General Introduction to the Global Ocean Health Index

The Ocean Health Index is the first assessment tool that scientifically compares and combines key elements from all dimensions of the ocean’s health – biological, physical, economic and social—to measure how sustainably people are using the ocean. Using the definition “A healthy ocean sustainably delivers a range of benefits to people now and in the future,” the Index assesses and tracks a portfolio of ten goals (shown in Table 1) that people have for a healthy ocean and their associated benefits. The goals, shown below, were selected by an expert group of scientists, sociologist, and economists after reviewing available literature to learn what people expect from a healthy ocean. Scores show how well coastal regions optimize a sustainable long-term flow of those benefits to people. The amount of each benefit gained is compared with a sustainable reference point. The score is the average of present Status (the most recent value) and Likely Future Status (the probable change in Status during the coming 5 years) as shown below in Table 2. The Index can be used at nearly all geographic scales from global to local. A regional-assessment of the Ocean Health Index was recently completed for the U.S. West Coast. The

Table 1: Ocean Health Index goals and the associated benefits that are measured

<table>
<thead>
<tr>
<th>Goal</th>
<th>Sub-Goal</th>
<th>Benefit Measured</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food Provisioning</td>
<td>Fisheries</td>
<td>Seafood sustainably harvested for human consumption from wild, or cultured stocks</td>
</tr>
<tr>
<td></td>
<td>Mariculture</td>
<td></td>
</tr>
<tr>
<td>Artisanal Fisheries</td>
<td></td>
<td>Opportunity to engage in artisanal fishing as a social, cultural and livelihood activity</td>
</tr>
<tr>
<td>Natural Products</td>
<td></td>
<td>Amount of sustainably harvested natural products (other than for food provision)</td>
</tr>
<tr>
<td>Carbon Storage</td>
<td></td>
<td>Conservation of coastal habitats affording carbon storage and sequestration</td>
</tr>
<tr>
<td>Coastal Protection</td>
<td></td>
<td>Conservation of coastal habitats affording protection from inundation and erosion</td>
</tr>
<tr>
<td>Tourism and Recreation</td>
<td></td>
<td>Opportunity to enjoy coastal areas for recreation for locals and tourists</td>
</tr>
<tr>
<td>Livelihoods &amp; Economies</td>
<td>Livelihoods</td>
<td>Employment (livelihoods) and revenues (economies) from marine-related sectors</td>
</tr>
<tr>
<td></td>
<td>Economies</td>
<td></td>
</tr>
<tr>
<td>Sense of Place</td>
<td>Iconic Species</td>
<td>Sense of place and cultural connectedness to the ocean afforded by lasting special places and iconic species</td>
</tr>
<tr>
<td></td>
<td>Lasting Special Places</td>
<td></td>
</tr>
<tr>
<td>Clean Waters</td>
<td></td>
<td>Clean waters that are free of pollution, debris and safe to swim in</td>
</tr>
<tr>
<td>Biodiversity</td>
<td>Habitats</td>
<td>Conservation of biodiversity of species and habitats for their existence value</td>
</tr>
<tr>
<td></td>
<td>Species</td>
<td></td>
</tr>
</tbody>
</table>
The results, released on June 18, 2014 in the scientific journal PLOS ONE, assess the health of the coast and waters of California, Oregon, and Washington.

Each goal is assessed on a scale from 0 to 100. A score of 100 means that the evaluated system has achieved its defined target (reference point) for that goal, is sustainably delivering all of the specified benefits, and is likely to continue doing so in the near future. It does not imply that conditions are pristine or that benefits are maximized absolutely, but only relative to the chosen reference points. A score of ‘0’ means that none of the available benefits were gained or that they were obtained in an unsustainable manner. A region’s score is the average of its goal scores. Goals not applicable to a region are not calculated or averaged. Natural Products was not assessed for the U.S. West Coast because trade in non-food marine products is nearly zero in the region.

Global assessments measure the marine conditions of every coastal nation and require similar data from each one, allowing country-to-country comparison of results. Regional assessments, such as that for the U.S. West Coast, take advantage of higher quality data that may be available in some countries or areas, yielding more accurate results for use by local managers or policy makers. However, those results are specific to the region studied and not comparable to global results or other regional assessments.

### U.S. West Coast regional and sub-regional scores

The U.S. West Coast study used regional data for 80% of the 49 data layers examined. Region-specific methods or reference points were used for all of the 17 goals and sub-goals assessed. Scores were calculated for five coastal sub-regions – Southern California, Central California, Northern California, Oregon, and Washington – and the overall score is the area-weighted average of those five scores.

The U.S. West Coast scored 71 out of 100. Oregon was the highest scoring sub-region (74), followed by Southern California (73), Central California (71), Northern California (67), and Washington (65). Though not strictly comparable, the overall regional score was slightly higher than the global score for the entire U.S. in 2012 and 2013 (67), possibly because the U.S. global score included all five of the country’s EEZ: Alaska, Hawaii, U.S. West Coast, U.S. East Coast, and the Gulf of Mexico. The U.S. West Coast is a well studied, relatively healthy, and sustainably managed system, but the area is not fully maximizing all the ocean benefits that it could, particularly in the lowest scoring goals and sub-goals: mariculture, lasting special places, artisanal fishing opportunities, coastal protection, iconic species, carbon storage, and biodiversity.
Figure 1: U.S. West Coast study region. Goal scores per sub-region (left) and overall U.S. West Coast (right). The width in each petal in the plots represents the weight for the goal or sub-goal. The color legend and goal names correspond with table 1. The center number is the overall index score. The natural products goal is shaded gray because it is not applicable. Regions are depicted with coastal counties and the 200 nm Exclusive Economic Zone is shaded in darker blue for reference only.
Overall results for the U.S. West Coast

Table 1: Regional Assessment scores for the U.S. West Coast and each of the five regions studied

Goals are labeled in bold; sub-goals in light text. Goal scores are the arithmetic averages of their sub-goal scores, except for Food Provision, where the sub-goal scores are weighted by yield before averaging.

<table>
<thead>
<tr>
<th>Region</th>
<th>Average Score</th>
<th>Fisheries</th>
<th>Food Provision</th>
<th>Agriculture</th>
<th>Artisan Fish</th>
<th>Carbon Storage</th>
<th>Coastal Protection</th>
<th>Tourism &amp; Recreation</th>
<th>Livelihoods &amp; Economies</th>
<th>Sense of Place</th>
<th>Iconic Species</th>
<th>Sea Grasses</th>
<th>Great Wetlands</th>
<th>Habitats</th>
<th>Biodiversity</th>
<th>Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S. West Coast (area weighted average)</td>
<td>71</td>
<td>73</td>
<td>71</td>
<td>20</td>
<td>57</td>
<td>59</td>
<td>58</td>
<td>99</td>
<td>89</td>
<td>87</td>
<td>84</td>
<td>58</td>
<td>48</td>
<td>37</td>
<td>87</td>
<td>69</td>
</tr>
<tr>
<td>Northern California</td>
<td>67</td>
<td>79</td>
<td>77</td>
<td>24</td>
<td>51</td>
<td>46</td>
<td>51</td>
<td>99</td>
<td>83</td>
<td>74</td>
<td>65</td>
<td>57</td>
<td>48</td>
<td>38</td>
<td>89</td>
<td>65</td>
</tr>
<tr>
<td>Central California</td>
<td>71</td>
<td>79</td>
<td>78</td>
<td>24</td>
<td>57</td>
<td>54</td>
<td>55</td>
<td>99</td>
<td>94</td>
<td>90</td>
<td>86</td>
<td>64</td>
<td>48</td>
<td>42</td>
<td>85</td>
<td>74</td>
</tr>
<tr>
<td>Southern California</td>
<td>73</td>
<td>79</td>
<td>78</td>
<td>25</td>
<td>55</td>
<td>61</td>
<td>57</td>
<td>99</td>
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<td>57</td>
<td>52</td>
<td>47</td>
<td>85</td>
<td>73</td>
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<tr>
<td>Oregon</td>
<td>74</td>
<td>56</td>
<td>56</td>
<td>5</td>
<td>69</td>
<td>73</td>
<td>71</td>
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<td>64</td>
<td>44</td>
<td>25</td>
<td>89</td>
<td>64</td>
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<tr>
<td>Washington</td>
<td>65</td>
<td>64</td>
<td>53</td>
<td>27</td>
<td>47</td>
<td>69</td>
<td>51</td>
<td>100</td>
<td>70</td>
<td>63</td>
<td>63</td>
<td>45</td>
<td>28</td>
<td>26</td>
<td>86</td>
<td>65</td>
</tr>
</tbody>
</table>

Overall findings:

1. Individual goal scores for the overall region ranged from 20 (mariculture) to 99 (tourism and recreation).

2. Tourism & recreation, clean waters, and livelihoods & economies scored highest.

3. Artisanal fishing opportunities, carbon storage, coastal protection, and sense of place scored lowest.

4. Goal scores that depend on coastal habitats (carbon storage, coastal protection and biodiversity) scored relatively low due to the historical and continuing decline in extent or condition of salt marshes, sea grasses and sand dunes.

5. Status for most goals declined during the past decade, but likely future scores suggest near-term improvements may occur for most goals in most regions. Exceptions were coastal livelihoods & economies in Washington; fisheries and species biodiversity in Oregon; fisheries, species biodiversity, carbon storage, and coastal livelihoods & economies in Northern California; and species biodiversity and fisheries in Central and Southern California.

6. Changing the goal weights from equal (such as in the global model) to regionally-specific — determined by an expert panel (Halpern et al. 2013), which gave the highest weights to clean waters and sense of place — produced lower scores for some sub-regions and higher scores for others, but only changed scores by a point or two.
Goal and sub-goal results for the U.S. West Coast

Food Provision: both land and ocean will need to increase food supply to meet the demand of a growing human population and increase human well-being. The goal is to maximize the amount of sustainably caught and farmed seafood.

<table>
<thead>
<tr>
<th>Food Provision</th>
<th>U.S. West Coast</th>
<th>Southern California</th>
<th>Central California</th>
<th>Northern California</th>
<th>Oregon</th>
<th>Washington</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>71</td>
<td>78</td>
<td>78</td>
<td>77</td>
<td>56</td>
<td>53</td>
</tr>
</tbody>
</table>

Findings:

- Results of regional assessments, such as the US West Coast, cannot be compared quantitatively those from global assessments owing to difference is data and methods. However, it can generally be said that all of the U.S. West Coast’s sub-regions are closer to meeting their targets (reference points) than the U.S. as a whole, which received a global score of 40.

- Scores for California’s sub-regions were considerably higher than those of Oregon and Washington, but all sub-regions could obtain higher scores by maximizing the amounts of benefits obtained sustainability.

Wild-caught Fisheries sub-goal: the goal is to maximize sustainable wild catch.

Reference point: the total biomass of wild-caught fisheries should be within 5% of the biomass that produces maximum sustainable yield (MSY); and the percent of the population removed by fishing should be within 5% of that at MSY. Regional stock assessments data replaced global fisheries data that were used in the global study.

<table>
<thead>
<tr>
<th>Wild-caught Fisheries</th>
<th>U.S. West Coast</th>
<th>Southern California</th>
<th>Central California</th>
<th>Northern California</th>
<th>Oregon</th>
<th>Washington</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>73</td>
<td>79</td>
<td>79</td>
<td>79</td>
<td>56</td>
<td>64</td>
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</tbody>
</table>

Findings:

- Though exact comparison is not possible, all sub-region scores were higher than the U.S. score (33) in the 2013 global study, probably because the U.S. West Coast is relatively healthy and generally well managed.

- The scores indicate that significant improvement in fish stocks and management practices is needed in all areas and most especially in Oregon and Washington states.

- The resolution of fisheries catch data was too coarse to permit calculation of sub-region scores, so one score was calculated for the entire state.

- Different stocks dominate the respective fisheries. Low scores in Washington and Oregon are partially related to dependence on Pacific hake, which has historically made up about 30% of the total catch, but that stock was at low biomass and fishing effort levels when...
evaluated for this study. Pacific hake abundance varies considerably because it has a relatively short life span and large natural year-to-year variations in recruitment success. A successful year-class, such as that of 1999, can rebuild stocks quickly, but many years may pass before another occurs (Miller et al. 2009). Fishing pressure can be managed by agencies as well as economic decisions by fishermen, but there is no way to alter the stock’s natural variability, so it is harder to keep the species at its target abundance (‘reference point’) where total biomass is within 5% of the biomass that produces maximum sustainable yield (MSY); and the percent of the population removed by fishing is be within 5% of that at MSY. In California, on the other hand, yellowfin tuna has historically made up about 40% of the total catch. This very productive, highly migratory species is currently at ideal levels of biomass and fishing effort, is more resilient to fishing pressure and can respond quickly to management actions than do species that reproduce more slowly and in smaller numbers (NOAA, undated).

- The trend for the most recent five years (2006-2011), only using data from assessed stocks) was slightly negative for Washington (-0.04), but more negative for Oregon (-0.17) and California (-0.20). Considering the future status five years hence, Washington was the only area where status is likely to increase (0.08). Future status is likely to fall in Oregon and Northern California (both -0.03) and somewhat less in central and Southern California (-0.01)

- The study indicates that all five regions are currently reporting smaller harvests at lower sustainability than might be possible if management could improve methods for staying within 5% of the maximum sustainable yield for commercial species.

- Data beyond those used in this study showed that the harvest of wild-caught fish in California, Oregon and Washington had a dollar value of $566 million in 2010 representing 13% of the total tonnage and commercial value for fisheries landings of the entire USA. (NOAA U.S. Commercial Fisheries Landings, http://www.st.nmfs.noaa.gov/Assets/commercial/fus/fus10/02_commercial2010.pdf).

- Other NOAA analyses indicate that commercial fisheries support 1 million jobs and $32 billion in income to the U.S. economy each year through direct, indirect and induced employment and spending.

Sub-goal Mariculture: this sub-goal goal is to maximize sustainable harvest of farmed seafood. Shellfish production was evaluated since no marine fin-fish are raised for food on the U.S. West Coast.

Reference point: as mandated by NOAA, increase the amount of U.S. shellfish production by 350% over 2005, to be achieved by 2020. Sub-region targets were derived by distributing that increase over currently farmed bays using a constant proportion of each bay for mariculture. Sustainability is measured using indicators specific to the long-term sustainability of the aquaculture operation itself, namely type of wastewater treatment (closed vs. open system), origin of feed (algae, fishmeal etc.) and origin of seed (native or introduced). These affect the long-term sustainability of the mariculture operation itself. They and other factors, such as habitat modification, use of chemicals, and employment may impact other goals negatively or positively and are incorporated into calculations of those goal scores. Certification, eco-labeling, compliance with FAO Code of Conduct and traceability of product and feed were incorporated as resilience measures.
Findings:

• Mariculture was the lowest scoring goal in the Index, even though use of local data and a new method substantially increased scores compared to the global study.

• Oregon scored lowest and its trend for mariculture status (-0.13) was also the poorest for any area, followed by Washington (-0.09). The trend for the California sub-regions was -0.01. Future status scores appear likely to remain the same (0.00) in Washington and Oregon and to improve slightly (0.02) in the California sub-regions.

• More than 99% of mariculture throughout the region consists of bivalve mollusks (oysters, abalone, clams, mussels, geoducks).

• Concerns about pollution, transmission of parasites or other diseases to wild stocks and genetic pollution of wild populations by fish that escape from farms has limited fin-fish aquaculture. Bivalve aquaculture has faced similar concerns in Puget Sound and elsewhere.

• Scores are low because almost no fin-fish are raised for direct human consumption and because bivalve production is low relative to the sustainable reference point used. Existing bays and estuaries may have room for mariculture development or expansion, but other uses such as tourism and recreation, protection of areas for biodiversity conservation, shoreline protection, wild fisheries and other businesses compete for that same space.

• Fin-fish mariculture currently exists only in Washington, where it is only a small portion of total mariculture. Most of the production is or restocking of food provision purposes rather than food provision, so it is not included in the mariculture sub-goal. Exact numbers are not available because data are proprietary. The small amount of Washington fin-fish production for food purposes, if any, would not affect the state’s overall score food provision score, because it would contribute very little to the mariculture score; and the food provision score is calculated as the yield-weighted average of the sub-goal scores for mariculture and fisheries.

• In Oregon, Both Coos and Yaquina Bays had large salmon-ranching businesses in the 1990s, but no salmon or other marine fin-fish are raised in Oregon today (Oberrecht, undated). The California legislature passed legislation in 2003 that prohibits commercial salmon mariculture in its coastal waters and there are now no commercial salmon culture operations, though land-based tank operations use eggs and sperm from wild-caught fish to produce tens of millions of smolts for release into California's rivers to increase wild populations (Beer, 2010). Those young fish are not produced as human food, so they are not counted as part of mariculture. Any contribution that they make to wild populations would implicitly be counted as part of the biodiversity goal and wild-caught fisheries sub-goal.
• Marine fin-fish are raised extensively in other countries, but competing uses for coastal space and resources, economic factors (including low cost imports) and restrictive regulatory requirements have hindered such development along the U.S. West Coast and elsewhere in the country (Drawbridge and Taylor, 2010). Whether environmental and economic conditions, as well as technological advances (such as offshore farming) might enable growth of a fin-fish mariculture industry is not yet known.

• Bacterial infections, infestations of parasites, toxic algal blooms, elevated sea temperature events, predation by sea ducks, and imports of lower cost shellfish from growers and harvesters in other states and countries have all impacted the financial success and viability of U.S. West Coast growers. Ocean acidification appears to be harming bivalve aquaculture, especially in Washington and Oregon, by making it harder for the animals, especially larvae, to form shells.

• It is not known whether seafood farming on the U.S. West Coast will contribute to the growing importance of mariculture to the world’s food supply. The World Bank projects that by 2030 aquaculture will make up more than 60% of all seafood directly consumed by people. Most of the increase will come from freshwater aquaculture, but mariculture will also make an important contribution. Amounts expected for direct human consumption and their comparison with amounts from wild capture fisheries are:

<table>
<thead>
<tr>
<th></th>
<th>Actual 2006 (million tons)</th>
<th>Projected 2030 (million tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aquaculture</td>
<td>47.2</td>
<td>93.6</td>
</tr>
<tr>
<td>Wild Catch</td>
<td>64.3</td>
<td>58.2</td>
</tr>
<tr>
<td><strong>Global Total</strong></td>
<td><strong>111.7</strong></td>
<td><strong>151.8</strong></td>
</tr>
</tbody>
</table>


• In 2010 the worldwide value of aquaculture harvests was US$ 119 billion compared to the value of wild-caught at US $ 98.5 billion. In 2010 all of North America produced only 1.1% of that aquaculture output. (World Review of Fisheries and Aquaculture 2012 http://www.fao.org/docrep/016/i2727e/i2727e00.htm).

**Artisanal Fishing Opportunity:** people need and value the opportunity to catch fish for personnel subsistence or for cultural reasons. This goal seeks to maximize that opportunity.

**Reference point:** there should be fish available to catch (measured by NOAA Fish Stock Sustainability Index [FSSI] in relation to the maximum potential FSSI score); and all areas should be accessible by foot (% of coastal area within 1 mi of a shore access point) and by boat (using the ratio of gas price to median income now vs. 5 yr ago as a proxy, because it represents a major cost of trailoring or driving a boat to areas where fish are available).
Findings:

- Oregon had the highest score (69) and Washington the lowest (47). Public access was the main driver of scores. The public has access to Oregon’s entire coastline, leading to a higher score, whereas Washington and California both allow privately-owned access to the coast and have large stretches of restricted-access coastline.

- The U.S. West Coast and its sub-regions scored much lower on this goal in the regional assessment than did the entire U.S. in the 2013 global study, where the U.S. was one of many countries that scored 99 and the overall global score was 95. Those high scores resulted from use of a different type of reference point that compared the opportunities for small-scale local fishing with its estimated need as expressed by per capita GDP corrected by purchasing power parity (PPPpcGDP). The high global score, 95, suggested that most countries were meeting most of the apparent economic need for their citizens to be able to carry out small-scale fishing for subsistence, barter or commercial purposes (mainly local markets). The different reference point used for the U.S. West Coast study takes advantage of detailed regional information for both geographical access and the amount of fish available to catch, neither of which could be evaluated in the global study. It is worth noting that even though better data will produce more accurate scores, those scores will not always be higher.

Natural products: harvesting non-food marine products can provide benefits to coastal residents. This goal seeks to maximize the amounts of such products that are harvested sustainably.

Findings and comments:

- This goal was not included for the U.S. West Coast regional assessment so there is no score.

- The global Ocean Health Index study evaluated production of ornamental fish for aquariums, fish oil, seaweeds, shells, sponges and coral products, because at least some of those products were harvested in many places and data on the amounts of production were available. The Natural Products goal is excluded from the U.S. West Coast study because there is no recorded trade within the region for those products, even though some might occur at small scales. During the 1950s-1990s kelp was harvested in Southern and Central California, but the company now harvests the extensive kelp beds in Chile. Small quantities of kelp are harvested as food for farmed abalone, but not for direct human use. Rather than give scores of zero (0) to all sub-regions, the goal was dropped.

- It would be useful for the region to determine whether there are any other kinds of non-food marine resources that might be sustainably harvested. Such regional resources exist elsewhere. For example, saltwater pearls were not included in the global study, because they are only produced in a few places. However they could be included in a regional Ocean Health Index study for Tahiti, Australia, Indonesia, the Philippine Islands or other places where pearls are harvested or cultured. Asian abalone farmers have developed techniques for growing pearls in their abalone, but whether that could be done in U.S. West Coast abalone farms is not known. Culture of red algae, a beneficial food for abalone and nutritional supplement for people, could perhaps also be a useful future product.

- Researchers at U.S. West Coast universities and biomedical companies are bio-prospecting for medically active compounds in the bodies or secretions of marine
phytoplankton, algae, plants, sponges, jelly organisms, snails, tunicates, echinoderms and other organisms from the U.S. West Coast and worldwide. Many important discoveries have already been made and more are sure to come, but there is no way to include bio-prospecting in Ocean Health Index calculations, because its current realized value is not known and its potential future value is unknowable though potentially very high.

• The Ocean Health Index also does not evaluate extraction of minerals such as oil, gas, sand or gravel from the seabed, although in the calculation of goal scores it does include the pressures caused by those activities. Minerals extraction is not evaluated because the substances mined cannot be replaced as quickly as they are removed and because, in contrast to fisheries, there is no agreed-upon limit to the amount of material that could be removed, so resource exhaustion could occur. Thus, despite the considerable economic significance of minerals extraction in some areas, with the reference points now available this activity is by definition not sustainable.

Carbon Storage: global climate change and ocean acidification caused by increasing concentrations of carbon dioxide (CO2) in the atmosphere are the most urgent long-term problems confronting people and nature. Coastal marine forests, marshes and seagrass beds are among the world's most efficient habitats at taking up and sequestering carbon for long periods of time—-centuries if undisturbed. The goal is to maximize carbon-storage by coastal habitats.

Reference point: maintain or restore salt marshes to 50% of their pre-industrial extent and condition; support seagrasses by ensuring zero input of nutrients from land-borne runoff.

<table>
<thead>
<tr>
<th>Carbon Storage</th>
<th>U.S. West Coast</th>
<th>Southern California</th>
<th>Central California</th>
<th>Northern California</th>
<th>Oregon</th>
<th>Washington</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>59</td>
<td>61</td>
<td>54</td>
<td>46</td>
<td>73</td>
<td>69</td>
</tr>
</tbody>
</table>

Findings:

- High quality regional data on habitats and better estimates of reference points showed habitats to be worse off than with global data, so habitat-based goals (Carbon Storage, Shoreline Protection) scored lower than in the global U.S. assessment.
- Variation among sub-regions for the carbon storage goal (as well as this goal's generally low scores for all sub-regions) is primarily due to the status of salt marsh habitats. Salt marsh habitat has been lost throughout the U.S. West Coast, but it has been most severe in California. Washington and Oregon have lost about 35% of the 3.6 million acres of wetlands that existed there in the 1780s (Frenkel and Morlant, 1991), but California has lost 91% of the wetlands estimated to have been present before the 1850s (California Department of Fish and Game, 2001)
- The main causes for salt marsh loss have been residential, commercial, industrial or urban development; diking, filling, draining, pad building for oil exploration, road building, draining for mosquito control or livestock grazing, contamination, introduction of exotic species, sea level rise and excessive level of nutrient run-off from land.
Most loss of salt marshes occurred decades ago, but the effects of those losses are still felt today. Moreover, losses continue, though much more slowly owing to more effective regulations.

The California Department of Fish and Game (2001) reported estimates that the state had lost 91% of the historic wetland acreage present before 1850, a total loss of 5 million acres. By contrast, historical maps showed that the coast of New England, which has a much longer settlement history, has lost an estimated 37% of its historical salt marsh coverage, with higher amounts for the state of Rhode Island, which lost 55% since 1832; Massachusetts, which lost 41% since 1777; and Boston, which has lost 81% of its salt marshes. Most losses were attributable to urban growth (Bromberg and Bertness 2005).

As of 2001, the extent of California’s remaining salt marshes was estimated to be 31,300 acres along the North Coast, 3,800 acres along the Central Coast, 93,000 out of an original 200,000 in San Francisco Bay (54% loss) and 13,000 out of an original 53,000 in Southern California (75% loss). More recent work (Solek et al. 2012) noted that the small lagoons and river mouth estuaries of California’s central and southern coast are more fragmented by roads, railroads, levees, and developed areas than are northerly areas, reducing tides and lowering species richness; and that approximately 75% of the salt marsh area along the southern coast (given as 3,070 acres) is located in estuaries greater than 500 acres in size, where water flow and biotic structure were better. Solek et al.’s (2012) study used statistically based Rapid Assessment Programs of many factors to grade salt marsh quality, and—in contrast to Ocean Health Index results that are based mainly on geographical extent---their detailed study showed a gradient in salt marsh health from highest in Northern California to lower in the south.

In addition to reducing the amount of carbon that can be stored (and releasing large amounts to the atmosphere when marshes are destroyed), loss of salt marshes also decreases nursery areas and food supplies for commercially important fish and invertebrates, reduces coastal protection from flooding and erosion, harms biodiversity, impacts some touristic and recreational activities and reduces water quality.

Coastal Protection: coastal vegetation helps protect human life and property from storm surges, flooding and erosion caused by rising sea levels and large storms. Natural habitats cannot protect coastlines from extreme storm waves or flooding, but they can reduce the damage to homes, roads, municipal infrastructure, parks and other property and structures caused by more commonly experienced storm events. The goal is to maximize the protection that natural habitats provide.

Reference point: maintain or restore salt marshes to 50% of their pre-industrial extent and condition; restore sand dunes to their extent and condition between the 1950s and 1960s; and support sea grasses by having zero nutrients introduced from land-borne runoff.

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<tr>
<th>Coastal Protection</th>
<th>U.S. West Coast</th>
<th>Southern California</th>
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Findings and comment:
• All sub-regions scored in the 50s except for Oregon which scored 71. The reason for such low scores is that all sub-regions historically lost substantial amounts of the habitats evaluated for this goal. Oregon scored higher because it has retained a higher percentage of its historical extent of salt marshes than have the other sub-regions and its current rates of habitat loss are somewhat less than elsewhere.

• Trend measurements (2005-2009) show that habitat losses are continuing in most places.

• The trend for the status of salt marsh wetlands was nearly neutral in Washington and Oregon (-0.00 for both), and mildly negative for northern (-0.03), central (-0.02) and southern (-0.02) California.

• The trend for the status of seagrass was positive in Washington, 0.10, slightly negative in Oregon (-0.02), strongly negative in Northern California (-0.41) and negative in Central California (-0.11) and Southern California (-0.08).

• The trend for the status of sand dunes was strongly negative in all areas: -0.14 in Oregon, -0.21 in Washington and -0.17, -0.19 and -0.21 for northern, central and Southern California, respectively.

• People often perceive the coast of Northern and Central California as ‘more natural’ than the highly-developed coast of Southern California, yet Southern California scores slightly higher for this goal. The reason is that the reference point for coastal protection (as well as carbon storage and the habitats sub-goal of biodiversity) is based on the extent of habitat remaining compared to the historical extent. Southern California has lost a smaller percentage of habitats than have the other two areas; and its rates of current loss (trends) for salt marshes and seagrasses are the same or smaller than in central or Northern California, though its rate of sand dune loss is slightly larger.

• Longer-term data available for the U.S. West Coast showed that the status of these habitat-based goals and sub-goals has declined over the decade from 2000-2010.

• Despite these trends, near-term (five-year) future scores indicate that the status of salt marshes, sand dunes and sea grass is likely to improve owing to more effective management actions and other resilience measures.

• Coastal protection by permanent geological features such as headlands, points, cliffs or others is not included in the goal. Places endowed with such protective features may benefit in ways that more exposed locations do not. Houses built near the edges of cliffs, especially on less consolidated formations that erode easily, are at higher risk from storm waves, sea level rise and other forces that undermine the cliffs. The habitats evaluated in this goal cannot prevent such damage.

Livelihoods & Economies: ocean-related employment helps build healthy sustainable societies. The goal is to maintain the economic vigor of marine sector jobs, wages and economic revenues.

Reference point: there should be no net loss of marine jobs, wages and revenue when compared with the performance of all economic sectors in the sub-region five years ago. Sectors evaluated, using data from the National Ocean Economics Program were living marine resources (fish hatcheries and aquaculture, fishing, seafood markets and seafood processing); tourism and recreation (amusement and recreation services, boat dealers, eating and drinking places, hotels
and lodging, marinas, recreational vehicle parks and campsites, scenic water tours, sporting goods retailers, zoos and aquaria); shipping and transport (deep sea freight, marine passenger services, marine transportation services, dredge and navigation equipment, warehousing); marine-related construction; and ship and boat building and repair.

A high score represents minimal net loss of marine-sector jobs, wages and economic revenues compared to all sectors. The methods correct for broader economic patterns that are independent of the condition of marine and coastal systems, such as the global recession that began in 2008. The performance of each sub-region's marine sectors is compared to itself over time, avoiding direct comparison of economies that differ greatly in size, for example Southern California's coastal economy with that of Oregon.

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<tr>
<th>Livelihoods &amp; Economies</th>
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<th>Economies</th>
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<td>U.S. West Coast</td>
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<td>U.S. West Coast</td>
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<td>U.S. West Coast</td>
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**Findings:**

- Oregon scored highest and Washington lowest in all aspects of this goal. Southern California scored almost as high as Oregon, but Northern California scored significantly behind the rest of the state.

- Despite its high score, Oregon’s marine-related jobs, wages and revenue did not increase much, but suffered less decline from their 2004 levels than other sub-regions did.

- Washington, followed by Northern California, posted the lowest scores for both livelihoods and economies, demonstrating the greatest net losses in marine-sector jobs, wages and revenue in nearly all economic sectors. Washington's largest marine sectors declined significantly in the last five years, particularly for jobs in the tourism and transportation sectors and for revenue in tourism and living resources sectors.

- Jobs and revenue in construction and minerals extraction were Washington’s best performing sectors. Jobs and revenue in minerals, tourism and transportation were Oregon’s best performing sectors. None of Northern California’s sectors exceeded their targets. Jobs in Central California’s construction, mineral extraction and tourism sectors reached their targets as did revenue for construction and mineral extraction. Jobs and revenue for ship and boat building, jobs for tourism and revenue for transportation met their targets in Southern California. When analyzed over 5 years, wages were weak within all sectors and sub-regions.
• The ‘no net loss’ reference point for this goal intends to ensure that marine sectors keep up with other parts of the economy in order to support vibrant coastal communities that keep their links with the sea. Washington and Northern California’s low scores could indicate that their economies are tending to develop on a path that is based on non-marine sectors such as technology, manufacturing or others.

• Detailed information on methods and data used for coastal and ocean market studies are provided by C.C.Colgan (2007) www.oceaneconomics.org/Download/Market_Guide.asp and in the supplementary online material accompanying the U.S. West Coast study.

**Tourism & Recreation:** tourism is the largest and fastest growing industry in the world and coastal and marine tourism is one of its most important segments and a major component of thriving coastal communities. The goal is to maintain the value people have for experiencing and enjoying coastal areas and to attract the maximum sustainable number of tourists to those places.

**Reference point:** there should be no net loss in public participation in 19 different marine and coastal tourism and recreational activities compared to values in 2000.

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<tr>
<th>Tourism &amp; Recreation</th>
<th>U.S. West Coast</th>
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**Findings:**

• The entire U.S. West Coast region and its sub-regions all met their reference targets and received very high scores (99 or 100).

• These scores were much higher than the U.S. score of 45 for tourism & recreation in the 2013 global study for two reasons.

  ○ First, detailed local data exist for actual participation rates in coastal tourism and recreation activities in this region; and these data express the goal’s intent better than either the international tourist arrivals data used in the 2012 global study or the proportion of the total labor force employed in coastal tourism and travel that was used in 2013. The participation data used include both domestic and international tourism.

  ○ Second, the availability of adequate time-series data allowed comparison of each sub-region to itself over time rather than comparing it to the best performing region as was done in the global studies.

• Data included the number of people who visited beaches or other marine watersides or participated in surfing, swimming canoeing, personal watercraft use, kayaking, motor boating, rowing, sailing, wind surfing, water-skiing, scuba diving, snorkeling, and hunting waterfowl, viewing or photographing scenery, birds or other wildlife in saltwater surroundings.

• Better data do not always lead to a higher score, but they did in this case.

• The important economic benefits (jobs, wages and revenue) that tourism & recreation provides to coastal communities are evaluated in the livelihoods & economies goal. The
tourism & recreation goal is only concerned with maintaining the number of tourists over
time and matching that number to the maximum sustainable number.

- The score of ‘100’ does not imply that the number of tourists is ‘perfect’ for the region, but
merely that the reference target has been met. Future changes in ecological, social or
political conditions, availability of different types of data or other considerations could allow
or necessitate setting a different reference point with resulting changes in scores.
Nevertheless, tourism & recreation on the U.S. West Coast is at present successfully
meeting expectations for its contribution to ocean health.

**Sense of Place:** in addition to material benefits with ecological or economic value, the ocean also
provides people with intangible benefits such as cultural or personal identity, spiritual or aesthetic
enjoyment and appreciation that particular marine species or environments exist. Those values
accruce not only to coastal residents or people who visit the coast or work or travel on the ocean,
but also to people who will never visit personally, but cherish the awareness that such places exist.
For example, most people will never visit Antarctica, yet many place very high value on knowing
that it exists and that its unique animal populations are protected. This goal seeks to maximize and
protect the cultural and personal identity that people derive from marine areas. Since direct
measurements of these benefits are not available, this goal uses as proxies the condition of iconic
species and the degree of protection of the coastline and marine waters for all purposes.

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<th>Sense of Place</th>
<th>U.S. West Coast</th>
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**Iconic Species:** a small number of the many marine species present in an area become culturally
‘iconic’ to people for cultural, traditional, aesthetic and spiritual reasons. These species thereby
help to represent intangible aspects of the area’s importance. The goal is for all regional iconic
species to be at minimal risk of extinction. For the U.S. West Coast regional assessment, a
comprehensive list assembled containing species with potentially high aesthetic value, association
with traditional activities such as fishing, hunting or commerce, or local ethnic or religious
significance to the people of California, Oregon, and Washington. The list was then narrowed
based both on internal discussion and data availability from the NatureServe database to include
the following species:

- Bald Eagle (Haliaeetus leucocephalus)
- Blue Whale (Balaenoptera musculus)
- Bocaccio (Sebastes paucispinis)
- Brown Pelican (Pelecanus occidentalis)
- California Sea Lions (Zalophus californianus)
- Delta Smelt (Hypomesus transpacificus)
- Gray Whale (Eschrichtius robustus)
- Great Blue Heron (Ardea herodias)
• Abalone (Haliotis spp.)
• Humpback Whale (Megaptera novaeangliae)
• Northern Sea Otters (Enhydra lutris kenyoni)
• Orca (Orcinus orca)
• Osprey (Pandion haliaetus)
• Salmon spp. (Oncorhynchus spp.)
• Southern Sea Otters (Enhydra lutris nereis)
• Steelhead (Onchorynchus mykiss)
• Stellar Sea Lions (Eastern pop.) (Eumetopias jubatus)

Reference Point: each sub-region was evaluated only for those species that occurred within it. Factors included in scoring were the weighted average of species extinction risk weights, whether populations were increasing, stable or decreasing, all ecological pressures (except human pathogens) and all resilience measures except climate change regulations.

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<th>Iconic Species</th>
<th>U.S. West Coast</th>
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Findings:

• The relatively low score of 58 for the U.S. West Coast indicates that populations of many of these iconic species are broadly challenged throughout the region.

• Oregon (64) and Washington (63) scored highest. California sub-regions all scored in the mid-50s.

• Trends were positive everywhere except in Washington, which had a negative trend (-0.07).

• California Sea Lion, Gray Whale, Humpback Whale and Osprey populations were all increasing with relatively low extinction risk. The Northern and Southern Sea Otter populations were also increasing, but with higher risk of extinction, especially the southern population.

• Bald Eagle, Blue Whale, Brown Pelican and Great Blue Heron populations were all stable (neither increasing nor decreasing) and had intermediate risks of extinction.

• Abalone, Boccacio (rockfish, Sebastes paucispinis, Washington only), Delta Smelt, Orca, Salmon (all), Steelhead and Stellar Sea Lion all had negative population trends and intermediate risks of extinction.
• Here and elsewhere it would be highly desirable to collect accurate information on which species different people consider to be iconic and in what ways those species are part of their cultures or personal lives.

**Lasting Special Places:** many geographic locations hold significant aesthetic, spiritual, cultural, recreational, or existence value for people. The goal is to protect them and their values in perpetuity. People value such places for many reasons that are hard to ascertain and measure. As is true for iconic species, there is no list of all the places that people within a region consider special or of what percent of and how well those areas are protected. As a proxy the protection status of all marine and coastal areas is assessed, with the assumption that protected status indicates a place’s significance to people.

**Reference point:** 30% of the total area within each of the following three zones to be under public protection: (a) 200 nm – 3 nm offshore; (b) 3 nm offshore – shoreline; and (c) shoreline - 1 mi inland. The 30% guideline originated at the 2003 Fifth World Parks Congress where it was developed for biodiversity conservation. In the absence of other guidance we used it as a target for the fraction of land to be owned and managed in the public’s best interest in perpetuity.

**Findings and comments:**

• The U.S. West Coast and all its sub-regions scored poorly. California sub-regions, led by Southern California, scored highest. Oregon scored lowest followed closely by Washington.

• Raising scores will require all sub-regions to protect more of their coastline and waters, including establishment of ‘no-take’ areas, in order to approach the 30% goals. None of the regions come close to that target.

• Only fully-protected ‘no-take’ areas are counted, because that high level of protection insures that the area will provide their intended benefits in perpetuity. It is true that placing regulations on an area to protect it could in some cases prevent the very activities that made it special to people in the first place, so greater protection may not represent a healthier state in their view. Nevertheless, if a place is special, enacting appropriate regulations and protection for that location (for example, limited access, fishing, etc.) probably ensures the long-term sustainability of a place people care about.

• Oregon scored lowest despite having public access to its entire coastline. Public access is laudable and important, and was responsible for Oregon having the highest score for the artisanal fishing opportunities goal. However, it is a much smaller factor for lasting special places. This sub-goal focuses on the protection status of all marine and coastal areas, assuming that protection of a place signifies its special importance to people. Despite its beautiful and accessible coast, Oregon is the sub-region with the lowest percentage of protected area in all three of the measured zones, only 0.2 percent

• People might suspect that Northern California, with its beautiful coastal redwoods and scenic coastline, would score higher than Southern California for lasting special places, but
it doesn’t. This is because the percentage of the coastal zone designated as Marine Protected Area (MPA) is the most important component of this sub-goal score. MPAs make up 6.4% of Southern California’s coastal zone, and the public can access all of that area. Southern California’s eight large offshore islands, all of which are fully protected, also contribute to its high score. Corresponding percentages for central and Northern California are 2.8% and 1.5%, respectively. Both Oregon and Washington have less than 1% of their coastal zone in protected status.

**Clean Waters:** clean water is the foundation for all other ocean health benefits. This goal supports the optimal function of natural communities and human well-being by ensuring that ocean water is clean.

**Reference point:** there should be zero pollution from excessive nutrients, chemicals, pathogens, and trash. Global methods and reference points were used for nutrients and trash, but with local data. Chemical pollution was indicated by regional NOAA Mussel Watch data and NOAA/FDA-based reference points for As, Cd, Pb, Cr, Hg, Ni, Chlordane, Dieldrin, Mirex and PCB. Pathogen contamination was represented by the number of days when beaches were closed because pathogen counts exceeded EPA standards.

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<th>Clean Water</th>
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**Findings:**

- A Clean Water score of 100 would indicate that waters of the area studied are completely free of pollution from excessive nutrients, chemicals, pathogens and trash.

- The U.S. West Coast’s Index score of 87 is high, but not high enough. Here and elsewhere global climate change will probably cause rainstorms of greater intensity and volume, more intense rainstorms. New measures to prevent, sequester and treat pollution will be needed to meet the water quality challenges that our changing weather will present. Since clean water is a foundation upon which all other ocean benefits depend, the urgency of this task cannot be overestimated.

- The use of different data and methods precludes direct comparison of results from regional studies with those from global studies. With that caution in mind, it is worth noting that the score for the whole region, 87, was higher than the global score for the U.S. (80) and the overall global score (78) reported for the 2013 global assessment.

- Chemical pollution lowered scores in all California sub-regions. Nutrients lowered scores in Central California, Oregon and Washington. Pathogens lowered the score in Southern California. Trash lowered scores in all California sub-regions. All trends were positive except for pathogen pollution in Southern California and Oregon; and trash, which was negative everywhere except in Oregon (where it was strongly positive (0.19). The trend for the entire Clean Waters goal was slightly positive in all regions except California, where it was slightly negative (-0.02). The likely future status (~5 yr) is strongly positive everywhere, probably because improving water quality has been a public goal for many years and has led to enactment of many resilience measures.
• Among other pathways, pesticides, herbicides and nutrients from lawns, gardens and farms; sewage, motor oil, and other pollutants are carried by rainwater draining from the land into streams, rivers and the ocean. Consequently, heavy rains can pollute water so that it is unsafe for swimming or other water contact recreation. Drought conditions reduce such run-off.

• Precipitation levels are expected to rise with the predicted onset of El Niño conditions in the Pacific Ocean later in 2014. The strong rainfalls associated with El Niño can lead to extreme runoff of pollutants into nearby streams, rivers and oceans.

• Different types of pollution affect ocean benefits and services in different ways and to different degrees. Chemical pollution might exert its strongest effects on food provision (fisheries and mariculture) and biodiversity. Nutrients would have strong effects on those goals and also on carbon storage and coastal protection (by harming salt marsh and seagrass habitats) and on tourism & recreation (by causing algal blooms). Pathogens have very strong effects on tourism & recreation, but could also affect mariculture. Trash can also have very strong effects on tourism & recreation as well as potential effects on iconic species and biodiversity. Any or all or those effects may cause economic changes that ripple through the livelihoods & economies goal, impacting jobs, wages and the revenue accruing to coastal communities.

• It will never be possible to eliminate the last pollutant molecule, the last pathogenic microbe or the last piece of trash from the ocean. However, the closer that scores get to 100 (and levels of pollution get to zero), the better the ocean can deliver all of its potential benefits and services. All pollution represents a waste of materials and money, so efforts toward a cleaner ocean will have overall financial benefits and will advance the transition toward a cleaner, healthier and more efficient economic system.

**Biodiversity:** ‘biodiversity’ is the term used to describe the richness of an area’s plant and animal species, the biological legacy that underlies all ecological benefits and services. The goal is to maintain a broad range of marine species and habitats to support robust functions of natural ecosystems and their human uses. Species and Habitats are assessed as separate sub-goals with the average of their scores forming the goal score.

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<th>Biodiversity</th>
<th>U.S. West Coast</th>
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**Finding:**

• All sub-regions scored in the mid 60s or low 70s indicating that biodiversity faces challenges throughout the U.S. West Coast.

**Species sub-goal:** ecological assessments of biodiversity traditionally count the number of species and measure the distribution among them of all organisms present. Such an assessment could not be made for the entirety of the U.S. West Coast sub-regions; moreover, doing and repeating such measurements often enough to detect changes in such large areas would be challenging, expensive and impractical. Instead, the U.S. West Coast regional assessment uses the status of a small sub-sample of species as a proxy for overall species status. Species status was
calculated for 164 species whose risks of extinction have been assessed by the International Union for Conservation of Nature’s (IUCN) Global Marine Species Assessment.

**Reference point:** is for all species within a sub-region to have minimal risk of extinction (‘Least Concern’), implying that no species are in immediate danger of serious decline or loss.

**Findings:**

- Scores were similar to the overall goal score. No sub-region’s scores stood out as better or worse than any others.
- Species conservation requires additional attention in order to raise the scores for this sub-goal.
- This target does not satisfy the formal definition of biodiversity, because it does not measure the relative distribution of organisms among the species, however a score of 100 suggests that the number of species present is remaining more or less constant. On the other hand, a score of 0 suggests that many species are either in highly threatened categories or extinct, either of which implies severe decline in biodiversity.
- All species present should be at minimal risk of extinction.

**Habitats sub-goal:** habitats are the environments where plants and animals live. Each type of habitat is inhabited by predictable groups of plant and animal species that function together ecologically. Some habitats, such as coral reefs, mangrove forests, sea grass beds and others are created by their dominant species. Because they provide homes to so many species, those and other habitats are an important component of biodiversity. This goal measures how successfully habitats are being conserved.

Four habitats — salt marshes, seagrasses, sand dunes and soft-bottom habitats — were used because they represent a large portion of regional coastal and marine environments and have publicly available data with relatively comprehensive temporal and spatial coverage. Other important habitats such as kelp forests, rocky reefs, and the rocky intertidal could not be included due to lack of data on current and/or past spatial extent and condition.

**Reference point:** the current condition of each habitat was compared to a habitat-specific reference point that is ambitious but feasible: salt marshes should be at 50% of their pre-industrial extent; sea grasses should receive zero nutrients from land-borne runoff; sand dunes should have the same extent as they did in the 1950s or 1960s; and soft-bottom habitats should have zero pressure from bottom trawling.
Findings:

- Central and Southern California scored slightly higher than other sub-regions.

- If time-series data were available on the number of species present and the number of individuals within each species there might be less need for a habitats sub-goal. Lacking those data, data on habitats provide useful information about changes in biodiversity, because they provide living space, shelter, nurseryman space, food or other support for many species. Loss of habitats is a good proxy indicator for decline in biodiversity.

- Historically, all sub-regions have lost substantial amounts of three of the habitats evaluated for this goal (salt marshes, sea grasses and sand dunes) and trend measurements (2005-2009) show that losses are continuing in most places, though much more slowly than in the past.

- The trend for the status of sand dunes was strongly negative in all areas: -0.14 in Oregon, -0.21 in Washington and -0.17, -0.19 and -0.21 for northern, central and Southern California, respectively.

- The trend for the status of salt marsh wetlands was nearly neutral in Washington and Oregon (-0.00 for both), and mildly negative for northern (-0.03), central (-0.02) and southern (-0.02) California.

- The trend for the status of seagrass was positive in Washington, 0.10, slightly negative in Oregon (-0.02), strongly negative in Northern California (-0.41) and negative in Central California (-0.11) and Southern California (-0.08).

- The fourth environment evaluated, soft bottom habitat, is neither created nor destroyed, so its condition is measured as the percentage of its area that is fished using bottom trawls. Bottom trawling disturbs the habitat and injures or kills organisms that use it. The trend for the status of soft bottom habitats was positive in Washington (0.07), strongly negative in Oregon (-0.19), mildly negative in Northern California (-0.03), positive in Central California (0.04) and neutral in Southern California (0.00).

Perspective on the quest to improve ocean health

Given the integrated nature of the Ocean Health Index, factors affecting one goal frequently affect others. In most areas, many goals need improvement. Selecting which to work on first depends both on the availability of human and financial resources and on the region’s long-term strategy. A downloadable Toolbox will be available in 2014 to help countries evaluate scores and make those strategic choices.

Restoring ocean health will take decades and, for some goals, several generations. With patience, commitment and continuity of effort, the Ocean Health Index and other instruments will be important guides in that quest. Key to success will be:

- Gaining broad public acceptance of the new definition of ocean health that includes benefits to people;

- Promoting the importance of regular, quantitative measurement of ocean health components;
• Gaining broad agreement on the need to collect and report---in an agreed-upon format---all data needed by the Ocean Health Index (at whatever scale it is being used) and by other assessments related to ocean health;

• Engaging individual nations to construct their own national or sub-national Ocean Health Indices that are tuned to individual situations and incorporate any higher quality local information and knowledge available to them; and,

• Continuing measurement of the Ocean Health Index (and other assessment tools) for long periods to monitor progress toward ocean health and guide actions thereto.

The Ocean Health Index can report the following success to date:

• The World Economic Forum endorsed it as one of two strategies for ocean improvement.

• The United Nations will consider the Index as one input into its World Ocean Assessment.

• The U.S. West Coast study and ongoing focal studies for Brazil and Fiji (in preparation) demonstrate the geographic scalability of the method.

• China, Colombia and Israel are in the early stages of regional Ocean Health Index assessments carried out in-country.

• Ecuador, Taiwan, portions of Canada and New Caledonia, among others have expressed desire to initiate their own focal studies.

• A workshop for Baltic Sea nations held in May 2014 may stimulate use of the Index in that region.

• Presentations of results to the 10-nation Nairobi Convention in 2012 and 2013 may stimulate adoption in some eastern African locations.
References for interpretation of regional assessment results.


Scientific publications from the Ocean Health Index project (Updated May 16, 2014)


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