

# The Ocean Health Index 2012-2015

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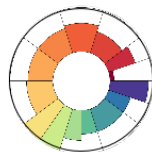
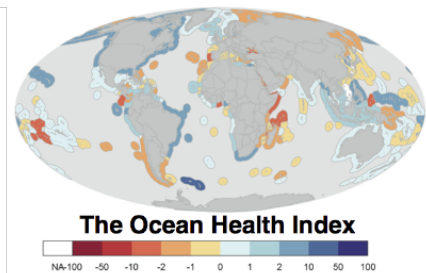


# The Ocean Health Index 2012

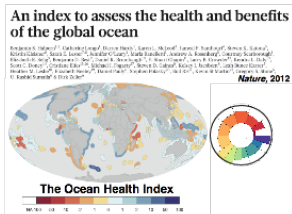
## An index to assess the health and benefits of the global ocean

Benjamin S. Halpern<sup>1,2</sup>, Catherine Longo<sup>1</sup>, Darren Hardy<sup>1</sup>, Karen L. McLeod<sup>3</sup>, Jameal F. Samhouri<sup>4</sup>, Steven K. Katona<sup>5</sup>, Kristin Kleisner<sup>6</sup>, Sarah E. Lester<sup>7,8</sup>, Jennifer O'Leary<sup>1</sup>, Marla Ranelletti<sup>1</sup>, Andrew A. Rosenberg<sup>5</sup>, Courtney Scarborough<sup>1</sup>, Elizabeth R. Selig<sup>5</sup>, Benjamin D. Best<sup>9</sup>, Daniel R. Brumbaugh<sup>10</sup>, F. Stuart Chapin<sup>11</sup>, Larry B. Crowder<sup>12</sup>, Kendra L. Daly<sup>13</sup>, Scott C. Doney<sup>14</sup>, Cristiane Elfes<sup>15,16</sup>, Michael J. Fogarty<sup>17</sup>, Steven D. Gaines<sup>8</sup>, Kelsey I. Jacobsen<sup>8</sup>, Leah Bunce Karrer<sup>5</sup>, Heather M. Leslie<sup>18</sup>, Elizabeth Neeley<sup>19</sup>, Daniel Pauly<sup>6</sup>, Stephen Polasky<sup>20</sup>, Bud Ris<sup>21</sup>, Kevin St Martin<sup>22</sup>, Gregory S. Stone<sup>5</sup>, U. Rashid Sumaila<sup>6</sup> & Dirk Zeller<sup>6</sup>

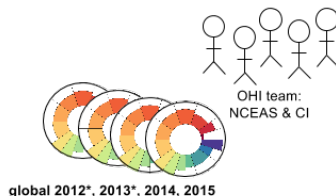
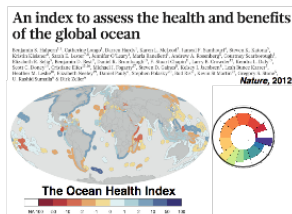
***Nature*, 2012**



# The Ocean Health Index 2012



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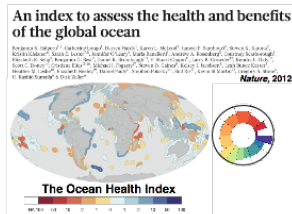


\* published

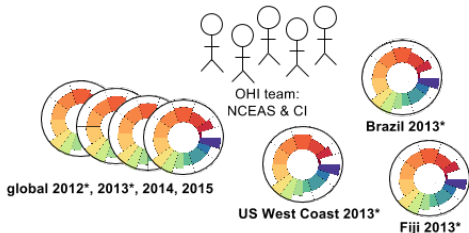




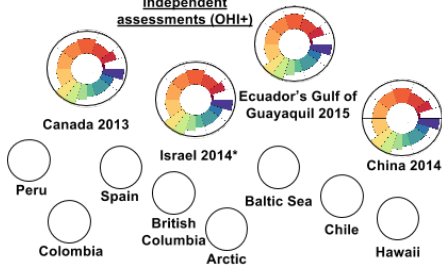
# The Ocean Health Index 2012-2015



*Nature*, 2012



## independent assessments (OHI+)



## Toolbox and resources to enable independent assessments (OHI+)

open-source  
software

visualization tools

training program

\* published



# Outline

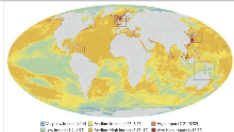
- ▶ Motivation for developing OHI
- ▶ OHI: an assessment framework
- ▶ OHI Toolbox
- ▶ Support for independent assessments

# Motivation for developing OHI

## A Global Map of Human Impact on Marine Ecosystems

Benjamin S. Halpern,<sup>1,2</sup> Shaun Walbridge,<sup>1,2</sup> Kimberly A. Selkoe,<sup>1,2,4</sup> Carrie V. Kappel,<sup>1</sup> Fiorenza Micheli,<sup>2</sup> Caterina D'Agrosa,<sup>4</sup> John F. Bruno,<sup>5</sup> Kenneth S. Casey,<sup>6</sup> Colin Ebert,<sup>1</sup> Helen E. Fox,<sup>7</sup> Rod Fujita,<sup>8</sup> Dennis Heinemann,<sup>9</sup> Hunter S. Lenihan,<sup>10</sup> Elizabeth M. P. Madin,<sup>11</sup> Matthew T. Perry,<sup>1</sup> Elizabeth R. Selig,<sup>6,12</sup> Mark Spalding,<sup>13</sup> Robert Steneck,<sup>14</sup> Reg Watson<sup>15</sup>

*Science*, 2008

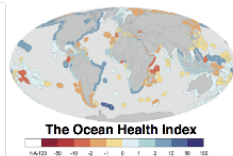


Cumulative Human Impacts

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

Benjamin S. Halpern<sup>1,2</sup>, Catherine Longo<sup>1</sup>, Darren Hardy<sup>1</sup>, Karen L. McLeod<sup>3</sup>, Jameal F. Samhouri<sup>4</sup>, Steven K. Katona<sup>5</sup>, Kristin Kleiser<sup>6</sup>, Sarah E. Lester<sup>7,8</sup>, Jennifer O'Leary<sup>9</sup>, Marla Randknecht<sup>10</sup>, Andrew A. Rosenberg<sup>11</sup>, Courtney Scarborough<sup>12</sup>, Elizabeth R. Selig<sup>13</sup>, Benjamin D. Sill<sup>14</sup>, Daniel B. Brumbaugh<sup>15</sup>, F. Stuart Chaplin<sup>16</sup>, Larry B. Crowder<sup>17</sup>, Kimberly L. Daly<sup>18</sup>, Scott C. Emswiler<sup>19</sup>, Cristiane Eklöv<sup>20,21</sup>, Michael J. Fogarty<sup>22</sup>, Steven D. Gaines<sup>23</sup>, Kelsey I. Jacobson<sup>24</sup>, Leah Hanson-Karrer<sup>25</sup>, Heather M. Leslie<sup>26</sup>, Elizabeth Neeley<sup>27</sup>, Daniel Pauls<sup>28</sup>, Stephen Polasky<sup>29</sup>, Brad Rice<sup>30</sup>, Kevin St Martin<sup>31</sup>, Gregory S. Stone<sup>32</sup>, U. Rashid Sumaila<sup>33</sup> & Dirk Zeller<sup>34</sup>

*Nature*, 2012



The Ocean Health Index

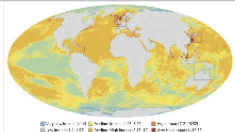
- Cumulative Human Impacts is only the negatives, what about the positives?

# Motivation for developing OHI

## A Global Map of Human Impact on Marine Ecosystems

Benjamin S. Halpern,<sup>1,†</sup> Shaun Walbridge,<sup>1,\*</sup> Kimberly A. Selkoe,<sup>1,2,†</sup> Carrie V. Kappel,<sup>1</sup> Fiorenza Micheli,<sup>2</sup> Caterina D'Agora,<sup>4,†</sup> John F. Bruno,<sup>5</sup> Kenneth S. Casey,<sup>6</sup> Colin Ebert,<sup>1</sup> Helen E. Fox,<sup>7</sup> Rod Fujita,<sup>8</sup> Dennis Heinemann,<sup>9</sup> Hunter S. Lenihan,<sup>10</sup> Elizabeth M. P. Madin,<sup>11</sup> Matthew T. Perry,<sup>1</sup> Elizabeth R. Selig,<sup>6,12</sup> Mark Spalding,<sup>13</sup> Robert Steneck,<sup>14</sup> Reg Watson<sup>15</sup>

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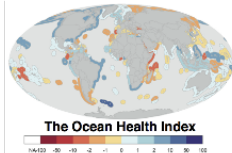


Cumulative Human Impacts

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

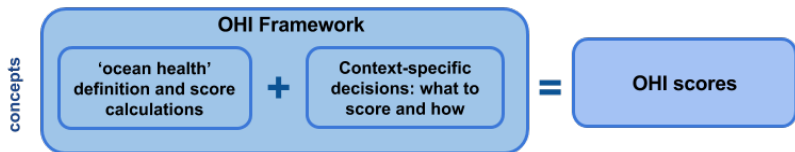
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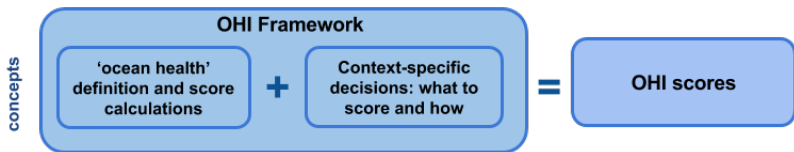


- ▶ Cumulative Human Impacts is only the negatives, what about the positives?
- ▶ Policy mandates to 'keep oceans healthy'
- ▶ What is a 'healthy ocean'? Must define in order to measure

# OHI Framework



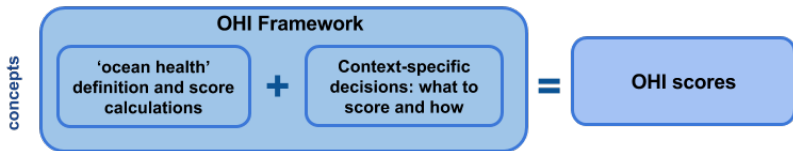
# OHI Framework: definition



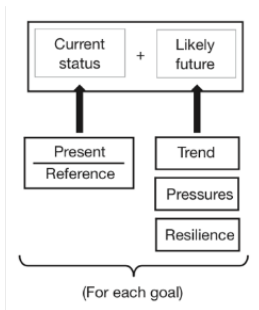
*‘A healthy ocean sustainably delivers a range of benefits to people now and in the future’*

- ▶ a healthy ocean is not necessarily ‘pristine’
- ▶ human priorities are explicit
- ▶ assesses a range of benefits, categorized as ‘goals’

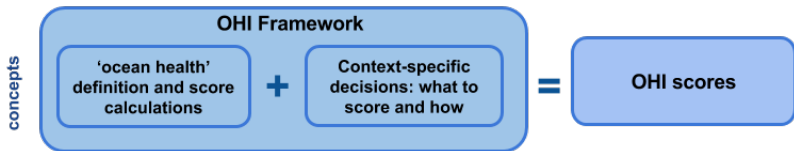
# OHI Framework: score calculations



- ▶ score calculations: **current status** + **likely future state**



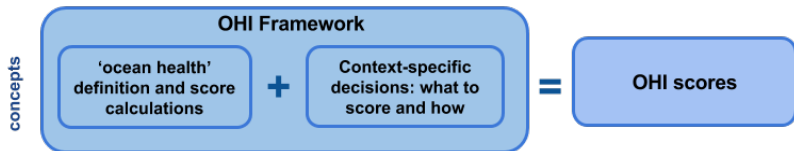
# OHI Framework: context-specific



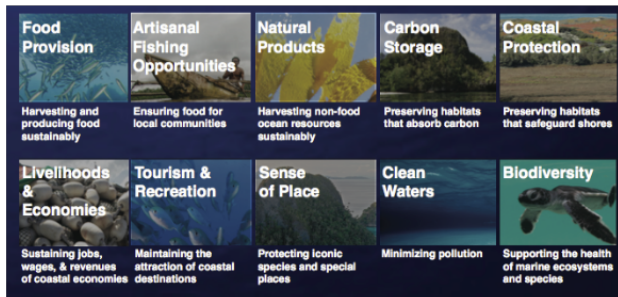
## Context specific decisions:

- ▶ which goals are important?
- ▶ how should they ideally be measured?
- ▶ what are key characteristics of the area?
- ▶ what are cultural priorities?
- ▶ what are pressures affecting these goals?
- ▶ what mitigates these pressures (resilience)?

# OHI Framework: context-specific

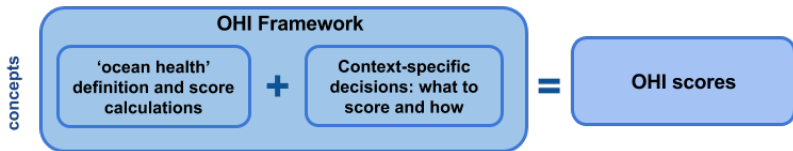


Ten goals were identified as important for global assessments:





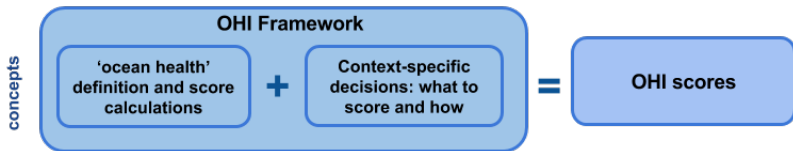
# OHI Framework



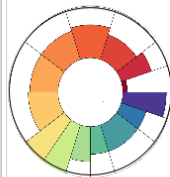
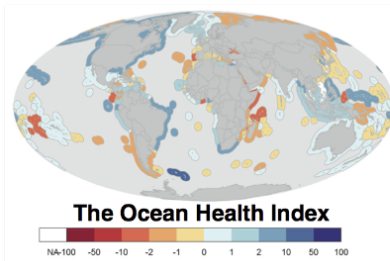
**Make context-specific decisions BEFORE gathering information (data/indicators).**

- ▶ information should fit into the framework; the framework should not be built around available information (biases)
- ▶ remain true to the planned goals
  - ▶ include indirect (proxy) information
  - ▶ highlight knowledge gaps

# OHI Framework: scores



- ▶ OHI scores are on a unitless scale from 0-100
- ▶ visualized with maps and flower plots



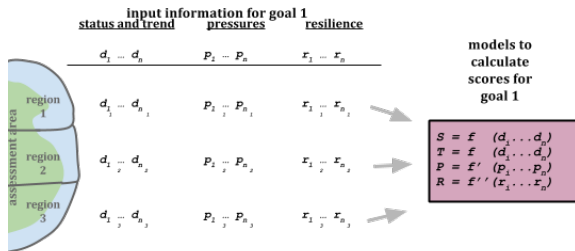
# OHI calculations overview

Information is required for all regions in an assessment area

	input information for goal 1		
	<u>status and trend</u>	<u>pressures</u>	<u>resilience</u>
	$d_1 \dots d_n$	$p_1 \dots p_n$	$r_1 \dots r_n$
assessment area region 1	$d_{1,1} \dots d_{n,1}$	$p_{1,1} \dots p_{n,1}$	$r_{1,1} \dots r_{n,1}$
region 2	$d_{1,2} \dots d_{n,2}$	$p_{1,2} \dots p_{n,2}$	$r_{1,2} \dots r_{n,2}$
region 3	$d_{1,3} \dots d_{n,3}$	$p_{1,3} \dots p_{n,3}$	$r_{1,3} \dots r_{n,3}$

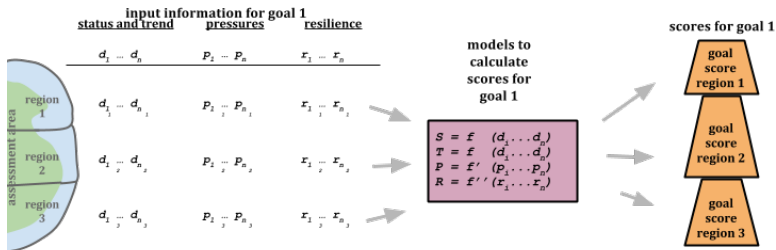
# OHI calculations overview

The same model is used for all regions



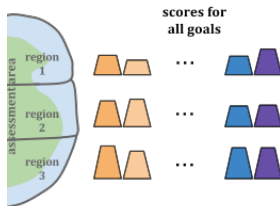
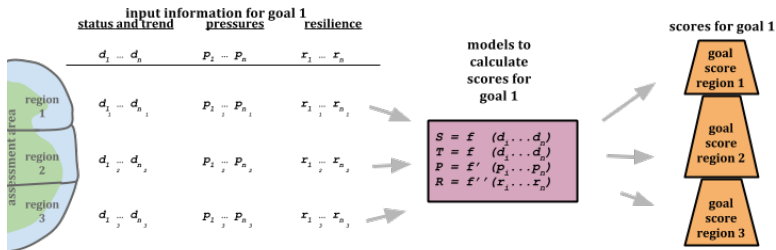
# OHI calculations overview

Scores are calculated for each region for a single goal



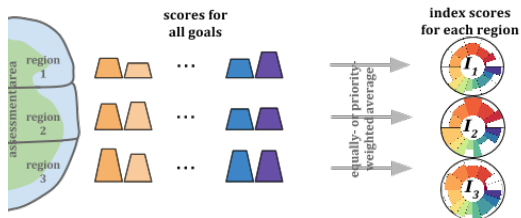
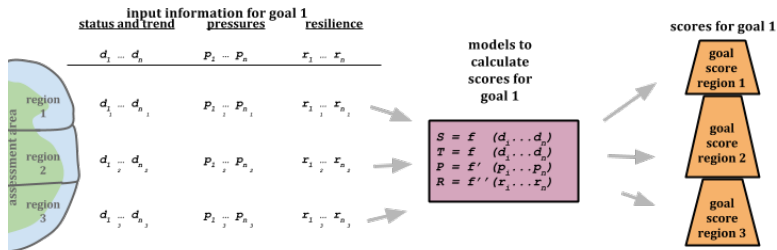
# OHI calculations overview

Scores are calculated for each region for all goals



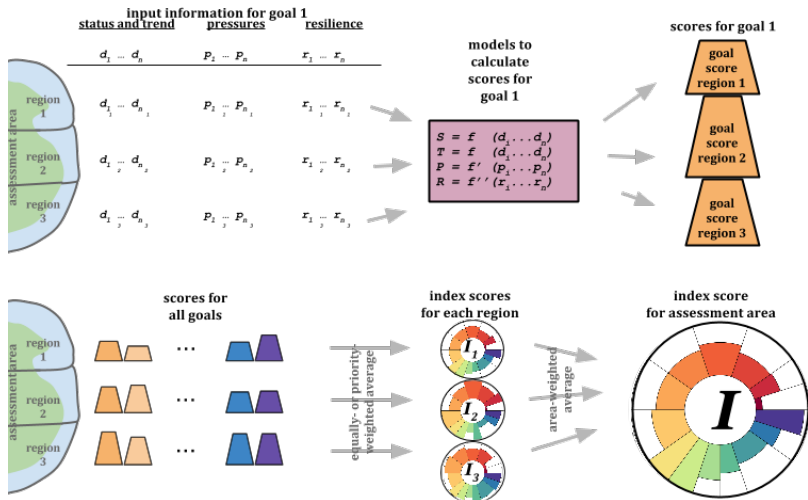
# OHI calculations overview

Goal scores are averaged into index scores for each region



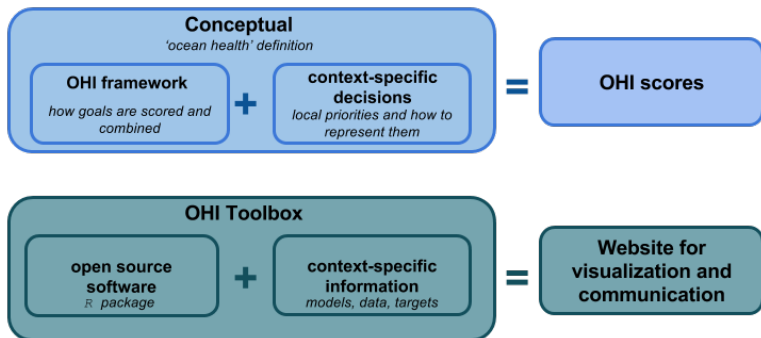
# OHI calculations overview

Assessment index score is the average of region index scores



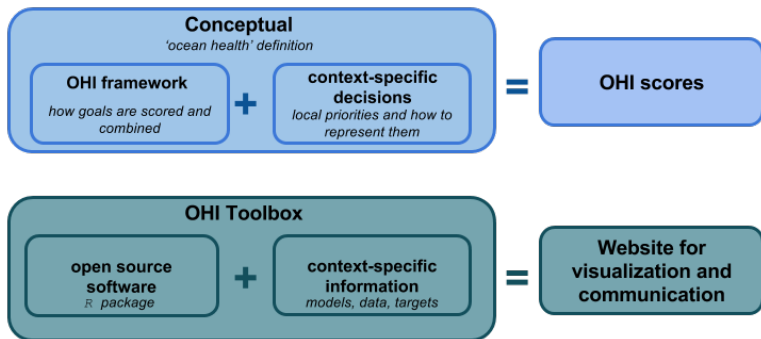


# OHI Toolbox



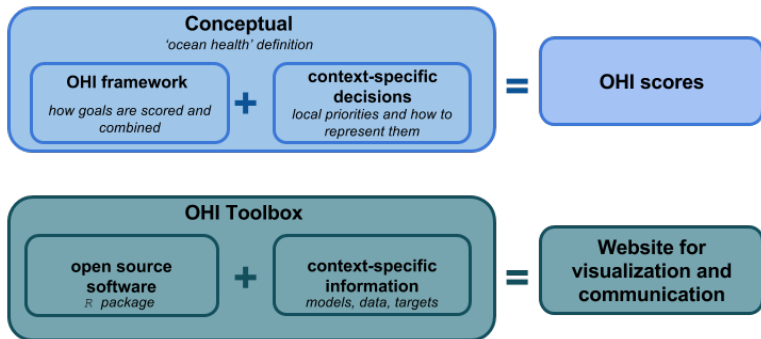
- ▶ open-source tools for analysis, visualization + communication
- ▶ tools are shared through the collaborative platform **GitHub**

# OHI Toolbox: R package



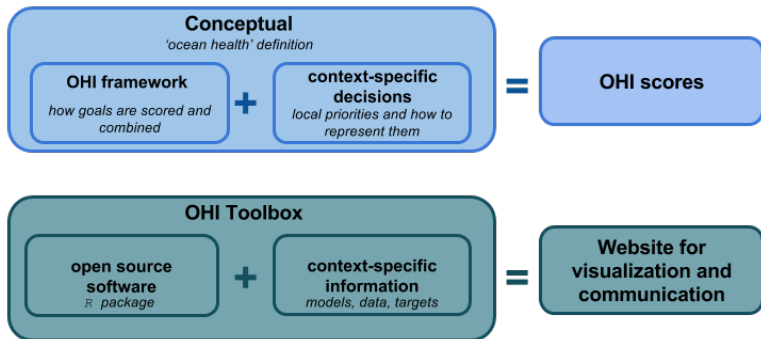
- ▶ Open-source software (R package) to calculate scores
  - ▶ [github.com/ohi-science/ohicore](https://github.com/ohi-science/ohicore)

# OHI Toolbox: context-specific



- ▶ Context-specific info stored in a structured GitHub repository
  - ▶ Ecuador ex: [github.com/ohi-science/gye](https://github.com/ohi-science/gye)
  - ▶ Chile ex: [github.com/ohi-science/chl](https://github.com/ohi-science/chl)

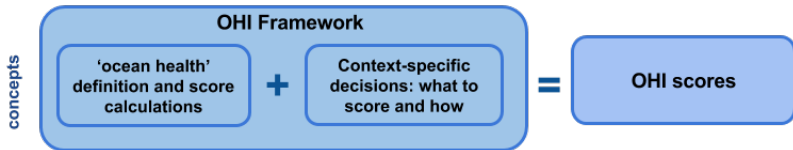
# OHI Toolbox: website



- ▶ Website to display methods and scores
  - ▶ Ecuador ex: [ohi-science.org/gye](https://ohi-science.org/gye)
  - ▶ Chile ex: [ohi-science.org/chl](https://ohi-science.org/chl)

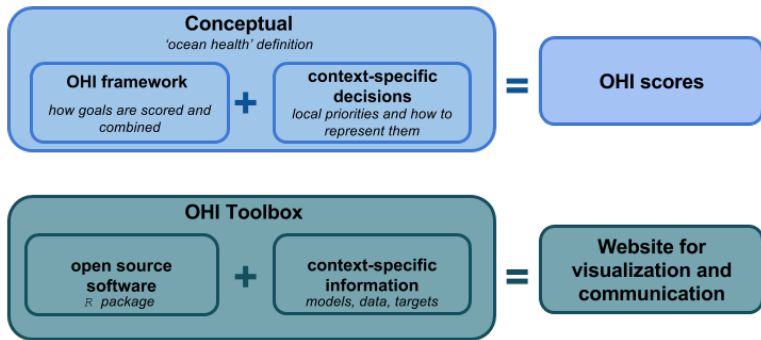
# OHI Assessments

The OHI framework is standardized, yet modifiable to suit assessments in different contexts.



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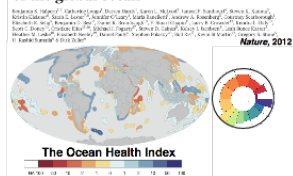
The

Toolbox and GitHub facilitate assessment calculations, but also organization, remote collaboration, and documentation.

# Support for independent assessments

All resources are at **ohi-science.org**

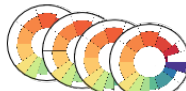
## An index to assess the health and benefits of the global ocean



*Nature*, 2012



OHI team:  
NCEAS & CI



global 2012\*, 2013\*, 2014, 2015



Brazil 2013\*



US West Coast 2013\*



Fiji 2013\*

## independent assessments (OHI+)



Canada 2013



Ecuador's Gulf of  
Guayaquil 2015



Israel 2014\*



China 2014



Peru



Spain



Baltic Sea



Chile



Hawaii



Colombia



British  
Columbia



Arctic

## Toolbox and resources to enable independent assessments (OHI+)

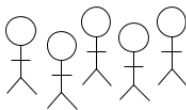
open-source  
software

visualization tools

training program

\* published

# Support for independent assessments



**Contact us** Julie Lowndes: [lowndes@nceas.ucsb.edu](mailto:lowndes@nceas.ucsb.edu) Ning Mendes: [mendes@nceas.ucsb.edu](mailto:mendes@nceas.ucsb.edu) Erich Pacheco: [epacheco@conservation.org](mailto:epacheco@conservation.org)