come from certain habitats (in the case of coral) or animals (in the case of fish oil)? This information will help calculate the sustainability of the harvest of eah natural product. harvest amounts and the spatial data are used to calculate **exposure** further on, and can also be used to set the **relative weighting** between the products. These spatial data may have already been used in other goals, or they may lead you to find useful data that can be used in other parts of the assessment (See **Best Approaches**).

> TIP: The data layer, `hab_extent` is used here and in other goal models in the default code for the Global Assessment.

It should be noted that in the Global Assessments, the harvested amounts are derived from the information from the Food and Agriculture Organization of the United Nations (FAO), and these are combined with habitat values used elsewhere in the assessment. You should be conscious of this as you go through the model and change it, because you may be able to simplify aspects of the code such as gap-filling.

The third component is to try to find the **sustainability** coefficients of the identified products. These could be given values, in which case you would simplify the model, or they could be derived from two factors, **exposure and risk**. The **exposure** will come from the spatio-temporal harvest amount data already prepared, and the **risk** will come from the scientific literature or a developed indicator. For both of those cases, the values can be calculated in separate equations as part of your data preparation process.

> Global assessments borrow principles from fisheries science to make estimates of product sustainability. In the Global 2013 assessment the sustainability component was derived from the historical maximum harvest recorded, the maximum harvesting density recorded, and risk status assessments by the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

One very important thing to consider at this point is your **reference point for the relative harvest amount**. The relative harvest of your data is multiplied by the sustainability coefficient in the last step.

$$S_p = 1 - \left(\frac{E + R}{N}\right)$$

Figure 2: Natural Products goal model from OHI Global Assessment 2013

Setting the reference point is a decision your team must make based on the available data and an inferred functional relationship between the harvest of the product and the amount in the system. Understanding the patterns in harvest can help inform how to set the reference point. For example, knowing whether harvesting effort was constant or whether product yields changed due to the market demand and not the availability. This information could help inform whether it is more appropriate to set the reference point as the peak yield of the timeseries, or some percentage above or below, or some other approach that is ambitious yet realistic (SMART principles).

[insert an image of trend in total harvest vs time?]

Example: The Global assessment used the following information in the Natural Products equations:

product	relative tonnes (1)	weighting (2)	Exposure (3)	Risk (4)
coral	FAO	FAO	coral habitat	all 1
sponges	FAO	FAO	coral + rocky reef habitat	all 0
ornamentals	FAO	FAO	coral + rocky reef habitat	1 if blast/cyanide fishing, otherwise 0
fish oil	FAO	FAO	fish score/100	–
shells	FAO	FAO	coral + rocky reef habitat	all 0
seaweeds	FAO	FAO	rocky reef habitat	–

1.4.0.8 What's the code trying to do? [check!]

You may have already looked at the **NP** section of `functions.R`. In simple terms, here is what the code is doing:

- It pulls out the appropriate data layers to find out the amount of each product per unit area. It does gap-filling as necessary for the Global data.

  Note that "amount" here could be dollar amount or physical tonnage, depending on your situation – these two variables are sometimes used interchangeably in assessments as a means of gap-filling.

- It calculates Exposure by finding how intensely each identified product is being harvested (amount of product per km^2), and then transforms this from a scale from 0 to 1.
- In parallel to this, it finds the Risk of each product based on a scoring system that becomes binary: 0, or 1.
- It then averages the two factors, Exposure and Risk, to reveal where risk and intensity are highest. This value is then inverted to become Sustainability and to reward lower intensity and lower risk.
- The amount of each kind of product, relative to the total amount [of?], is multiplied by the sustainability coefficient to create sustainability-weighted scores for all regions and all years available.
- The latest year value is used in the status, and the past few years' values are used in the trend to produce the final score.

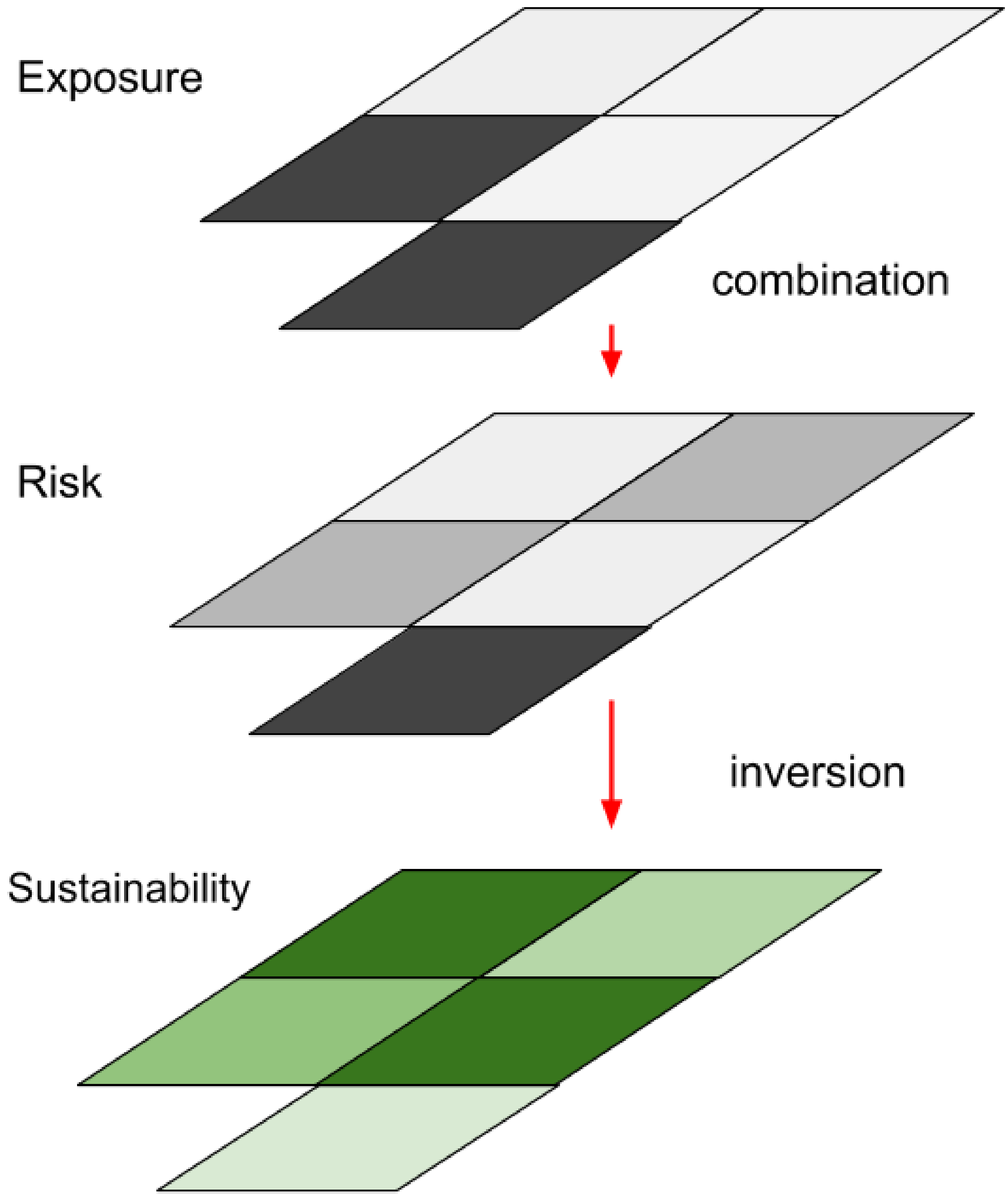

Figure. Diagram of sustainability calculation, NP.

1.4.0.9 Data Sources If the case is that corals, sponges, and then you might be able to use FAO data, which is the data source of the Global Assessments. Otherwise, you will have to find comparable data in your area or consult local statistical offices and local fisheries managers to get harvest values similar to landing values and any other kinds of stock assessments. The IUCN offers quantified assessments of risk to species, but that is more appropriate for biodiversity; CITES signatory data may be more appropriate for the trade products. Exposure can be calculated spatially, and for this you should be able to find or produce your own maps if possible. Your maps might have finer resolution than those in global resolution.

1.4.0.10 What are other considerations?

Coming soon.

1.4.1 Appendix - source materials

1.4.1.1 Recommendations for regional assessments

The kinds of marine products included, and how much should each contribute to the overall score may vary from case to case and should be decided based on the data available (see model details below in Evolution of the Approach). For example, if seaweed is a natural product, but it is also food, if there are no data to indicate the proportions of these two uses, some other source of information will have to be used to decide what proportion should be used to calculate Food Provision and what proportion should be computed for Natural Products. As another example, oil from marine mammals was excluded from the models presented here, but if a region has a considerable amount of mammal oil harvest, they should include it in the calculation, keeping in mind that the sustainability of this type of harvest is likely to be low and should be reflected in the score.

It is possible to measure sustainability in a number of different ways. Quantitative information can be used, or expert judgment, perhaps based on information or rough estimates of how sustainable the harvest method is, which is what was done in Global 2012. We based the sustainability component on the historical maximum harvest recorded, the maximum harvesting density recorded, and risk status assessments by the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). In the absence of these, we borrowed general principles from fisheries models to provide rough estimates.

1.4.1.2 Appendix - Global Data Approach (Technical Notes)

Data Overview

product	relative tonnes (1)	weighting (2)	Exposure (3)	Risk (4)
coral	FAO	FAO	coral habitat	all 1
sponges	FAO	FAO	coral + rocky reef habitat	all 0
ornamentals	FAO	FAO	coral + rocky reef habitat	1 if blast/cyanide fishing, otherwise 0
fish oil	FAO	FAO	fish score/100	–
shells	FAO	FAO	coral + rocky reef habitat	all 0
seaweeds	FAO	FAO	rocky reef habitat	–

(1) relative tonnes: tonnes relative to max tonnes for region with 35% buffer. The maximum corresponds to the year with the highest $ value - but it would probably be better to just base this off tonnes. When we redo these data lets evaluate this approach.

(2) weighting: This weights the contribution of each product according to USD at max year for a region. It makes sense to use $, because comparing extraction weight of sponges vs. ornamentals doesn't make sense.

(3) Exposure: For fish oil this value is the FIS score (which is a bit different than what is described in the paper because FIS score can have penalties for underfishing). The other values are determined by: log (harvest/habitat area + 1) / log[max(harvest/habitat area) +1].

The habitat area used for seaweeds: rocky reef The habitat area used for coral: coral The habitat area used for shells, ornamentals, sponges: coral plus rocky reef

1.4.1.3 Calculation

For each product: sustainability = 1- average(exposure, risk) Prod_score = sustainability*relative tonnes

Then take a weighted average of the Prod_score using the "weighting" file.

1.4.1.4 Notes on modifying the function

1. Several data layers are called that are not used: np_harvest_tonnes, np_harvest_usd, np_harvest_usd_relative

1.4.1.5 Preparing the Data

Notes from Katie while updating the NP goal:

Natural products **harvest:** - explore simplifying gap-filling: use correlation model of dollar value vs harvested tonnage, while discarding the part of script using dollar ratio (curr dollar value/peak dollar value) as a gap-filler for harvest ratio - switch the gap-filling order: using the dollar value correlation model first (in cases where the most recent year has no harvest reported but has dollar value reported, that's a better estimate than using the harvest from the previous year), then gap-fill any remaining cases of missing harvest for the current year with harvest from the previous year

sustainability: - check cases where country-product pair has 0 for sustainability score, but relatively high harvest ratio (curr harvest/peak harvest) – it may be a flag that the sustainability score is off (eg because the habitat area is off)

1.4.1.6 Tech Specs

Updating the Script

I just pushed a new script, `data_prep_2015a.R`, and the resulting outputs to `ohiprep/globalprep/fao_commodities/v2015`. The new script reworks the gap-filling, based on Mel's and Katie's suggestions. I'll post later about the smoothing and calculations based on new input from Katie, but would love to get input on the gap-filling first. * Before gap-filling, binds the USD and tonnes data for all natural products at the commodity level (rather than product level). * By commodity & year: Identifies years with neither USD nor tonnes data, flags as `no_data`, and determines first reporting year based on first year with either data (and deletes years prior to this). * By commodity & year: Gap-fills according to these rules: * If `no_data`, and not the last year of data set, assume that non-reporting means zero harvest; replace `NA` with `0` for both USD and tonnes * Create regression models for `(tonnes ~ USD)` and `(USD ~ tonnes)` * Exclude NAs (these will be in either USD or tonnes, but not both) * Remove all commodities with fewer than four non-zero observations (within a particular region) * not enough info for a decent regression or meaningful peak * counting these could also penalize experimental production that later stops * Use `lm()` to generate slope/intercept, and gap-fill all NAs with the appropriate regression model * Regression gap-filling takes care of the most current-year gaps, per Katie's comment * Regression gap-filling fails for certain data, where there are no paired observations for correlation (e.g. every reported value for USD shows NA for tonnes, and/or vice versa), still need to figure out how to deal with those without losing useful data. * If `no_data` appears in most recent year of data set, not applicable for regression gap-fill, so end-fill based upon the prior year. * Outputs a .csv with rgn_id, commodity, product, year, and gapfill method at the commodity level. I made up text codes for now, pretty self-explanatory, but those are easy to change. File is `data/np_gapfill_report.csv` if you want to take a peek. * Collapses commodities into products at this point, in preparation for smoothing, finding peaks, and determining status and weighting.

Latest on NP: in ohiprep/globalprep/FAO-commodities, new (well, a week or so ago) data_prep2015.R that fixes: * the FAO data cleaning, so treats '0 0' as 0.1 instead of NA * gap filling: * it runs at commodity level instead of product level * gapfills between USD and tonnes in sequence: local regression, then georegional regression, then global regression. * does all that before end-filling. * produces a gapfilling report for every commodity/region/year. Currently this outputs a single file; needs to be updated to output individual files for tonnes, tonnes_rel, and prod_weight. Needs to be renamed to data_prep.R.

In ohi-global/eez2013, LSP_update branch, I've updated /conf/functions.R - cleaned up (dplyr, etc), chunked into sub-functions. Questions that need to be addressed: * currently calcs trend using last five years of data (year_max >= year > year_max-5), which means only four intervals for the regression. I think we want to include the (year_max - 5) data, for five intervals, so: (year_max >= year >= year_max-5). * currently, for regions with exposure = NA, replaces NAs with zero. Should these be replaced with one

instead? * Exposure for these indicates harvest intensity (tonnes/km^2) relative to the region with the max harvest intensity.
* NAs occur when a country hasn't reported area values for rocky (seaweeds), coral (corals), so tonnes/NA = NA. * Setting exposure to zero means intensity = none at all (boosting the status); leaving as NA removes from calculation (ignored in status); setting to one means intensity = worst case (penalizing the status).

Almost there!

1.5 Carbon Storage

> **Carbon Storage** describes how much carbon is stored in natural coastal ecosystems that absorb and sequester it in large amounts.

1.5.0.7 Philosophy

Carbon Storage evaluates the status of coastal marine habitats with high carbon storage capacity. In this case, "storage" means carbon sequestration. Highly productive coastal wetland ecosystems, like mangroves, salt marshes, and seagrass beds, have substantially larger areal carbon burial rates than terrestrial forests. Coastal habitats therefore play a significant role in mitigating global carbon levels, and the health of these habitats is important because their destruction also releases large quantities of carbon into the atmosphere, damaging the overall health of coupled marine systems and furthering global climate change.

> Though they form less than 2% of the ocean's surface, coastal ecosystems contribute more to long-term carbon storage and sequestration in sediments than any other ocean ecosystem.

Our focus here is on coastal habitats, so-called "Blue Carbon", because they have large potential to store carbon without causing acidification, and, contrary to open oceans, they provide a carbon storage service that can be affected by human actions such as conservation, and restoration efforts.

> The Global 2012 assessment focuses on three ecosystems — mangroves, tidal marshes and seagrasses — for their ability to store and sequester carbon in their plants and soils. When destroyed or degraded, these ecosystems not only stop sequestering carbon but can start to release it, and can emit carbon for centuries and contribute to climate change.

1.5.0.8 Ideal Approach

Ideally, to assess the amount of carbon stored in every coastal habitat, information would be available regarding coverage area and some measure of quality. For example, you would have data for both the spatial coverage of a mangrove and know its tree density. Additionally, different weights would be assigned to the habitats based on their relative ability to store carbon. The carbon storage model can incorporate such weights once they are available in a similar way to the methods developed for the coastal protection goal. The reference point for habitat-based goals will likely be a comparison with a historic extent or state; this means that historic data are needed such that current habitat extent data can be compared to them.

> TIP: The relative carbon storage abilities for different habitats is an area of active research.

1.5.0.9 Keep in Mind

In basic terms, the plants take up carbon dioxide and store it in organic form within their tissues. Leaves and detritus that fall to the bottom and become covered with sediment retain those organic compounds for centuries or millennia if undisturbed. Storms and human development disturbance exposes this buried material to oxygen with the result that carbon dioxide is released and traps even more eat in the Earth's atmosphere.

Even though the pelagic oceanic plays a large role in the sequestration of anthropogenic carbon, by acting as a large carbon sink, the mechanisms for open ocean carbon storage cannot be managed locally or regionally as there are no practical methods for intervention or manipulation. On top of that, the storage of global carbon in ocean water leads to its acidification, which has many consequences for marine life.

Because they store carbon for less than 100 years, seaweeds and corals were not included in the carbon storage goal in the Global Assessments. While the pelagic oceanic carbon sink, consisting of phytoplankton, plays a large role in the sequestration of anthropogenic carbon, the pelagic ocean mechanisms are not amenable to local or regional management intervention. Phytoplankton contribute to carbon fixation when they die and sink to the sea bottom at sufficient depth, because it is effectively out of circulation. However, if those phytoplankton are eaten, the carbon is cycled back into the system and not sequestered.

Something that could potentially be included in the carbon storage goal in the future is mollusc shells, if they are added to a landfill and not recycled in the sea. So if information on mariculture production and waste disposal are available, this could be an interesting addition to carbon storage at a regional scale.

Assessment	Model Description and Reference Point
Global 2012	The status of Carbon Storage is measured as a function of its current 'condition' relative to a
Global 2013	The goal model and reference point were the same as in Global 2012. There were improvemen
Brazil (2014)	The goal model was the same as in Global 2012.The reference condition was determined speci
U.S. West Coast (2014)	We used reconstructions of historic extents compared to current habitat coverage to set more

1.5.0.10 History of the Approach

1.5.0.11 Practical Considerations

1.5.0.12 Ideal Approach Ideally, information would be available to allow you to to assess the amount of carbon stored in every coastal habitat in your area. The best information would show area covered and some measure of the quality of the habitat for this goal. For example, a dense mangrove forest would be better quality than a sparse mangrove forest. Additionally, different weights would be assigned to the habitats based on their relative ability to store carbon, and this factor could be used to penalize areas where there is greater loss of carbon and reward areas where this is a greater storage of carbon. The carbon storage model could then incorporate such weights in a similar way to the **Coastal Protection** goal. The reference point for habitat-based goals will likely bes temporal in most cases. This means that historic data are needed so that current habitat values can be compared to a past state.

> TIP: Understanding habitat carbon storage rates is an area of ongoing research. The capacity for habitats to store carbon varies, and depends on the morphology of plants in the system.

1.5.1 Ready to start on Carbon Storage?

The overall **Carbon Storage** model and approach should not change from what is used in the current Global model. Knowing the area and the condition of of carbon-storing habitats are the two components that are most important. For example, if you have area of mangrove coverage and density of the mangroves within that area, you will find more robust results. It may not be the case in practice to have both variables, however.

One of the first decisions for your team to make is **whether to use the available data** in the Global Assessments or to use another dataset. This is because your goal model shouldn't change entirely from the Global, and you could even use the global data layers that are spatially-explicit and offered at a resolution of 1 km^2. The global data layers show mangroves, saltmarshes, and sea grasses. Further, they are already available for you to use and will therefore expedite your process for this goal. You should think here, however, of how your regions' size compare to the dataset's scale, and return to this question once you are thinking about the **reference points** farther on. You should also remember that we recommend using habitats that can store carbon on the order of 100 years, thereby limiting the types of habitat types you will need.

> TIP:, if you look at your default data on the WebApp, you will see **Carbon Storage** information presented for **mangroves**, **salt marshes**, and **sea grass** even if there are no mangroves in your area. You will not be scored on these if they are not in your area.

The second group of items to consider are the **condition** and **carbon contribution** if you can find the data for it. **Condition** is more essential than **contribution** in this case. **Contribution** is how much each habitat stores relatively to the others–such as the rates of carbon uptake as measured by empirical data. For this you would have to go to the literature and find ratios of organic nutrient uptake between habitats, and you would have to make sure these studies are done correctly to represent your area. For example, were the studies done with a young mangrove forest, or an older one, which might have different growth rates? The **condition**, on the other hand, is a judgment made to find how well the habitat is doing now compared to how it was doing in the past.

> For example, in Global 2012, seagrass's condition was calculated as "Current % cover or hectares of habitat divided by reference % cover or hectares." Salt marshes, on the other hand, were assigned a score of 1 if they had an increasing or stable trend, and assigned 0.5 if they had a decreasing trend.

A vital consideration for this goal is **the reference point**. It's an important decision to be made based on good science given the limitations of available data. The reference point is the extent of the habitat at some time in the past, in other words the ideal condition. You will need historical data for this–either from satellites, published papers, or even hand-drawn maps. For questions of sustainability, you must consider, what is a good year to set as your historical past extent? Do you want to be ambitious and set it far in the past, so it gets closer to a more "pristine" condition? Or do you want to make it represent human use? Will it make your scores look better or worse if you choose a more recent or more distant example?

> In the U.S. West Coast assessment (2014), researchers went to the local public library to find hand-drawn maps of historical salt marsh extents in California. No digital data were available in the 1850s!

In this case, perhaps your choice of historical reference point may be guided by a policy target as well. For example, are there any climate change policies in your area, with defined targets and objectives? Are there any restoration or carbon storage projects in your area? Do any organizations offer guidance on the amount of carbon storage your management policies should be aiming for?