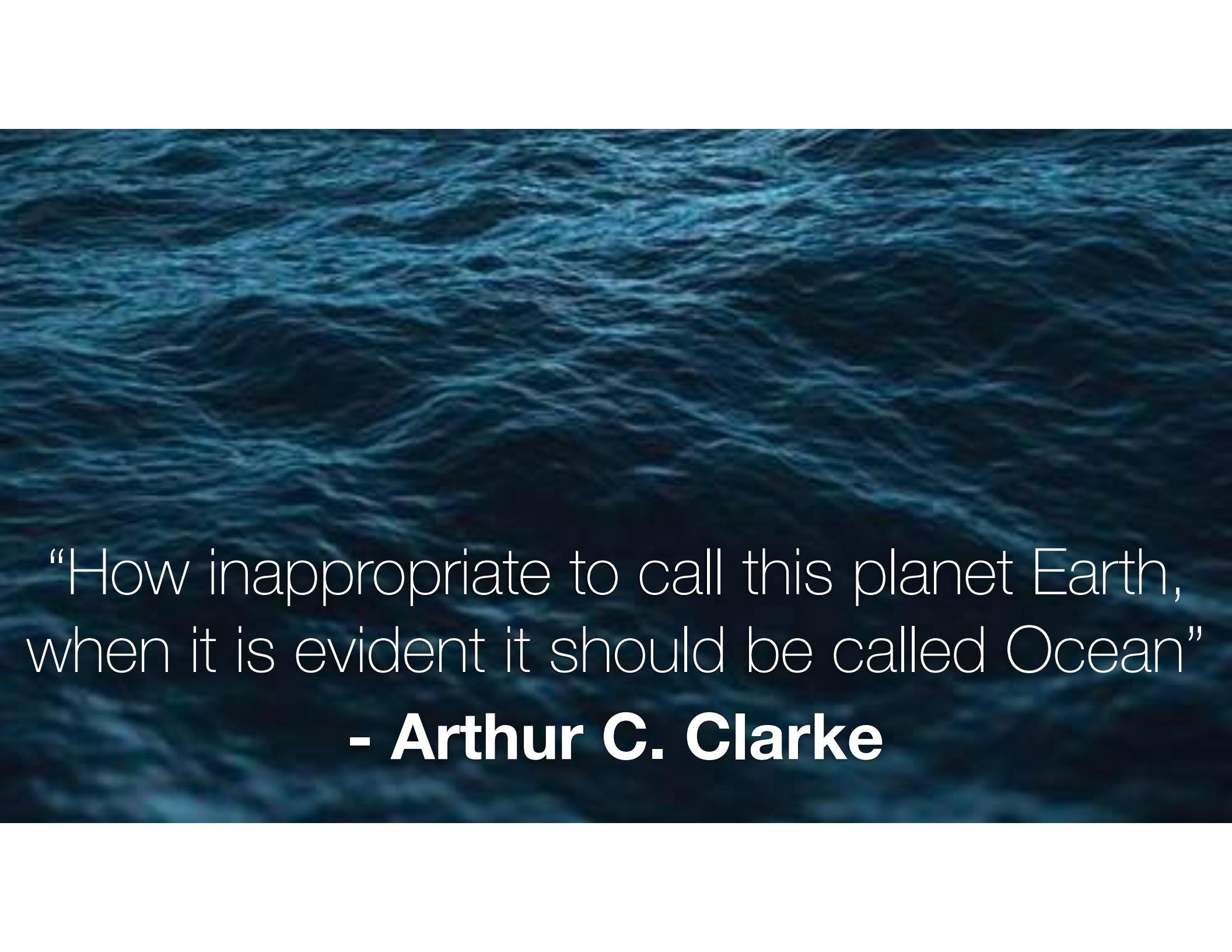


OCEAN
HEALTH
INDEX™

Healthy Oceans. Healthy People.

Core Framework and Methods

Updated Jan 2016. For updated information visit ohi-science.org

The background of the image is a close-up, low-angle shot of dark, choppy ocean waves. The lighting is dramatic, with highlights reflecting off the crests of the waves, creating a textured pattern of blues and dark greens. The overall mood is mysterious and vast.

“How inappropriate to call this planet Earth,
when it is evident it should be called Ocean”

- Arthur C. Clarke

An aerial photograph of a vast ocean, showing a large, intricate coral reef system in shades of turquoise and teal. The reef extends from the bottom left towards the top right, creating a complex pattern of lighter and darker blue-green waters. The surrounding ocean is a deep, dark blue. A few small white clouds are visible in the upper right corner.

Recognizing Ocean Values WORLDWIDE

© Olivier Langrand



\$21 trillion
services provided by the ocean



1 billion people
essential nutrition

photo: © art wolfe/ www.artwolfe.com



\$190 billion/year
seafood industry

500 million
ocean related jobs



OUTLINE

1. Need
2. Goals & Methods
3. Scale of Assessments
4. Uses & Benefits
5. Results of Global Assessment
6. Overcoming Limitations with
Independent Assessments





**WHY DO WE NEED AN OCEAN
HEALTH INDEX?**

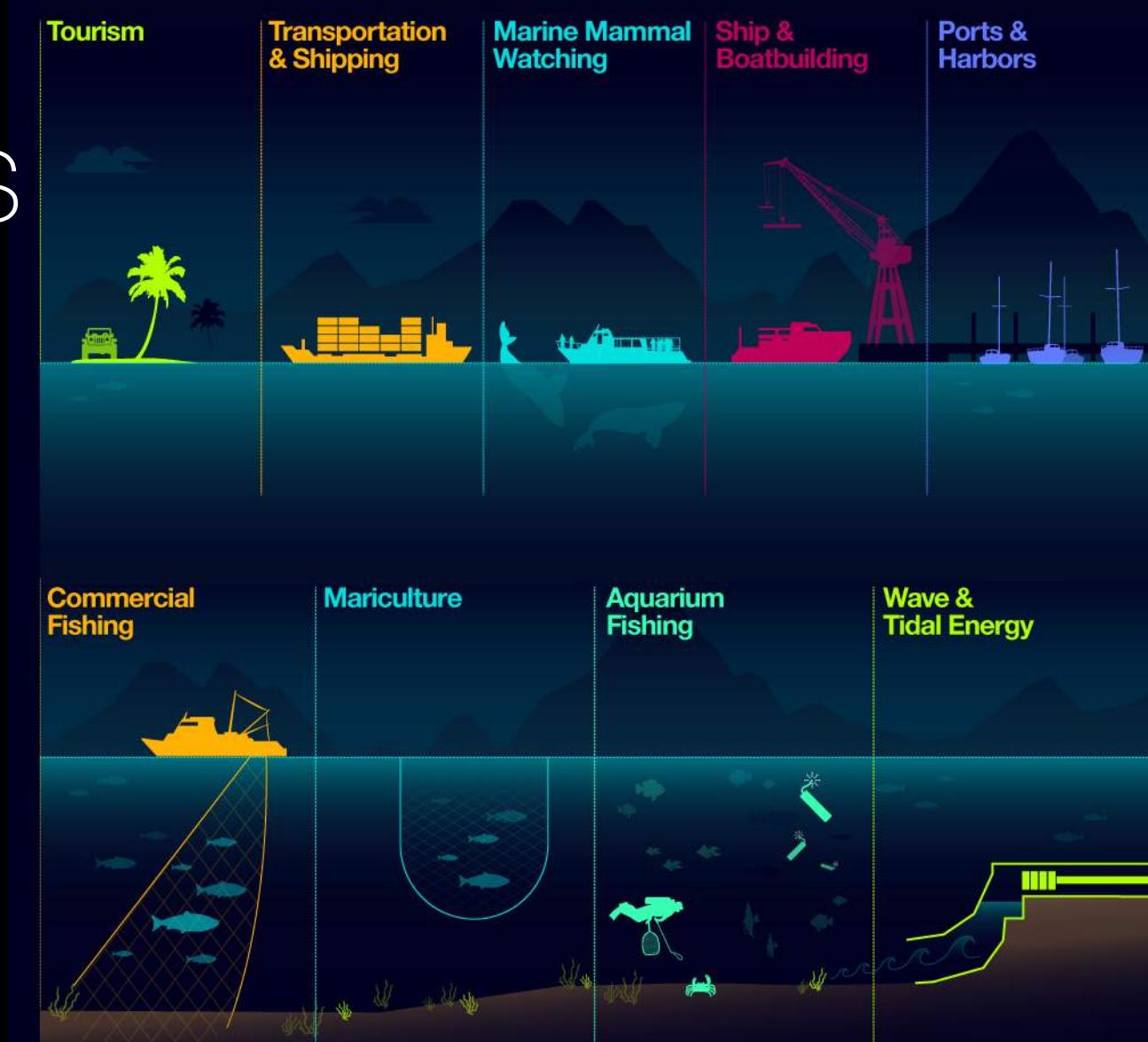
OCEAN & COASTAL GOODS AND SERVICES



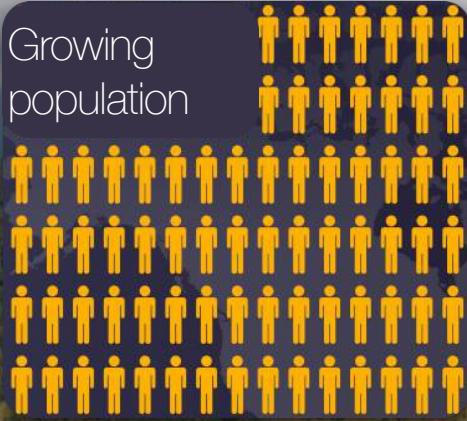
potential conflicts



need sustainable
balance



Growing population



Mangrove Populations Are Declining Worldwide

Between 1980 and 2005 there has been a total loss of 3.6 million hectares of mangroves worldwide.

1980

18.8
Million Hectares

20 %

Loss of Total Mangroves Worldwide



2005

15.2
Million Hectares



90%

**of Fishing Jobs
are Small-Scale**

Of the estimated 26-29 million total fishing jobs in developing countries, approximately 25-27 million are in the small-scale fisheries sector.

COASTS AND OCEANS ARE
CHANGING IN
unprecedented ways



HOW DO YOU MEASURE OCEAN HEALTH?

What is a healthy ocean?

One without human pressures?

A vibrant underwater photograph showing a dense school of small, silvery fish swimming in various directions. In the center-left, a rocky coral reef is visible, covered in bright orange and red coral polyps. The water is a deep, clear blue.

HUMAN BEINGS ARE PART OF MARINE
ECOSYSTEMS

Everywhere in the world

A photograph of a beach at sunset. The sky is filled with dramatic, orange and yellow clouds, with bright rays of sunlight streaming through them. The ocean waves are visible in the background, and a person is walking along the wet sand in the foreground.

Policies aim to achieve
healthy oceans

WITHOUT AN INTEGRATED TOOL TO
MEASURE ITS HEALTH

A large sea turtle swims gracefully through clear blue ocean water. Small yellow fish are scattered around it, some near its head and others further back. The background shows the textured surface of the water.

need to **CHANGE** business as
usual

1. Integrate various indicators
2. Evaluate cumulative pressures & resilience
3. Identify impacts of one sector over others

nature

An index to assess the health and benefits of the global ocean
published on 31.8.2012

doi:10.1038/nature11397

An index to assess the health and benefits of the global ocean

Benjamin S. Halpern^{1,2}, Catherine Longo¹, Darren Hardy¹, Karen L. McLeod³, Jameal F. Samhouri⁴, Steven K. Katona⁵, Kristin Kleisner⁶, Sarah E. Lester^{7,8}, Jennifer O'Leary¹, Marla Ranelletti¹, Andrew A. Rosenberg⁵, Courtney Scarborough¹, Elizabeth R. Selig⁵, Benjamin D. Best⁹, Daniel R. Brumbaugh¹⁰, F. Stuart Chapin¹¹, Larry B. Crowder¹², Kendra L. Daly¹³, Scott C. Doney¹⁴, Cristiane Elfes^{15,16}, Michael J. Fogarty¹⁷, Steven D. Gaines⁸, Kelsey I. Jacobsen⁸, Leah Bunce Karrer⁵, Heather M. Leslie¹⁸, Elizabeth Neeley¹⁹, Daniel Pauly⁶, Stephen Polasky²⁰, Bud Ris²¹, Kevin St Martin²², Gregory S. Stone⁵, U. Rashid Sumaila⁶ & Dirk Zeller⁶



a **HEALTHY OCEAN**
sustainably delivers a range of
benefits to people both now and
in the future

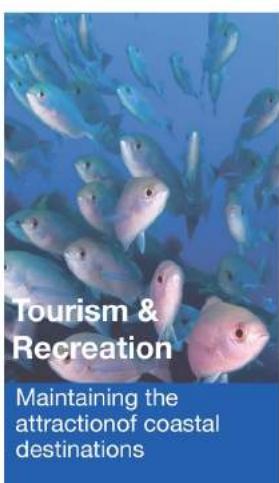
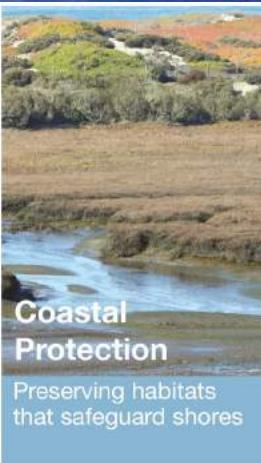
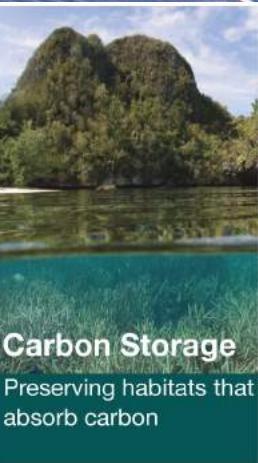
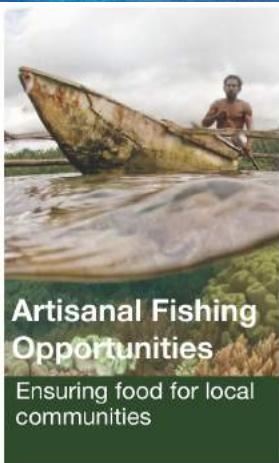
What is the Ocean Health Index?



A quantitative, repeatable, transparent and comprehensive tool

- that measures & tracks sustainable ocean use
 - with a common language to inform decision making

Ten Human Goals: an Ocean Dashboard



Food Provision

Artisanal Fishing Opportunities

Ensuring food for local communities

Natural Products

Harvesting non-food ocean resources sustainably

Carbon Storage

Preserving habitats that absorb carbon

Coastal Protection

Preserving habitats that safeguard shores

Livelihoods & Economies

Tourism & Recreation

Maintaining the attraction of coastal destinations

Sense of Place

Protecting iconic species and special places

Clean Waters

Minimizing pollution

Biodiversity

Supporting the health of marine ecosystems and species

The Ocean Health Index
I is the weighted sum of
individual goal indices I_i

Structure

status 2010
status 2011
status 2012
status 2013
status 2014

→ **Trend five most recent years**

pollution
Habitat destruction
Invasive species
by-catch
sea level rise
governance

fishing regulation
habitat integrity
species diversity
governance

Pressures

Resilience

Current Status 50%

access

need

Probable Future
State 50%

Understand Pressures

Stressor on the **social** or **ecological** system

Change how goals interact with each other

Five ecological categories: pollution, habitat destruction, species pollution, fishing pressure, and climate change

One social category: governance effectiveness

Understand Pressures

EXAMPLES OF INDICATORS USED TO CALCULATE GOAL PRESSURES

Ecological Pressures					Social Pressures
Pollution	Habitat destruction	Species Pollution	Fishing Pressures	Climate Change	Social factors
Chemical					
Pathogens					
Nutrients	Subtidal hard and soft bottom habitats	Invasive species	Commercial bycatch (high & low)	Sea surface temperature	Governance indicators
Trash					
	Intertidal habitats	Genetic escapes	Artisanal bycatch (high & low)	Ocean acidification	
			Selective harvesting	Ultraviolet incidence	
				Sea level rise	

Understand Resilience

Beneficial measures on the **social** or **ecological** system

Resilience helps shape the future of ocean health

Two ecological categories: regulatory (laws, policies, treaties, conventions, management actions) and ecological integrity

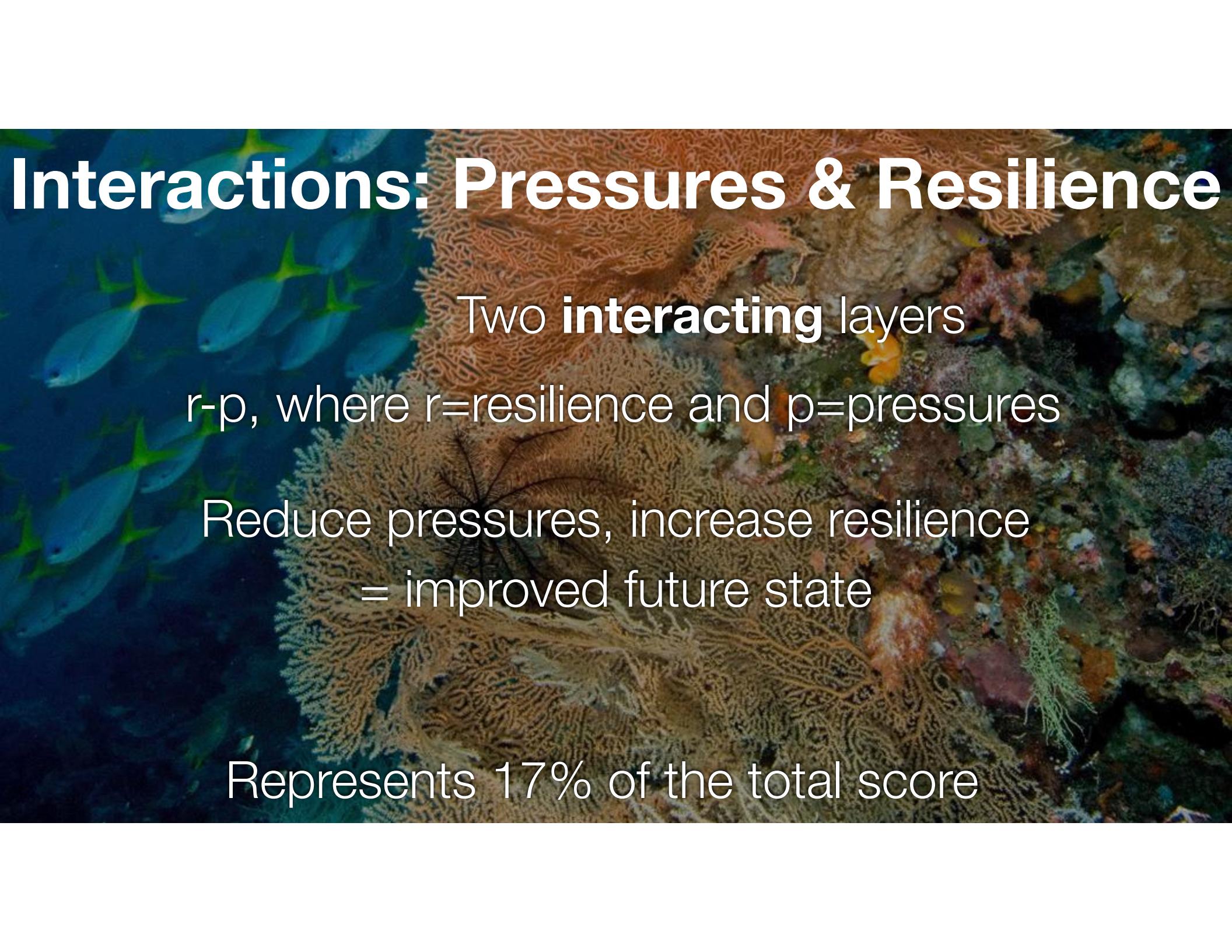
Social category: social integrity

Understand Resilience

EXAMPLES OF INDICATORS USED TO CALCULATE GOAL RESILIENCE

Ecological Resilience		Social Resilience
Regulatory	Ecological Integrity	Social Integrity
Invasive Species	Species Diversity	Global Competitiveness Index
CITES Signatories	Habitat Diversity	Sector Evenness
Fishing Regulations		Global Governance Indicators
Habitat Protection		
Biodiversity Protection		
Good Governance		
Sustainable Tourism Measures		
Clean Water Measures		

Interactions: Pressures & Resilience

A vibrant underwater photograph showing a school of blue and yellow fish swimming over a healthy coral reef. The reef is composed of various types of coral, including branching and soft corals, in shades of orange, red, and green. The water is clear, allowing for a detailed view of the marine life and the complex ecosystem.

Two **interacting** layers

r-p, where r=resilience and p=pressures

Reduce pressures, increase resilience
– improved future state

Represents 17% of the total score

Understand Trend

Rate of the change in status based on recent data

Indicates the **likely condition** assuming a linear relationship

Conveys the recent history of the indicator

Represents 33% of the total score

Understand Status

The current status of each measured goal
vs. goal-specific **reference point**

Best available data →

capture the goal philosophy of each goal

Represents 50% of the total score

Reference Points: optimal status

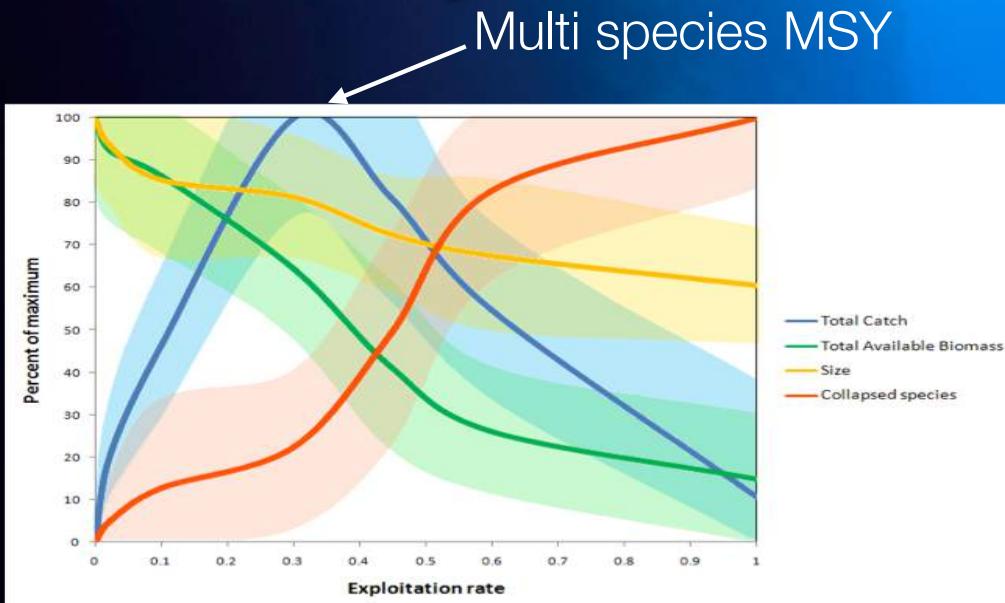
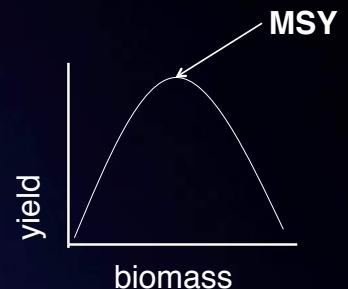
Specific
Measurable
Ambitious
Realistic
Time bound

Articulate management guides

selection of appropriate indicators for assessing the status of the goal

Types of Reference Points

1. Functional Relationships (preferred method)



Wild Caught
Fisheries



Artisanal
Fishing

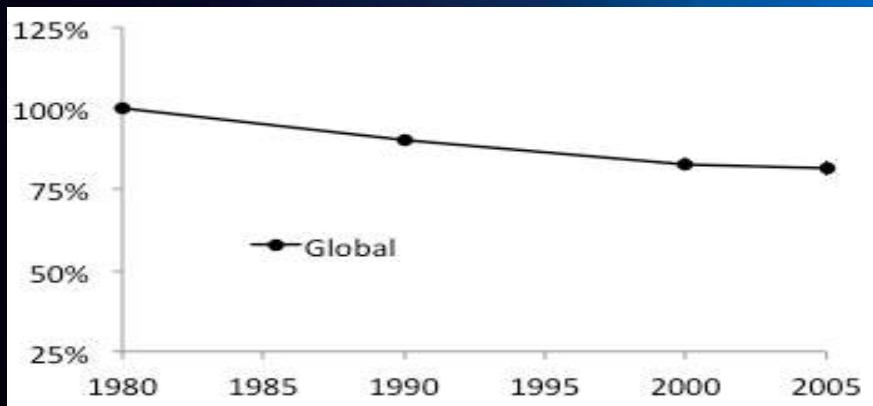


Natural
Products

Samhouri et al. 2012 Ecosphere

Types of Reference Points

2. Temporal comparisons



Natural Products



Carbon Storage



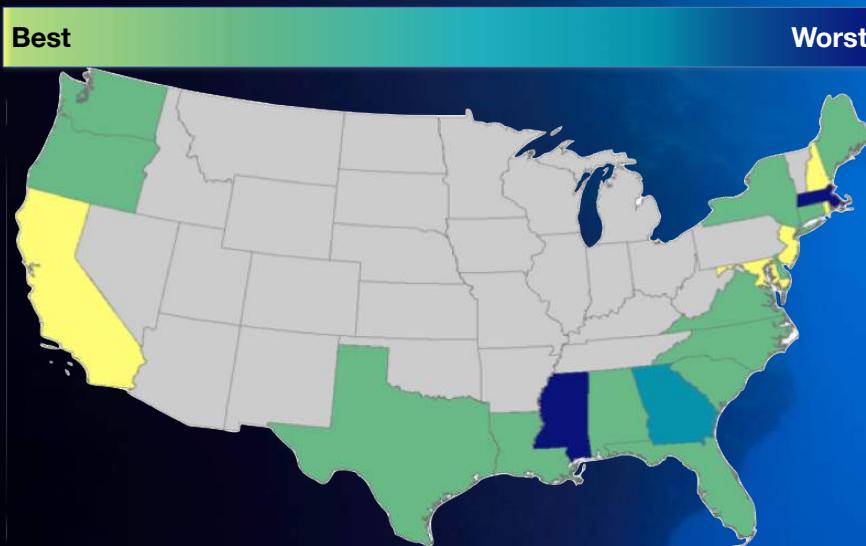
Coastal Protection

Livelihoods & Economies

Biodiversity: Habitats

Types of Reference Points

3. Spatial Comparison



Livelihoods



Tourism &
Recreation



Mariculture



Samhouri et al. 2012 Ecosphere

Types of Reference Points

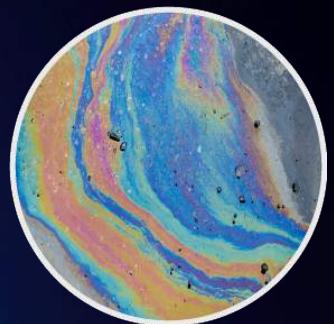
4. Known/established target



Convention on
Biological Diversity



Sense of Place:
Lasting Special Places



Clean Waters



Sense of Place:
Iconic Species



Biodiversity:
Species

Calculations for Each Goal

**Present
Reference**

$$\frac{X_i}{X_{i,R}} = x_i =$$

**CURRENT
STATUS** 50

Trend T

Pressures p_i

Resilience r_i

+

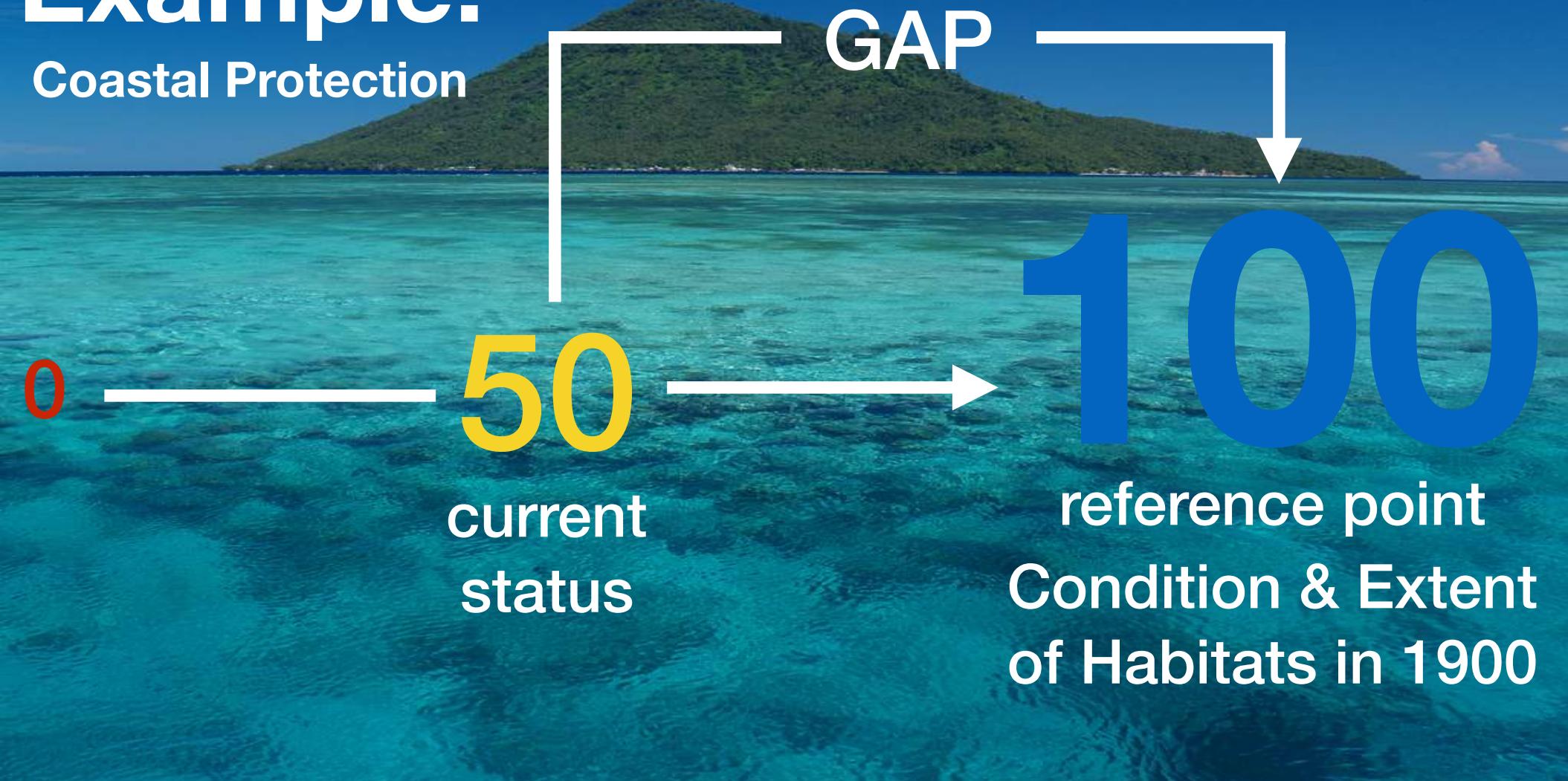
**PROBABLE
FUTURE
STATE** 50

$$l_i = \frac{x_i + \hat{x}_{i,F}}{2}$$

$$(1+\delta)^{-1} [1 + \beta T_i + (1 - \beta)(r_i - p_i)] x_i = \hat{x}_{i,F}$$

Example:

Coastal Protection





Goal Philosophies

1. Food Provision

Measures the amount of seafood sustainably harvested & produced

WILD-CAUGHT FISHERIES

Amount of wild-caught seafood that can be sustainably harvested

MARICULTURE

Annual harvested yields from marine & brackish waters

2. Artisanal Fishing Opportunity



The ability to access fish for food - small & local scales

3. Natural Products

Harvest of non-food natural products



4. Carbon Storage

Extent and condition of coastal habitats
store & sequester atmospheric CO₂

5. Coastal Protection

A vibrant underwater scene featuring a coral reef in the foreground with various species of fish swimming around. Above the reef, a mangrove forest with dense green foliage grows along the water's edge. The water is slightly choppy, creating a dynamic background for the title.

Extent and condition of coastal
habitats against flooding and erosion

6. Coastal Livelihoods & Economies

Jobs and revenue produced from marine-related industries

LIVELIHOODS

Jobs & wages

ECONOMIES

Revenue produced from marine-related industries



7. Tourism & Recreation

A photograph of an underwater environment. In the upper right, a scuba diver in a black wetsuit and green fins swims towards the left. The background is a dark blue-green color. In the lower left, there is a large, healthy-looking coral reef with various shades of yellow, orange, and white. A small starfish is visible on one of the coral branches. The overall scene suggests a tropical or subtropical marine ecosystem.

Capture experience in visiting coastal
& marine areas and attractions

8. Sense of Place

Condition of iconic species &
protection of special places

ICONIC SPECIES

Unique importance is
recognized through
traditional activities

LASTING SPECIAL PLACES

Geographic locations that
are valuable to people

9. Clean Waters

A photograph of a sea turtle swimming in clear, turquoise-blue ocean water. The turtle's head and front flippers are visible above the surface, which has gentle ripples and reflections of sunlight. The background shows more of the ocean's surface under a bright sky.

Measures the degree to
which waters are polluted

10. Biodiversity

Success in maintaining the richness
and variety of marine life

SPECIES

Average IUCN
conservation status
of marine species

HABITATS

Mangroves, coral reefs, seagrass
beds, salt marshes, sea ice, and
subtidal soft-bottom habitats

Goal Status

EXAMPLES OF INDICATORS USED TO CALCULATE GOAL STATUS				
Food Provision	Artisanal Fishing	Natural Products	Carbon Storage	Coastal Protection
Catch volume by species	Quality of artisanal fishing management	Tons harvest of non food products	Extent of coastal habitats	Extent of habitats 1km
Biomass/biomass of MSY	GDPpcPPP	Value of harvest by product	Relative weight of carbon storage by habitat	Condition of habitats 1km
Tons of Mariculture per species	Artisanal fishing need	Sustainability of the harvest		Ocean acidification
Mariculture sustainability				Ultra violet incidence
Coastal population				Sea level rise

Goal Status

EXAMPLES OF INDICATORS USED TO CALCULATE GOAL STATUS				
Economies & Livelihoods	Tourism & Recreation	Cultural Identity	Clean Waters	Biodiversity
Sector revenues	Proportional employment in tourism	Conservation status of iconic species	Chemical pollution	Conservation status of species
Employment and wages in the sectors	Tourism sustainability	Proportion of marine and coastal protected areas	Pathogens	Conservation status of habitats
Unemployment			Nutrient pollution	
Coastal GDP			Trash	
Marine sector evenness				

Data Normalizing

$$X' = \frac{X - X_{min}}{X_{max} - X_{min}}$$

All status, pressures, and resilience data
are **normalized from 0-100**

DATA LAYERS

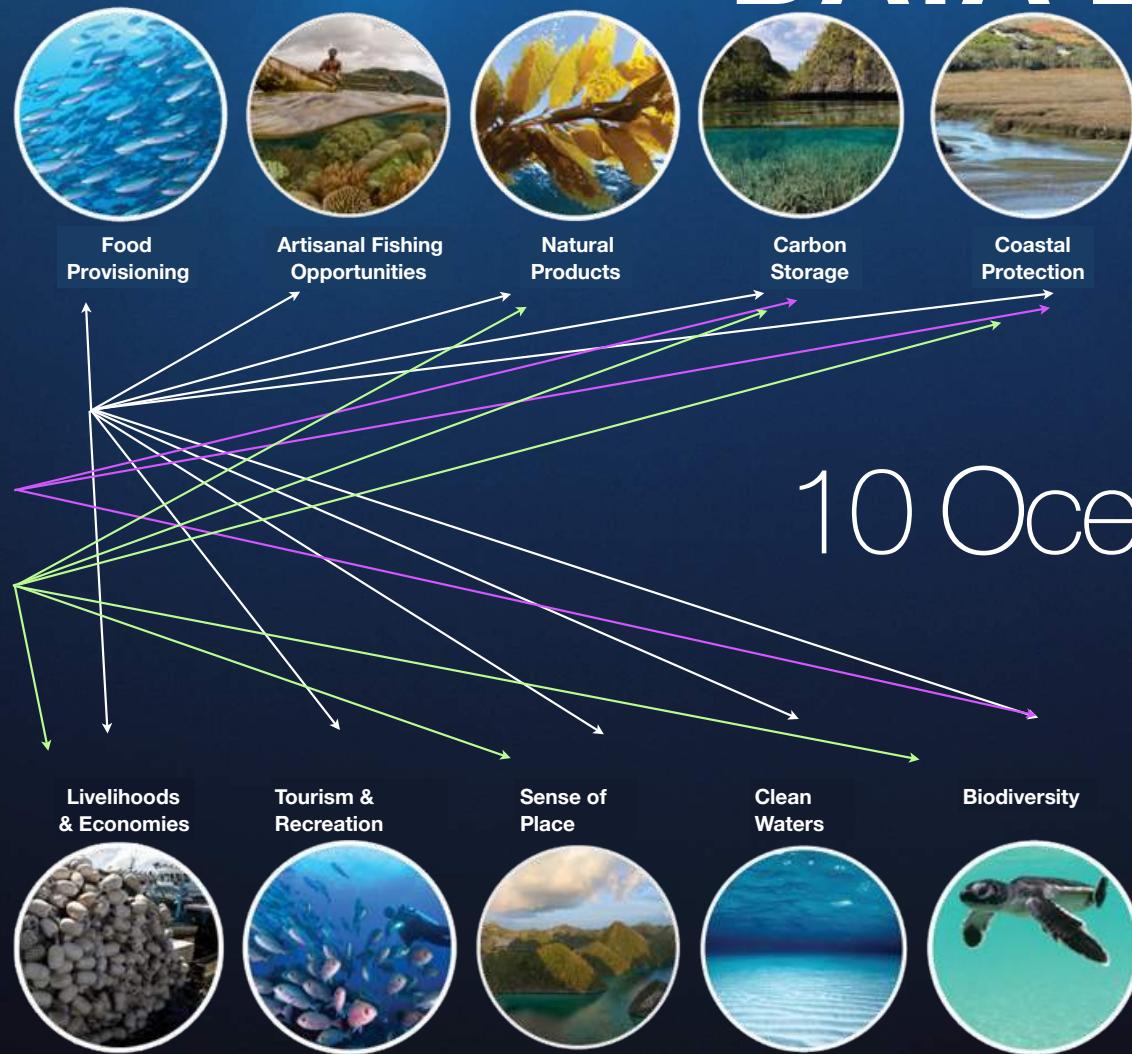
Alien species
Destroyed habitats
MPA
Salaries
Fish oil
Marine revenues
IUCN Risks

Nutrient Pollution

Mangroves

Acidification

Mariculture yields
Trash
Salt marshes
Tourism
World Governance
Indicators
CITES
Marine revenues
Ornamental fish



10 Ocean Goals

Components of Goal Scores

Present Status
50%

Goal's present value compared to a goal-specific reference point

Likely Future Status
50%

2/3
Trend
average percentage change in Status shown by the most recent five years of data

2/3

1/3

Pressure	Resilience
ecological and social factors that negatively affect status	sum of ecological and social factors that positively affect status and reduce pressures



Global Assessments

- Annual global studies led by OHI team
- Apply uniform data & methods
- 221 EEZ + High Seas



+ = independent Assessments

- Led by independent groups
- Customized scales
- Local data & methods
- Stakeholder participation
- Inform local decision-making

Study area & regions

Global
assessments

vs.

OHI+
independent
assessments

Study area: Country

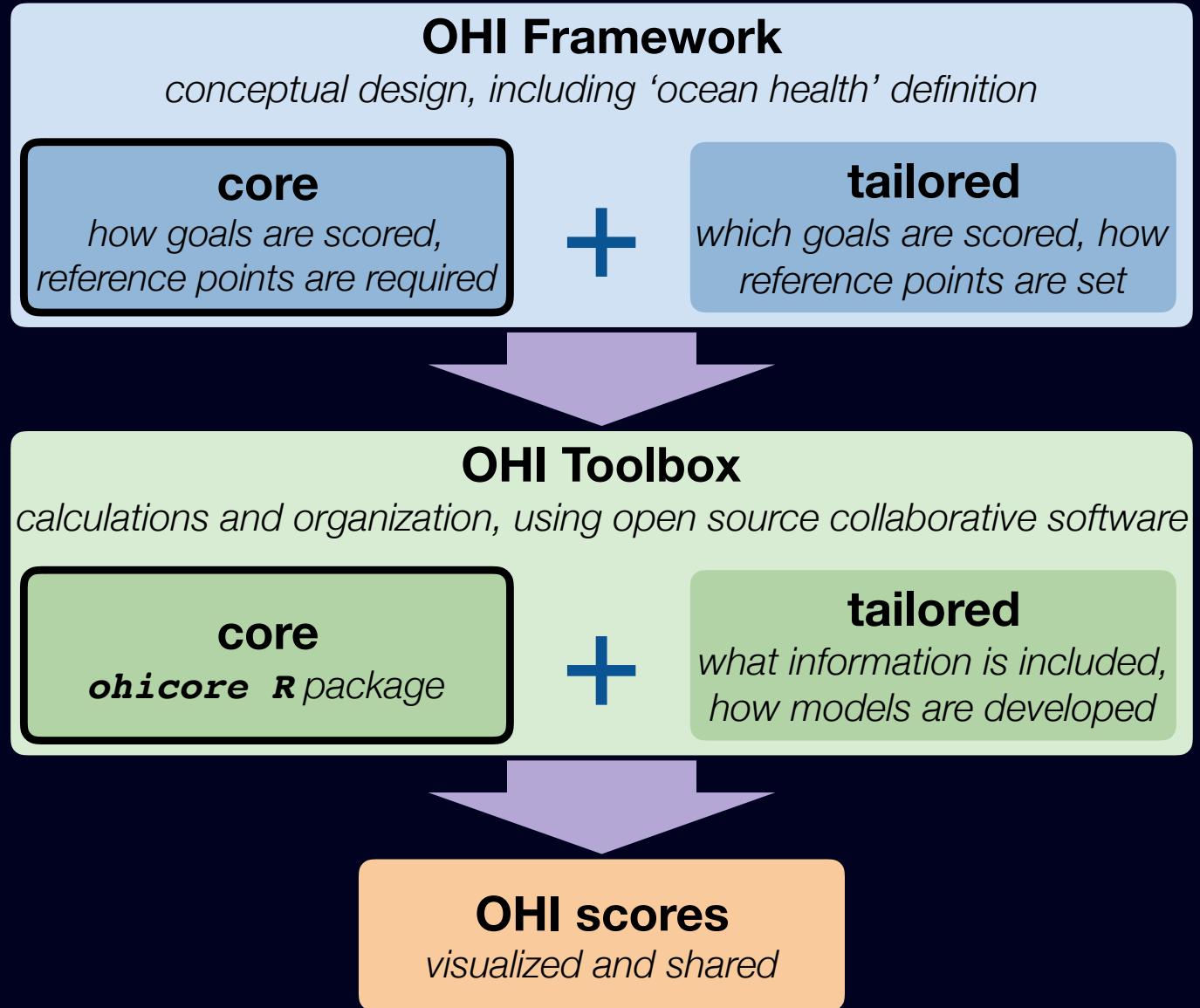
Region: States

Study area: Globe

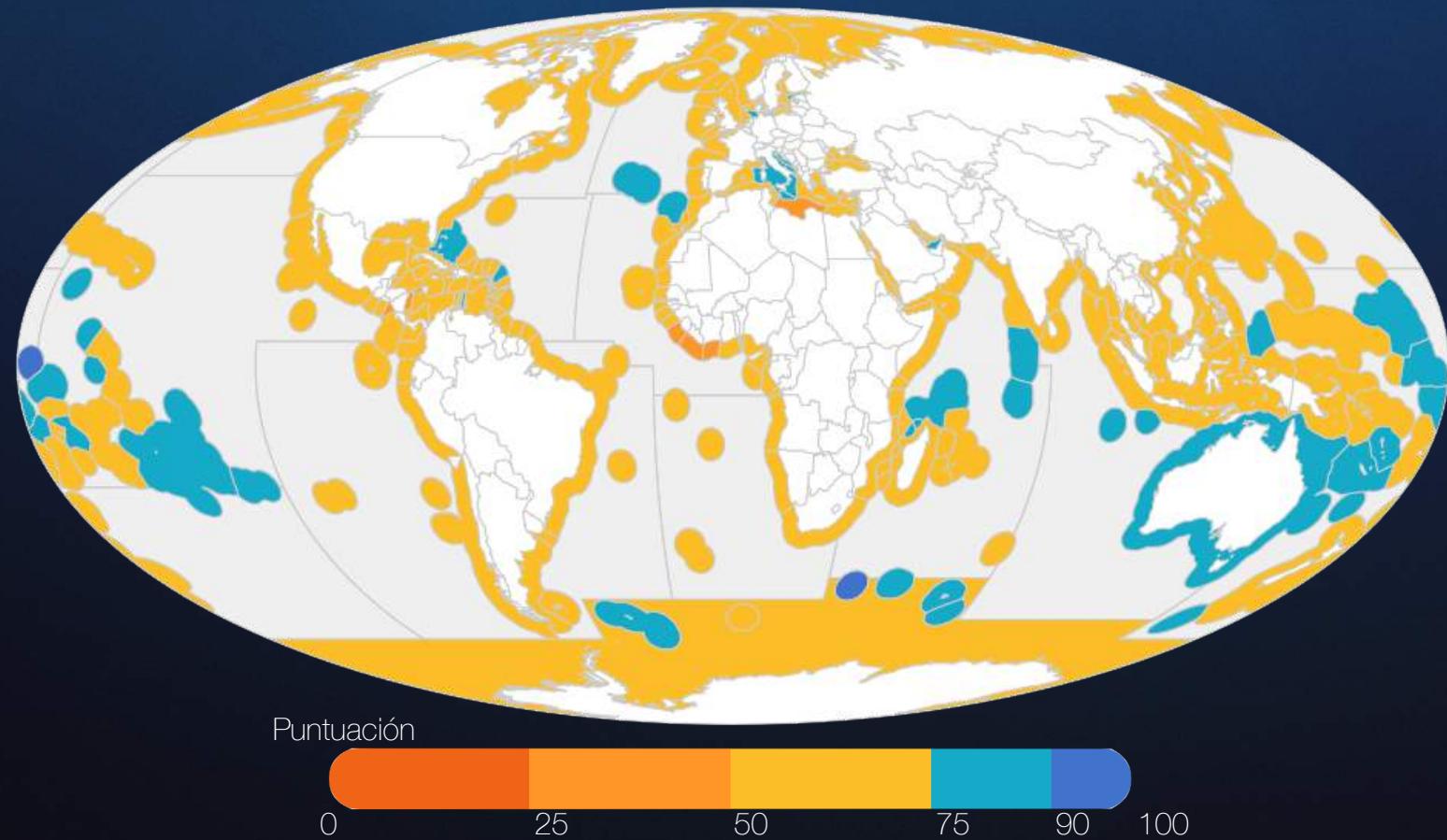
Region: Countries



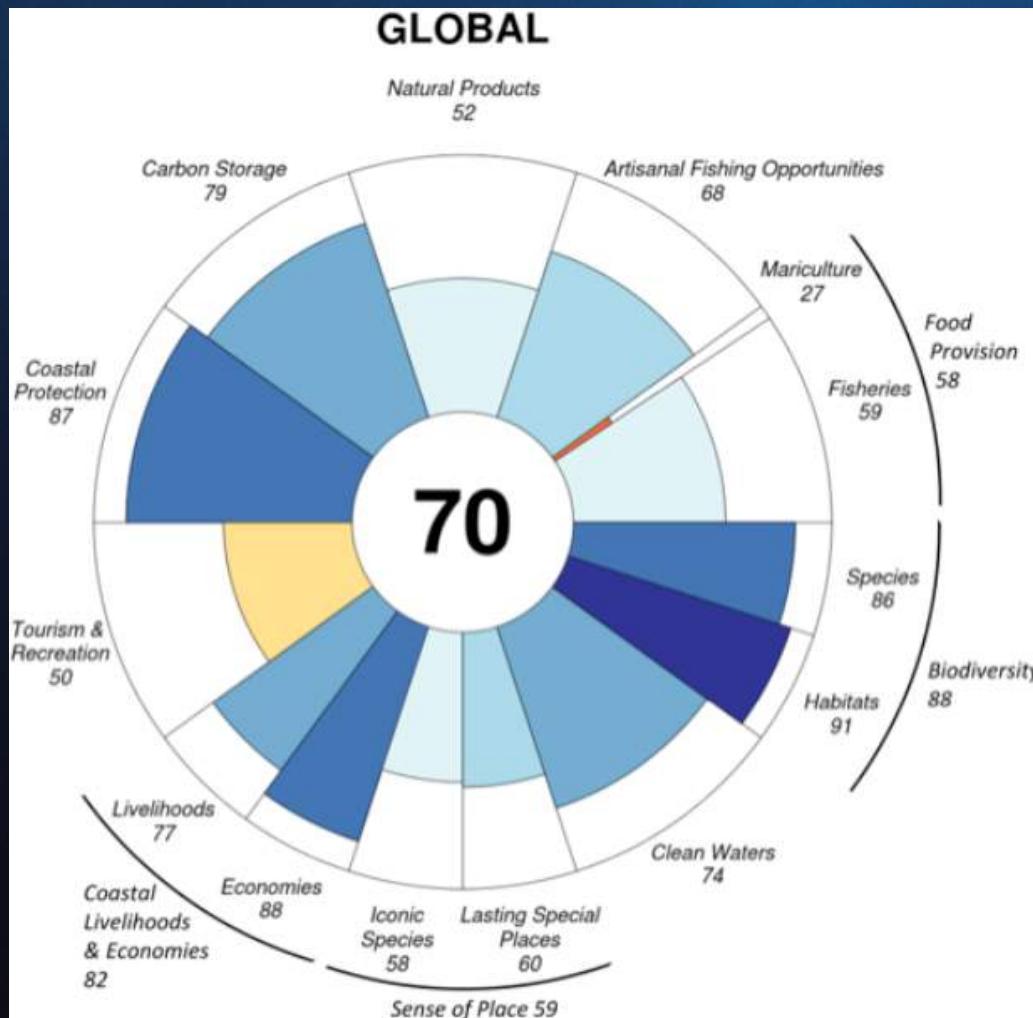
CORE + TAILORABLE framework



110 Global Data Sets
221 EEZ – Countries & Territories



2015 Global Assessments



Highest scoring areas:

Prince Edward Islands **92**
Howland Island and Baker Island **90**
Macquarie Island, Heard and McDonald Islands **87**
Phoenix Group, Northern Saint-Martin **86**
New Caledonia (pop. 269,000) **85**

Lowest scoring areas:

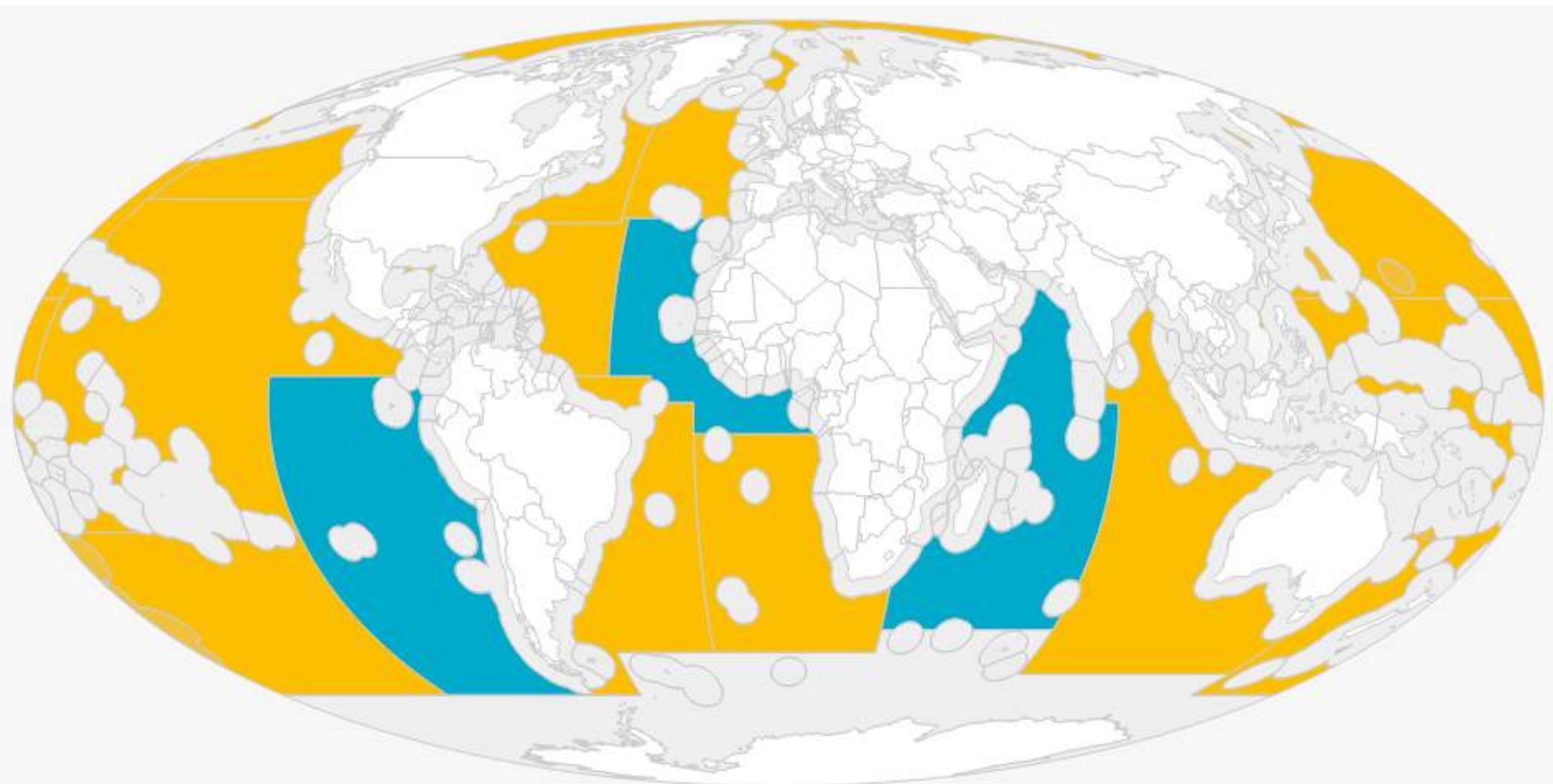
North Korea, Lebanon **50**
Liberia, Nicaragua **48**
Sierra Leone, Ivory Coast, DRC **47**
Dominica **46**
Libya **43**

High Seas Assessment

Based on 15 FAO subdivisions

Only three components assessed:

1. Food provision: fisheries
2. Sense of place: iconic species
3. Biodiversity: species



Lowest: 53 Pacific Northwest
Highest: 79 Western Indian Ocean

Limitations and challenges of the global assessment

- Data must be uniformly available from all countries
- Better data from individual countries can't be used
- Results are coarser than country-level data might provide
- Can't see local-scale phenomena

Strengths

Uniform methods & common language

Comparisons

Synergy with Multilateral Environmental Agreements

Limitations

Global data quality

Low local precision

Low policy relevance at local scales

Endorsements & Adoptions



Member login

United Nations World Ocean Assessment

Regular Process for Global Reporting and Assessment of the State of the Marine Environment Including Socioeconomic Aspects



A composite image featuring two distinct scenes. The upper scene shows a man with a beard and mustache, shirtless, sitting in a traditional wooden boat with a long wooden paddle. The boat is weathered and has some orange rust on its hull. The water is calm with some ripples. In the background, there are green hills under a cloudy sky. The lower scene is an underwater view of a coral reef. The reef is composed of various types of coral, including large brain corals and smaller, branching corals. The colors range from deep greens to bright yellows and browns. The overall image has a warm, slightly overexposed feel.

Thank You!
Questions?
www.ohi-science.org