MaPP Central Coast EBM Indicator Monitoring Program – Overview

The Central Coast Marine Plan was developed using an Ecosystem-Based Management (EBM) Framework, an adaptive approach to managing human activities that seeks to ensure the coexistence of healthy, fully functioning ecosystems and human communities (AORA, 2019; TNC, 2019). The intent of EBM is to maintain spatial and temporal characteristics of ecosystems such that component species and ecological processes can be sustained, and human wellbeing supported and improved. EBM aligns with provincial directions in resource management and is consistent with the current and historic practices of the Heiltsuk, Kitasoo Xai'xais, Nuxalk, and Wuikinuxv First Nations, whose stewardship laws and principles (e.g., respect for the natural world, intergenerational equity and knowledge transfer, reciprocity) can be seen in the principles of modern-day EBM.

EBM Principles

- Seeks to ensure ecological integrity.
- Includes human wellbeing.
- Is precautionary.
- Is adaptive.
- Includes the assessment of cumulative effects.
- Is equitable, collaborative, inclusive and participatory.
- Respects Aboriginal rights, Aboriginal titles and treaty rights.
- Is area-based.
- Is integrated.
- Is based on science and on wise counsel.

(MaPP, 2016, p. 7)

The objectives and strategies of the Central Coast Marine Plan flow from four interconnected goals of the MaPP marine EBM framework, which are to achieve:

1. Integrity of the marine ecosystems, primarily with respect to their structure, function, and resilience.
2. Human wellbeing supported through societal, economic, spiritual, and cultural connections to marine ecosystems.
3. Collaborative, effective, transparent, integrated governance, management and public engagement.
4. Improved understanding of complex marine ecosystems and changing marine environments.

To effectively implement EBM, it is necessary to have some objective knowledge about the state of an ecosystem – including the humans within it – and how this is changing over time. Only in this way is it possible to know whether a plan is achieving its aims, and how to adapt projects, programs, and the plan itself as conditions change and our understanding improves (see Figure 3). To that end the Central Coast Marine Plan commits to developing an EBM indicator monitoring program that will monitor changes in the state of Central Coast ecological and human wellbeing systems over time (see MaPP, 2015, s. 5.2, pp. 24-).

WHAT IS AN EBM INDICATOR MONITORING PROGRAM?

Monitoring is the systematic and purposeful observation of **values** and **ecosystem components** (the ecological or social elements of a system) through the measurement of **indicators**.

The program has a number of components:

Values

A value is something that people care about because it is seen as important to the integrity and wellbeing of people and communities, economies, or ecological systems. Values can be defined in policy, legislation or agreements with First Nations (B.C., 2017). In the context of the Central Coast EBM monitoring program, we are concerned with values related to ecological integrity, human wellbeing, and governance.

Indicators

Indicators are measurable parts of a system that can be used to simplify the evaluation of complex systems and make assessment and management more efficient and strategic. They can be either individual components of a system, such as a particular species, or an aggregate of components, and are used to measure either:

- the status (health) of a system / component, or
- a pressure or stressor that affects that status.

Status indicators provide a diagnosis of a system and can provide early warning signs of a problem with respect to ecological integrity or human wellbeing. They are most useful when we have some understanding of what an 'acceptable' level is for a given indicator. Pressure indicators are helpful for focusing on the sources of change in the system and, thereby, on guiding our management priorities.

A total of 29 indicators under seven reporting themes have been selected for monitoring in the Central Coast sub-region (Figure 1). "Trends in [these] indicators will

help determine if Central Coast Marine Plan goals are being achieved and will provide warning signs about potential or growing threats to marine values" (MaPP, 2015, p. 137). The multi-year process that was undertaken to select these indicators is described below.

Metrics

A Metric is a unit of measure that reflects the state of an indicator.

So, for example:

- 'healthy kelp forests' is a **value**,
- 'kelp distribution and abundance' are **indicators**, and
- *'percent linear distance in km by density type'* is a **metric** that can be used to measure kelp distribution and abundance.

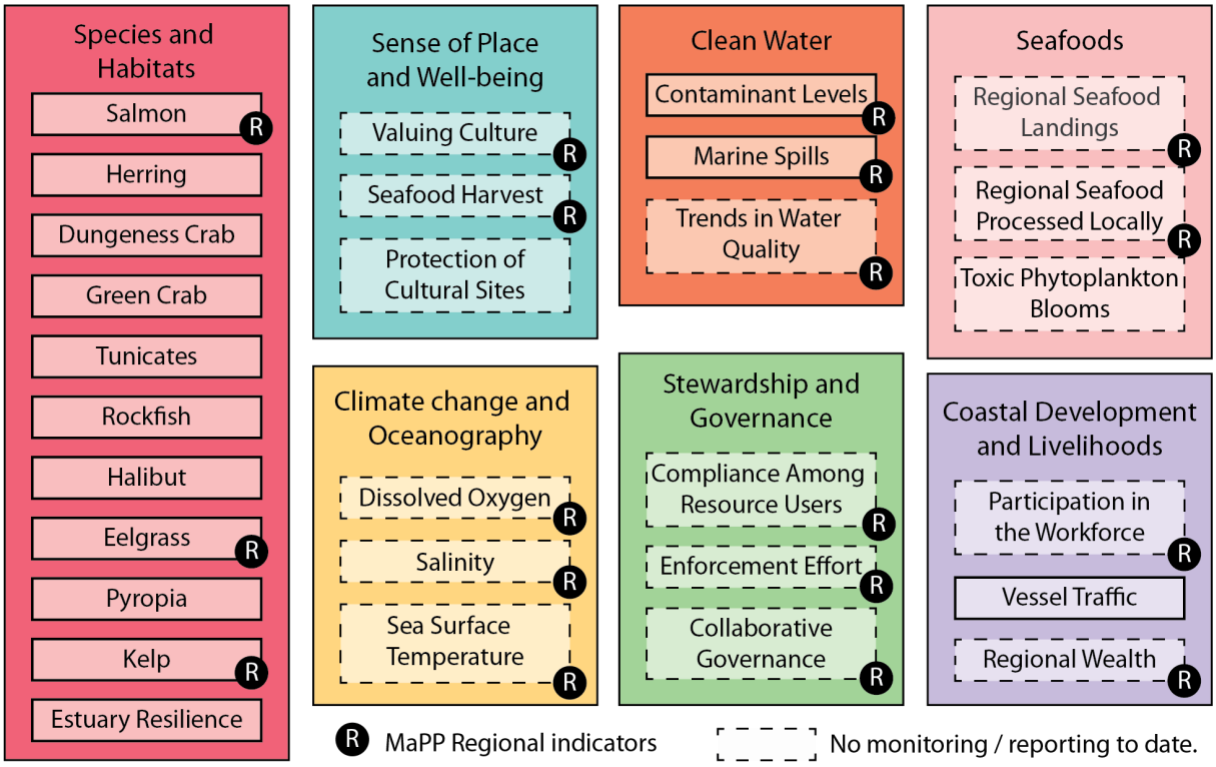

Figure 1: 29 Central Coast sub-regional and regional indicators by reporting theme. For the full indicator names (e.g., "pacific salmon abundance"; "vessel traffic magnitude and type) see Appendix A : List of Central Coast indicators.

The values we care about and the associated indicators we use to measure them are embedded in a complex web of interacting variables. While our understanding of this complexity will always be imperfect (it is not possible to monitor every variable), the monitoring program will improve our understanding of the relationships that matter most with respect to the values and

indicators we have identified. Each Central Coast EBM indicator report includes a section with a conceptual model (Figure 2) outlining what we currently understand about the relationships between that indicator and other factors influencing and / or influenced by it, including:

External drivers

An external driver is "a superior complex phenomenon" (or force) that can affect the direction of ecosystem change but is not affected in turn by that change (Oesterwind et al., 2016, p. 11; Selkoe et al., 2015). Drivers, which can result in a negative pressure (or 'stressor') on some or all parts of an ecosystem can be anthropogenic or natural in origin. Some drivers, such as climate change – one of the most consequential drivers and a source of multiple stressors in marine ecosystems – could be both. Anthropogenic drivers are based on economic, social and political needs like food, health, and employment (human values are a powerful driver of ecosystem changes). Natural drivers include such things as earthquakes or volcanic eruptions. Both anthropogenic and natural drivers are beyond direct control or management (Oesterwind et al., 2016).

Human activities

The marine environment is used by people in many different ways and with varying levels of impact on the environment. Human activities can be more or less disruptive on ecosystem components, and more or less compatible with one another. Like external drivers, human activities can be a source of stressors on ecosystems; but unlike drivers they *can* be directly influenced through management.

Ecosystem components

An ecosystem component is a biotic or abiotic element of a system linked to a given value and other components of the system – external drivers, human activities, and human wellbeing – via causal relationships. More than half of the 29 EBM indicators in our monitoring program relate to biotic (species and habitat) or abiotic (climate change and oceanography, clean water) ecosystem components.

Human wellbeing

Human wellbeing is tied to the marine environment through a myriad of social, economic and cultural connections. Any changes to the marine environment and people's ability to access it as a sustainable source of wealth, sustenance and cultural norms may impact the wellbeing of people and communities.

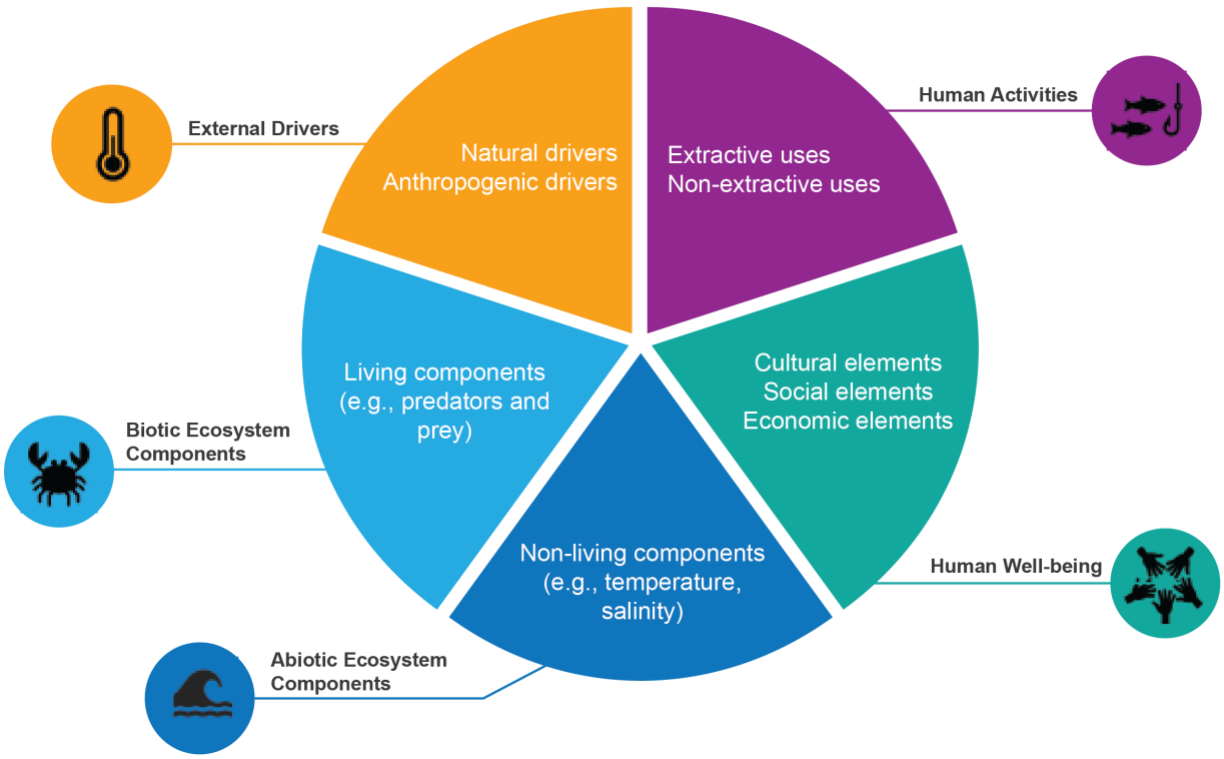

Figure 2. Conceptual model used in indicator reports to show the external drivers, human activities, ecosystem components and aspects of human wellbeing that the Central Coast partners are interested in exploring in relation to each indicator and associated value(s).

The key components of the EBM monitoring program described above are illustrated in Figure 3. A glossary of these and other terms and concepts can also be found on page 12.

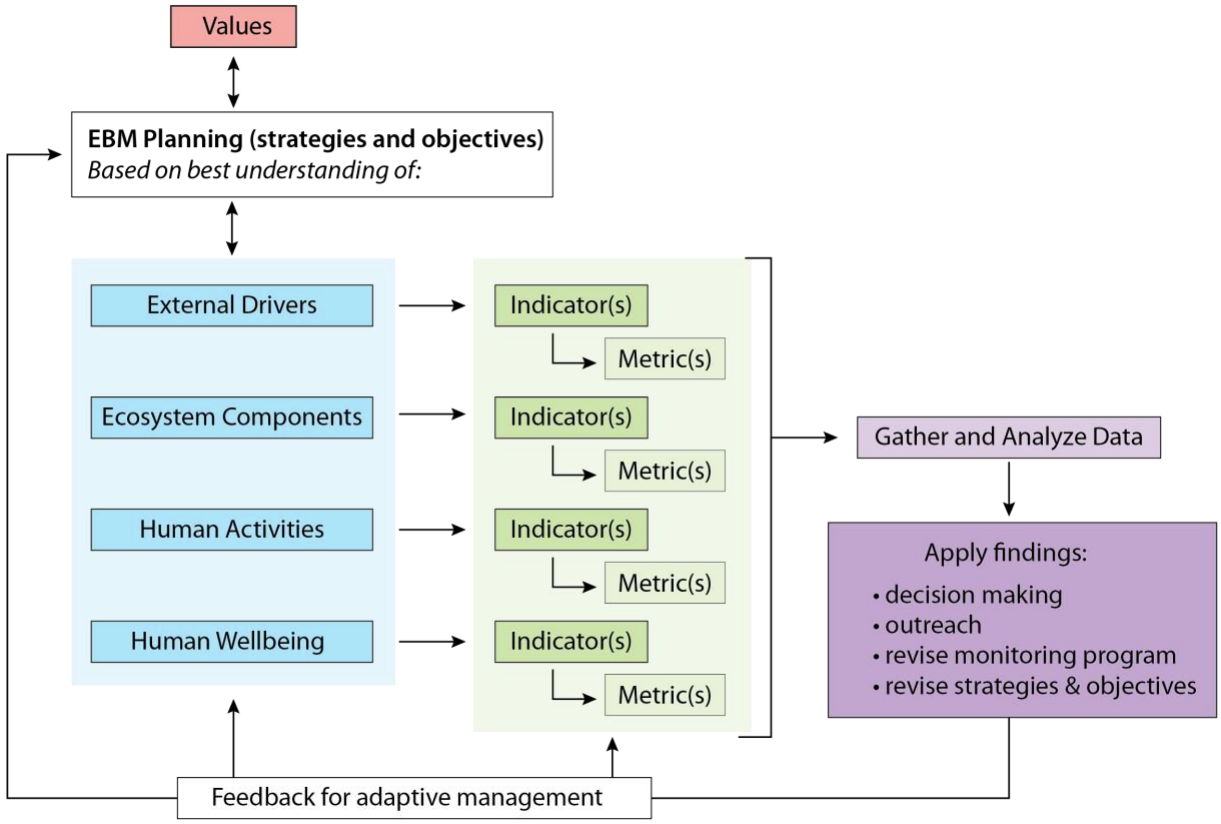

Figure 3. Key elements of an EBM monitoring program.

Monitoring and reporting on a suite of ecosystem health, human wellbeing and governance indictors is an important part of MaPP implementation in all sub-regions. Each of the MaPP sub-regional marine plans has a long-term vision of improved ecosystem health and associated human wellbeing.

The vision statement in the Central Coast Marine Plan is:

> *Connections between the land, the sea and the people are valued. Healthy marine ecosystems support human wellbeing, sustainable community prosperity and cultural resilience for future generations. The governance and management promoted by the Central Coast Marine Plan is collaborative, effective, transparent and integrated across jurisdictions, First Nations territories and international boundaries. Management incorporates evolving information and adapts to changing social, technological and environmental conditions* (MaPP, 2015, p. 5).

The Central Coast partners recognize that ecological, social, cultural, and economic changes occur in uncertain, unpredictable, and interconnected ways. Monitoring and reporting on the

suite of indicators in the Central EBM monitoring program – especially if relationships among values, external drivers, human activities, ecosystem components and related aspects of human wellbeing are understood will:

1. Contribute to our understanding of the **current state of health** and viability of a value or system. For example, monitoring over an extended period of time can help identify whether the abundance of a particular species is declining or increasing.
2. Provide **warning signs** about potential or growing threats to marine values (Martone et al., 2017). For example, monitoring can help uncover changes in the age structure of a species, which provides a warning about population instability.
3. Provide information about **the potential relationships** between external drivers, ecological components, human activities, and aspects of human wellbeing. For example, monitoring can help identify, explore and evaluate potential ecological and socio-economic consequences associated with change in abundance of a particular species or a change in occurrence of a particular human activity.
4. Inform the **implementation of projects and plans**. For example, monitoring can help identify where particular projects and plans are likely to be most effective (e.g., areas that require restoration, or information gaps that need to be filled).
5. **Inform management decisions** with long-term monitoring using the adaptive management approach. For example, information about the abundance of a particular species and the possible drivers of change can help decision-makers incorporate scientific, cultural and socio-economic information into management decisions about harvest quotas.
6. Help **assess whether objectives and strategies in the Central Coast Marine Plan are being advanced and/or achieved**. For example, monitoring can help support the implementation of objectives and strategies related to sustainable management of key ecological and cultural components in the Plan Area.

"The purpose of indicator monitoring is to lead to better decision making. The Province can use the data to set or affirm priorities, allocate resources and inform policy and decision making."

– Kristin Worsley, manager of B.C.'s marine and coastal resources section and member of MaPP's secretariat.

"Provincial decision-makers and First Nations will have evidence to inform their views on and decisions about issuing tenures for coastal activities."

– Steve Diggon, regional marine planning coordinator for Coastal First Nations-Great Bear Initiative.

HISTORY OF MAPP INDICATOR DEVELOPMENT

MaPP has been working since the planning phase (2012-2016) to build a strong foundation to support the evaluation of EBM indicators.

In 2013 a team of experts was contracted to identify a list of candidate indicators to monitor ecological and human wellbeing. The team spent three years doing research, conducting workshops and gathering expert opinions from the MaPP Partners and stakeholders, and produced reports in three phases:

Phase 1: An overview and framework on types of indicators.

Phase 2: Hundreds of indicator recommendations based on global best practices and expert opinion.

Phase 3: A comparison of Phase 2 indicators to draft MaPP strategies, and a narrowed-down list. Phase 3 indicators included 46 'dashboard' (top rated) indicators and 90 'toolbox' (lower rated) indicators that could be used to measure ecological integrity; and a further 36 dashboard indicators that could be used to measure human wellbeing. Guide sheets describing each indicator and current monitoring efforts were developed for each of the dashboard indicators. In order to be included in the report the Phase 3 indicators had to meet the following criteria:

- Provide scientifically sound and useful information.
- Be relevant, meaningful and understandable.
- Be practical to implement.
- Contribute to a balanced suite of indicators.

From this extensive list, regional and sub-regional 'pilot' indicators were selected during MaPP's early implementation phase (beginning in 2016) by MaPP Partners in collaboration with the Coastal Ocean Research Institute (CORI), with valuable input from stakeholders obtained during MaPP advisory committee meetings and focused EBM indicator workshops. Indicators were selected under a set of seven broad reporting themes proposed by CORI to encompass all key aspects of coastal and marine ecosystems (see Figure 1**,** above) and capture the MaPP priorities of ecological integrity, human wellbeing and collaborative governance. 'Pilot' refers to the iterative nature of these indicators, which are meant to be evaluated and re-evaluated for feasibility and relevance over time, and to be built upon as capacity, resources, and collaborations develop. In keeping with an adaptive approach, certain indicators may be changed if compelling reasons to do so arise.

The current suite of Central Coast sub-regional indicators was initially developed following a workshop in May 2016 that included the Central Coast MaPP technical team, along with

monitoring experts from the Central Coast sub-region. At the workshop, 44 potential Central Coast EBM indicators were selected. These were then ranked according to their priority among workshop participants, and a subset of 26 indicators was selected. Since then, we have added estuaries, halibut and collaborative governance to the initial suite and made some name changes based on data access and priority. We expect that as more work is done to understand each indicator, additional changes will be made, with some indicators removed and others added.

The Central Coast EBM indicator monitoring program is comprised of both regional and Central Coast sub-regional indicators. A **regional EBM indicator** is an indicator that all MaPP sub-regions monitor with identical methodologies and report on in a consistent manner. A **sub-regional EBM indicator** is an indicator that reflects a specific sub-regional priority or area of concern and is not (yet) prioritized across all sub-regions. A sub-regional indicator may become a regional indicator in the future.

Currently, the Central Coast EBM Indicator monitoring program is comprised of 18 regional indicators and 11 sub-regional indicators (Figure 1).

INDICATOR REPORTS

Reports are currently drafted for 14 indicators that have been monitored to date (see Appendix A and Summary Report, 2016-2020). Some of these reports will be finalized soon for posting to the MaPP website. The drafted reports will inform a review of the Central Coast EBM Indicators, which will happen in 2022/23, and updated and/or additional reports will be completed as the monitoring strategy is confirmed for the remaining indicators in our suite. Each indicator report contains:

- a description of the indicator and metrics, and the external drivers, ecological components, human activities, and aspects of human wellbeing associated with the indicator
- methodology
- results and limitations
- discussion of key findings including what the report can tell us about the current state of health and viability of a system; warning signs about potential or growing threats; causal linkages between associated external drivers, stressors, ecological components, human activities, and aspects of human wellbeing; linkages with implementation of projects and plans; potential linkages with management decisions; and whether objectives and strategies in the Central Coast Marine Plan are being advanced.

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APPENDIX A: LIST OF CENTRAL COAST INDICATORS

Metrics, datasets, and key findings will be included in individual indicator reports.

(R) = MaPP Regional Indicator

Indicators and Themes	Reporting
Species and Habitats	
Dungeness crab relative abundance	Draft report
Eelgrass distribution (R)	Draft report
Estuary resilience to climate change	Draft report
Green Crab presence and distribution	Draft report
Halibut population status	Draft report
Herring spawn timing and magnitude	Draft report
Kelp distribution and abundance (R)	Draft report
Pyropia abundance	Draft report
Rockfish length and age	Draft report
Pacific salmon abundance (R)	Draft report
Invasive tunicate distribution	Draft report
Sense of Place and Wellbeing	
Valuing culture (R)	No monitoring / reporting to date.
Seafood harvest (R)	No monitoring / reporting to date.
Protection of cultural sites	No monitoring / reporting to date.
Clean Water	
Contaminant levels in sediment (R)	Draft report
Size and location of marine spills (R)	Draft report
Water quality (R)	No monitoring / reporting to date.
Seafoods	
Regional seafood landings (R)	No monitoring / reporting to date.
Regional seafood processed locally (R)	No monitoring / reporting to date.
Toxic phytoplankton blooms	No monitoring / reporting to date.
Climate Change and Oceanography	
Dissolved oxygen (R)	No monitoring / reporting to date.
Salinity (R)	No monitoring / reporting to date.
Sea surface temperature (R)	No monitoring / reporting to date.

Indicators and Themes	Reporting
Stewardship and Governance	
Compliance among resource users (R)	No monitoring / reporting to date.
Enforcement effort (R)	No monitoring / reporting to date.
Collaborative governance (R)	No monitoring / reporting to date.
Coastal Development and Livelihoods	
Participation in the workforce (R)	No monitoring / reporting to date.
Vessel traffic	Draft report
Regional wealth (R)	No monitoring / reporting to date.

APPENDIX B: GLOSSARY

Adaptive management: A formalized, iterative process of management decision-making and adjustment in the face of uncertainty, with the goal of reducing uncertainty over time through monitoring (Wilson, 2020).

External driver: "A superior complex phenomenon" (or force) that can affect the direction of ecosystem change but is not affected in turn by that change (Oesterwind et al., 2016, p. 11; Selkoe et al., 2015). Can be anthropogenic or natural in origin.

Ecosystem-based management (EBM): An adaptive approach to managing human activities that seeks to ensure the coexistence of healthy, fully functioning ecosystems and human communities. The intent is to maintain those spatial and temporal characteristics of ecosystems such that component species and ecological processes can be sustained, and human wellbeing can be supported and improved (MaPP, 2016).

Ecosystem component: A biotic or abiotic element of a system linked to a given value and other components of the system – external drivers, human activities and human wellbeing – via causal relationships. More than half of the 28 EBM indicators in the Central Coast monitoring program relate to biotic (species and habitat) or abiotic (climate change and oceanography, clean water) ecosystem components.

Indicator: A measurable part of a system that can be used to simplify the evaluation of complex systems and make assessment and management more efficient and strategic.

Metric: Unit of measure that reflects the state of an indicator (Wilson, 2020).

Monitoring (indicator): The systematic and purposeful observation of values and ecosystem components through the measurement of indicators. Indicator monitoring involves one or multiple activities coordinated through space and time, and can consist of: 1) on-the-ground monitoring (i.e., the collection of data on a particular indicator in the field); and/or 2) accessing and collating existing data, available either at a regional (broad) scale or at a smaller scale (ref).

State (environmental): The actual condition of the ecosystem and its components established in a certain area at a specific time frame, that can be quantitatively-qualitatively described based on physical (e.g., temperature, light), biological (e.g., genetic-, species-, community-, habitat-levels), and chemical (e.g., nitrogen level, atmospheric gas concentration) characteristics (B.C., 2017).

Value: something that people care about because it is seen as important to the integrity and wellbeing of people and communities, economies, or ecological systems (B.C., 2017).