The Nature Conservancy

Freshwater Fisheries Indicator Reference Sheet

Common indicators for community-led freshwater fisheries co-management projects

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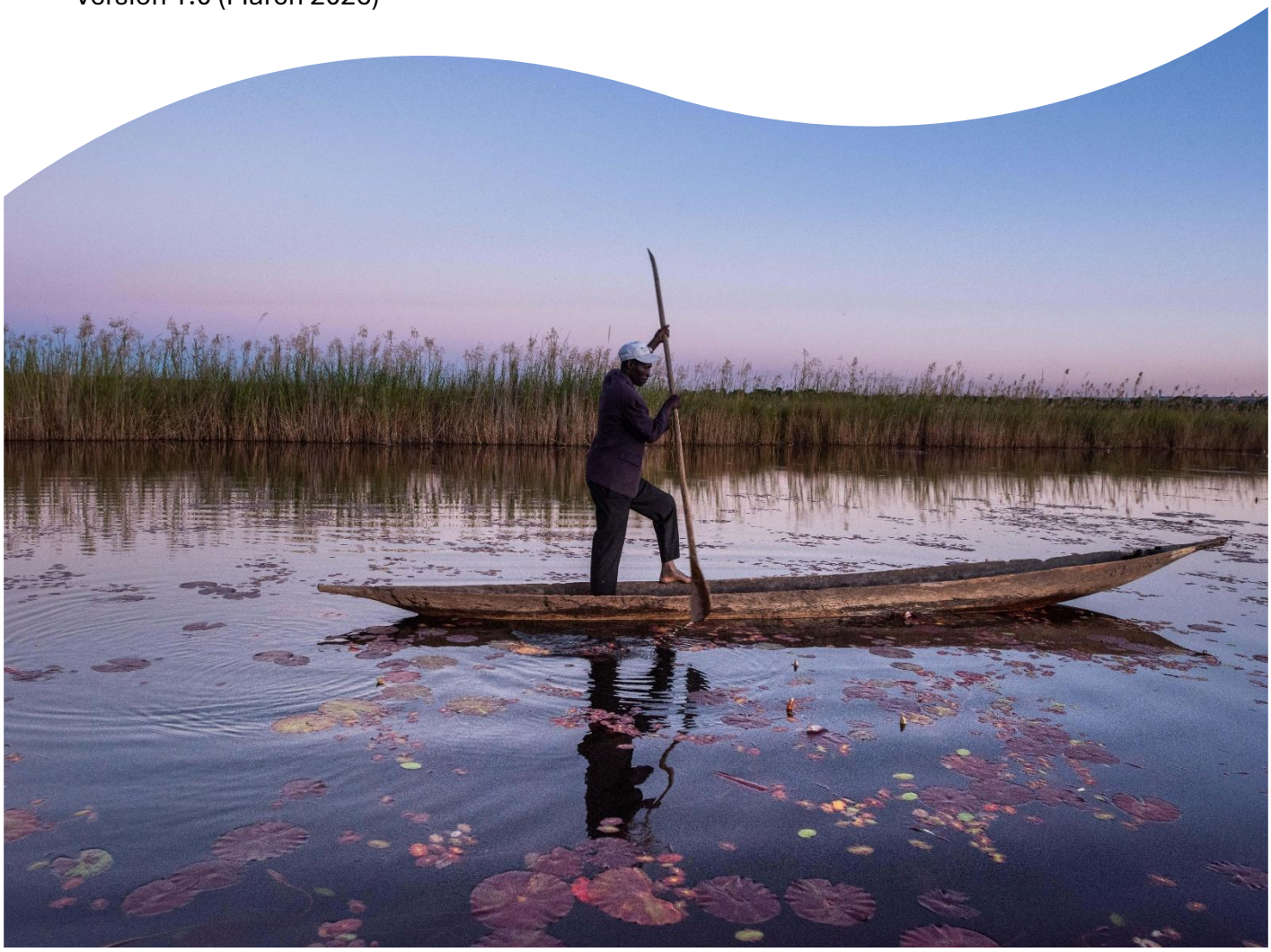

About

This indicator reference sheet document was curated by the Global Freshwater Fisheries Team (Fernanda Silva, Cecile Brugere, Shiteng Kang). It represents a 'working document' that will be updated and revised as we co-develop freshwater fisheries projects in the field. We welcome feedback and contributions from readers.

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1. Contextualization

The aim of this indicator reference sheet is to provide examples of common indicators to track and evaluate the implementation, compliance, and outcomes of community-led freshwater fisheries co-management projects. The primary intended audience for this document comprises local project teams, as well as partners such as local institutions, researchers and governments who support or regulate fisheries communities in leading responsible and sustainable co-management of freshwater fisheries. This document will be useful for projects following the Inland Fisheries Guide (TNC, 2023).

- **Phase 1** (identify, engage with, and obtain agreement of interested parties) is also critical to identify key information needs by the interested parties, co-develop and validate indicators in subsequent phases.
- **Phase 2.** Build a holistic understanding of the fishery: Compile existing and new data on the components of and threats to the target fishery as well as knowledge gaps to assess the state and condition of the fishery, which will inform associated indicator selection. This will also include a description of past and ongoing monitoring of the fishery. In many cases, the same set of indicators can be used to inform project's baseline, progress, and outcomes.
- **Phase 3**. Governance and management: Fisheries governance and management objectives determine the monitoring questions, data needs, and potential indicators to answer monitoring questions; they also inform the level of rigor (e.g., resolution, precision, accuracy) necessary to support decision-making.
- **Phase 4.** Consolidate and create opportunities for learning: Identified learning priorities and activities inform additional data collection needs and associate indicators.
- **Phase 5.** Data collection: Identify and design appropriate indicators based on outputs from previous phases and prioritized data needs.
- **Phase 6.** Evaluate and adapt: Analyze data to ensure indicators are used to evaluate the progress towards governance and management objectives and other learning priorities; review results with all interested parties.

Achieving equitable and durable conservation outcomes in freshwater fisheries requires a multidisciplinary approach, encompassing a range of ecological and human dimensions. This reference document offers an extensive, though not exhaustive, set of indicators across ecological, economic, social, and governance aspects to be considered within the monitoring and management plan, assessing the outcomes of fisheries co-management and sustainability. The indicators also reflect multiple dimensions of equity (Bennett et al. 2025, Blythe et al. 2026).

While this document aims to provide a practical and comprehensive range of indicators for most fisheries co-management projects, it is essential to emphasize that these indicators must always be linked to the outputs and outcomes along the Theory of Change of each project. When local fisheries management institutions have established indicators and systems in place, project

indicators should be compatible and integrable with them. Consequently, different projects, even within the same area or region, may have different indicators depending on their objectives and the fisheries contexts. Additionally, some donors may also mandate specific reporting indicators, which should be incorporated into the project's indicator selection.

2. Types of indicators

The typology of common fisheries indicators in this document is designed to help practitioners develop indicators to track key stages of a freshwater fisheries co-management project. They ensure that activities and objectives are monitored and evaluated in terms of **implementation**, **compliance**, and **outcomes**.

2.1 Implementation

These indicators are used throughout the implementation phase of a fisheries co-management project and are designed to monitor ongoing progress and the extent to which management plans are being executed as intended. They provide crucial information for making necessary adjustments to fisheries management projects. Table 1 provides a list of what activities need to be evaluated in a project, the justification to evaluate the activity and suggested indicators for this evaluation.

Table 1. Example indicators to track fisheries management implementation.

Activities	Rationale	Indicators
 **Existence of a co-management plan developed and agreed by resource users/co-management participants through a participatory mechanism**	*Co-management areas need a plan with clear goal, objectives, rules, regulations and addresses gender equity needs, reflecting diversity of perspectives in community/society.* *This can inform procedural and recognitional equity.*	The implementation of a co-management plan is reflected in more specific implementation indicators: • Number of staff (disaggregated by gender) to oversee/manage the implementation and compliance • Extent of buy-in by resource users/co-management participants (disaggregated by gender)
 **Existence of a mechanism to address conflict on the project area**	*Conflicts among different freshwater resources users are common and important issues to be addressed by management. Projects need ways to address if management is solving/reducing conflicts.* *This can inform procedural equity.*	• Mechanism in place for grievances and/or conflict resolution (yes/no) • Number of conflicts and/or grievances reported in a year

 **Actions to publicize the fisheries management plan (e.g. Fisheries Agreement)**	*Carrying out outreach activities for fishers and community members is essential to ensure that all stakeholders are informed about the current regulations*	• Number of pamphlets distributed per community • Availability of pamphlets in local language(s) • Number of promotional activities conducted
 **Existence of boundaries of the area to be co-managed**	*Co-managed areas need to have boundaries demarcated or otherwise clearly described in co-management agreement*	• Length or area of boundary delineated and marked • Spatially explicit data generated and regularly updated
 **Meetings to serve as a forum for discussion, power-sharing and trust building**	*Evaluate if management is promoting democracy and equity in decision making process.* *This can inform procedural equity.*	• Number of meetings held per year • Number of participants (disaggregated by gender, ethnicity, or other locally relevant social groups) • Decision-making process in place with a quorum needed and vote done by majority (yes/no) • Process in place to assess levels of stakeholder satisfaction/trust
 **Existence of a financial sustainability mechanism**	*Costs of implementation (e.g. meetings, patrolling, MEL plans) need budget and identified sources of funding*	• Amount of money spent on fisheries co-management in a year + amount of money generated • % of funding needs met, % of budgeted expenses
 **Existence of a monitoring and evaluation plan**	*Any management intervention needs a monitoring and evaluation plan with indicators, targets and baselines*	• Yes/no (plan exists or not). Additional implementation indicators depend on the monitoring actions undertaken. For example: • Number of households surveyed • Number of monitoring stations installed • Number of community monitors trained

			• Number of records entered in XX app/platform • Number of revisions or updated monitoring plan supported by results
	**Adaptive management strategy**	*Management plans need to be updated and adjusted in agreement with monitoring and evaluation results.* *This can inform procedural equity.*	• Documentation on any revisions made to decision making processes, supported by clear evidence for changes • Updated fisheries management plan
	**Activities for individual and resource user group empowerment and skills development to actively participate in co-management**	*Capacity building is a crucial element of community co-management programs. These programs require active skill development initiatives to empower fishers and enhance their participation in co-management activities.* *This can inform recognitional equity.*	• Number of meetings/trainings held • Number of participants (disaggregated by gender, ethnicity, or other locally relevant social groups) • Extent to which training participants (disaggregated by gender) are benefiting from the training 6 months / 1 year on. • Evidence of change(s) in practice(s) (qualitative).

2.2 Compliance

These indicators measure adherence to regulations, quotas, and rules agreed-upon in fisheries management projects (i.e., licensing, reporting, gear restrictions, catch limits, closed seasons/areas). Robust compliance monitoring can inform the degree to which fishers and stakeholders follow the rules set in management plan, as one of the key enabling conditions to achieving conservation and sustainability goals. Compliance focuses more on management than governance[1], in accordance with **Phase 3** of the Inland Fisheries Guide.

Table 2. Example indicators to track compliance with management rules

COMPLIANCE		
Types	**Description**	**Indicators**
 **Existence of clear management rules and a management system**	Management rules need to be clearly defined in the fisheries management plan. A management system is made of rules that need active monitoring/patrol and enforcement mechanisms	• Number of patrols undertaken per year/season • Graduated sanctioning of rules depending on the severity and frequency of the misconduct • Level of individual awareness of the management rules
 **Existence of system to monitor compliance with the rules (fishing gear, technical measures, and licensing/authorization)**	Infractions and fines need to be analyzed to evaluate the compliance of rules. Indicators need to be pertinent to specific management rules and their intended outputs.	• Number of illegal fishers fined/patrol/year • Number of illegal fishing gear confiscated/patrol/ year • Number of fishing activities outside the fishing season or areas/patrol/year • % of fishing units/boats (FUs) using authorized gear types • % of FUs licensed vs. total active vessels • Number of permits issued vs. permits required

[1] According to the Inland Fisheries Guide, 'management' is the process of designing and implementing formal and informal rules for the activities of fishing communities and stakeholders (i.e., what decisions are made and how activities promote compliance). 'Governance' relates to how decisions are made in fisheries and who is involved.

Here we provide two examples of common management rules and associated compliance indicators. Note that data on fishing effort (see Section 3, ecological outcomes indicators) are critical in evaluating compliance.

- **Compliance with fishing gear regulations (for example, mesh size or net length regulations)**

  Indicators: (1) % of inspected fishing gear that meet legal requirements, or % of fishing units/boats (FUs) using authorized gear types (2) Number of illegal fishing gear confiscated/patrol/ year.

  This can be used to assess whether fishing practices align with established standards designed to protect fish populations and ensure sustainable harvest. These regulations are critical because they influence the selectivity of fishing gear, helping to prevent overfishing of juvenile or undersized/immature fish and maintaining healthy population. Monitoring compliance provides insight into the effectiveness of enforcement measures and the level of awareness among fishers regarding sustainable practices.

  Data required: To evaluate this indicator, several types of data are required. First, the official regulatory standards must be clearly defined. In the case of fishing nets regulation, for example, this includes the minimum mesh size and maximum net length permitted for the specific fishery. Field data on gears are essential, such as direct measurements of mesh size and net length from nets used by fishers. Records of fishing effort, including the number of nets deployed and the frequency of fishing trips, provide additional context. Inspection data collected during landing sites checks, onboard monitoring, or community surveys are also necessary, alongside catch composition data that reveal the size distribution of fish landed. Finally, compliance records, including reports of violations, fines, or enforcement actions, help to build a comprehensive picture of adherence to regulations.

  How to measure and evaluate: Compare observed gear specifics with the regulatory thresholds. Mesh size can be measured using calibrated gauges at multiple points of the net, while net length is recorded with tape measures or electronic tools. Compliance is then quantified, often expressed as a percentage of inspected nets that meet legal requirements. Violation frequency can be tracked to identify trends in non-compliance. In addition, catch selectivity analysis can be performed by comparing the size distribution of landed fish with expected outcomes under legal mesh sizes. Over time, monitoring compliance rates and violation trends allows managers to evaluate the effectiveness of enforcement and outreach efforts. High compliance rates indicate strong regulatory control and fisher cooperation, while persistent non-compliance may highlight gaps in enforcement, economic pressures, or limited awareness of the regulations

- **Compliance with closed seasons and closed/protected areas**

  Indicators: Number of fishing activities outside the fishing season or areas/patrol/year.

This captures whether fishers respect restrictions (temporal and spatial) designed to protect spawning periods and sensitive habitats. These measures are not just bureaucratic and technical rules; they are vital pauses and boundaries that allow fish populations to regenerate and ecosystems to remain resilient. Observing how well these closures are followed offers a window into both the strength of enforcement and the willingness of communities to safeguard their resources.

Data required: Regulations must be clearly spelled out — when fishing is prohibited and which areas are off-limits. Then come the observations: records of fishing activity during restricted times, GPS or fishing unit/boat monitoring data to track movements, patrol reports, and even community-based monitoring. Catch data can reveal whether fish are being landed illegally during closures, while enforcement records (violations, fines, confiscations) add another layer of evidence.

How to measure and evaluate: Evaluation blends these inputs into a picture of compliance. Analysts compare observed activity against the rules, calculate the proportion of fishers adhering to closures, and track violation frequency to spot hotspots of illegal fishing. Tools like patrol logs help verify whether vessels enter restricted zones. Over time, trends in compliance rates tell the story: rising adherence signals effective governance and growing awareness, while persistent violations point to enforcement gaps or economic pressures that drive rule-breaking.

2.3 Outcomes[2]

These indicators monitor and evaluate the ecological, social, economic, and governance outcomes of fisheries management projects. They are essential during the evaluation phase to assess the overall successes of the project. Given their importance and the fact that they are often not well evaluated in many projects, they will be presented in more detail throughout this document.

Each indicator has its data requirement and appropriate method for evaluation. The process of defining indicators must follow the ten steps outlined in **Phase 4** of the Inland Fisheries Guide on Data Collection for Evidence-Based Project Decision-Making.

Table 3. Example indicators to assess outcomes of fisheries management

Outcomes	Rationale	Indicators

 **Ecological/Biological outcomes of fisheries management**	*Ecological and biological indicators are essential for assessing the health, productivity, and sustainability of fishery systems. They provide evidence of how management practices are influencing fish populations, habitats, and broader ecosystem dynamics. The selected indicators offer a comprehensive view of both the status of fish diversity, stocks and the ecological integrity of aquatic environments.*	• Spatiotemporal distribution of catch
		• Change in fishing effort and/or fishing gear
		• Species composition of catch
		• Size of fish in catch
		• Size relative to size at maturity
		• Catch discarded
		• Environmental factors (context specific)
		• *Optional*: Common biodiversity indicators (not part of this document)
		  ○ Species richness (number of species per unit area)
		  ○ Species abundance (number of individuals of each species per unit area)
		  ○ Species diversity index (Simpson's Index, Shannon-Wiener Index)

[2] Outcome vs. Impact: In general terms, outcomes represent the purpose of the project (changes the project is expected to achieve) and are directly influenced by the project. Impacts are long-term in nature and are usually expected to occur sometime after project closing.


Social outcomes of fisheries management
	Fisheries are deeply social systems that shape the well-being, equity, and resilience of communities. Evaluating social outcomes of fisheries management requires a holistic understanding of how benefits, opportunities, and resources are distributed and experienced across different groups.
	
	This is important to inform distributional equity.
		• Distribution of benefits and power/influence across actors of the fish value chain
		• Range of employment opportunities from fishing and fish-related activities (paid and unpaid, full-time and part-time), including for women and youth
		• Food security in community/ Nutritional quality of available fish products in community
		• Indirect social benefits:
		  ○ Change in educational attainment (disaggregated by gender)
		  ○ Change in gender equity and women's empowerment from fisheries management and value chains improvements
		  ○ Perception of well-being and quality of life

 **Economic outcomes of fisheries management**	*Fisheries are a cornerstone of local economies, particularly in rural and riverine communities. To ensure that fisheries management contributes to sustainable development, it is essential to assess the economic viability and resilience of fishing-dependent populations.* This is important to inform distributional equity.	• Benefits over costs (BC ratio) of operating and maintaining co-management arrangements (disaggregated by stakeholders) • Average percentage of income derived from fishing vs. non-fishing sources • Rate of change in fishing profitability • Indirect economic benefits: ○ Poverty index
 **Governance outcomes of fisheries management**	*Effective fisheries governance is foundational to achieving ecological sustainability, economic viability, and social equity. Governance indicators help assess whether management systems are inclusive, transparent, accountable, and rights-based,*	• Change in fishers' sense of empowerment and ability to actively participate in decision-making (disaggregated by gender, type of fishing, and other relevant social identities) • Number of conflicts (resolved and unresolved) in the fishery

	ensuring that all stakeholders — especially marginalized groups — have a voice and agency in decision-making. *This can inform procedural equity.*	• Level of transparency and accountability in decision-making regarding fisheries management • Change in use and control rights (disaggregated by gender, ethnicity, stakeholder type) • Legal/gazetted recognition of co-management arrangements • Level of government participation

3. Outcome indicator deep dive

In this section we will provide examples of outcome indicators that can be used to inform if fishing management is achieving intended outcomes.

Ecological outcomes

EXAMPLE OF OUTCOME STATEMENT

By 2030, areas under fisheries management show increases in average annual fishing catches.

By 2030, 80% of areas under fisheries management are able to maintain healthy fish stocks[3].

MENU OF INDICATORS

Fisheries data collection typically relies on a limited set of concepts and approaches, such as harvested quantities (catch), the type and duration of fishing activities (fishing effort), and their distribution across time and space. Using CPUE (Catch Per Unit Effort) as an index of abundance, together with size-based indicators, can provide a valuable initial understanding of stock status in fisheries management. However, it is essential to recognize the limitations, complexities, and potential biases that may arise when relying solely on CPUE. **Caution should be exercised when making inferences based on a single indicator**, as such indicators can be influenced by factors unrelated to actual stock status—for example, unusually high recruitment events may temporarily inflate values and give a misleading impression of abundance. Therefore, it is important to interpret the results of any single indicator carefully and in context, ideally alongside other complementary indicators, to ensure a more accurate and reliable assessment of the fishery.

Promoting the use of multiple indicators allows for a more robust and comprehensive assessment of stock status, ultimately leading to more informed and effective management decisions.

Additional aquatic biodiversity-related indicators are outlined in complementary guidelines referenced in this document and are essential for developing a comprehensive understanding of fisheries status.

We recommend using the following indicators:

- **Spatiotemporal distribution of catch:** refers to the total amount of fish caught within a specific region or zone that is subject to regulation. By tracking fish catches over time and space, fisheries managers can assess whether fish stocks are increasing, stable, or declining. If catches consistently decline, it may indicate overfishing or habitat

[3]Healthy fish stocks: fish populations with abundance and biomass levels that allow for fishing without population's decline. Healthy stocks also have: (i) balanced age structure; (ii) individuals capable of successful reproduction; (iii) genetic diversity, which provides resilience to environmental changes and disease; (iv) provide ecosystem function, playing ecological roles such as controlling prey populations or cycling nutrients.

degradation. Conversely, increasing catches might suggest successful management efforts. Furthermore, it is essential to distinguish changes caused by fishing activities from those resulting from natural ecosystem dynamics, seasonal cycles, fish reproduction and distribution patterns, or external environmental factors. These natural fluctuations influence population dynamics Distinguishing such natural variability from fishing impacts is critical for accurate interpretation of catch data and effective management decisions.

Data required: number or weight of fish catch, disaggregated by species, and measure of fishing effort (e.g., time fishing, fishing gear used) recorded by fishing activity. If the fish catch comes from a fishery which involved more than one fisher or fishing unit, the number of fishers or that of active fishing unit must be recorded.

How to measure and evaluate: Fish catch is evaluated using catch per unit of effort (CPUE), which represents the amount of fish caught (either in terms of numbers or weight) divided by a standardized measure of fishing effort (hours spent fishing, the number of fishers or of boat-days involved, or the size and quantity of fishing gear used). Catches should be disaggregated into categories as detailed as possible, with the primary classification made by species. To assess the outcome of management, it is essential to collect fishing data before implementing any management measures. If there is no existing baseline data, a comparison can be made between the managed area and another area that is not subject to management. These two areas should share similar characteristics, including factors like habitat type, species composition, and fishing pressure.

Additional resources to consult: **FAO handbook**

This indicator can also be broken down into the following indicators:

- **Change in fishing effort and/or fishing gear:** Change in fishing effort reflects the intensity of fishing activities over time, helping to understand the pressure exerted on fish stocks and the sustainability of fisheries. Trends can signal overexploitation, underutilization, or shifts in fishing practices due to policy, economic, or environmental changes. Change in fishing gears can indicate pressure on the resource. For example, reducing the mesh size of a purse net may lead to catching individuals before reaching optimal size. These changes can reflect adaptations by fishers in response to declining catch rates or shifts in resource availability and should be carefully monitored as part of a broader assessment framework.

  In some places fishing operations are named as Fishing units. Mapping the activities of fishing units by gear type and location allows managers to detect violations of spatial allocations or conflicts between gear uses (e.g., gillnets vs. traps), which may require zoning. By linking fishing operations with sociocultural, infrastructure, and economic data, more robust analyses of fishing unit activities can be achieved. Such analyses improve understanding of the motivations behind the behavior of different fishing units, enabling more accurate predictions of their responses to changes in the fishery.

  Data Required: Number and characterization of active boats/canoes/vessels (type, size, engine power); gear type and specifications (e.g., mesh size, length, hook number), fishing days, hours, fishers or trips per boat; spatial and temporal distribution of effort.

How to Measure and Evaluate: Effort data can be collected through boat logbooks, onboard observers, or landing sampling. Vessel details, crew, and gear specifications are gathered through surveys, inspections, and field checks. Operational data—such as trip frequency, timing, and effort—can be monitored via GPS, sensors, or validated self-reporting. Standardizing effort across different gear types and boat sizes is crucial for comparability. Once standardized, trends in effort can be analyzed over time and across regions. A rising effort with declining CPUE may indicate overfishing, while stable or reduced effort with stable CPUE could suggest sustainable practices. Comparing effort trends with biological reference points and management targets helps evaluate whether fishing pressure is within sustainable limits.

Additional resources to consult: McCluskey & Lewison 2008

- **Species composition of catch:** refers to the types and proportions of different target species or species group caught in fishing landings. Signs of overfishing in inland multispecies fisheries is when excessive pressure is exerted on few stocks (of high value, targeting biomass or size) leading to a shift of fishing pressure to less-preferred species or size classes (short-lived pelagic species).

  Data required: the number of individuals or weight of fish caught disaggregated by species. This needs to be combined with measures of fish size and fishing effort (time fishing, fishing gear used) recorded in fishing landings data.

  How to measure and evaluate: species composition of catch is calculated as the number or weight of each specie divided by the total catch. To assess changes in species composition, the proportion of individuals from each species by the total must be compared after a defined period (e.g.: past 10 years or compared to the first 5 years after the fishery management began if information is available).

- **Size of fish in catch**: refers to the length (or age) of fish species caught in fishing landings. Size and/or age structure provide essential information on stock composition and population dynamics. The decrease of fish size can be a signal that fishing is being modified by the direct removals of oldest and largest individuals through size-selective harvesting.

  Data required: length or weight of fish caught, disaggregated by species and fishing gear used recorded in fishing landings data. Size is typically expressed in *Total length* (TL in cm) or the distance from the fish's snout to the end of its caudal or tail fin, which provides the longest measure of the fish. However, this measurement method may be affected by whether the monitor pinches the fish's tail or if the caudal fin is damaged. For management and scientific purposes is better to use *standard length* (SL) that is the distance between the snout and the base of the caudal fin. Additional required data are including the examination of otolith rings and scale striations, sex (based on internal or external characteristics) and gonad condition.

  How to measure and evaluate: Evaluate whether the average size of fish, by species, has increased or decreased over a given period (e.g., compared to the first five years of fishery

management). Caution is advised when drawing conclusions from a single indicator, as it may be affected by factors such as unusually high recruitment events.

Additional resources to consult: Gebremedhin et al. 2021

- **Size relative to size at maturity (Size at first maturity - L50):** One aspect of fisheries management is setting minimum size limits for harvested fish, that are related to the size in which fish reach sexual maturity. Catch before maturity refers to the percentage of the fish caught that are smaller or younger than the size or age of first maturity. As exploitation increases, average fish size on landings decline. This causes two effects: fish are caught before reaching optimal market size (overexploitation of recruited stock), and fewer reach maturity to reproduce, risking recruitment failure (overexploitation of spawning stock). If too many immature fish are caught, it can lead to overfishing and depletion of fish populations because immature fish will not have a chance to reproduce, affecting the next generation

  Data required: size or weight of fish caught by species recorded in fishing landings data. Size is typically expressed in *Total length* or the distance from the fish's snout to the end of its caudal or tail fin, which provides the longest measure of the fish. However, this measurement method may be affected by whether the monitor pinches the fish's tail or if the caudal fin is damaged. For management purposes, it is better to use *standard length* that is the distance between the snout and the base of the caudal fin.

  How to measure and evaluate: One way to measure is through the percentage of mature fish in catch, with 100% as target, i.e., no young/immature individuals caught. Another additional way to evaluate is by the percentage of large or old highly fecund female "mega-spawners'' in catch, with 0 % as target and 30–40 % as representative of reasonable stock structure when no upper size limit exists. The focus on large fish specimens is supported by growing evidence that older fish play crucial roles in the long-term survival of a population: i) Increased Fecundity: Large female fish tend to be much more fecund because the number of eggs they produce increases exponentially with their length; ii) Sign of Fitness: Reaching old age is often an indicator of overall individual fitness. These "mega-spawners" serve as reservoirs and distributors of desirable genes within the population. iii) Longevity as a Safeguard: Extending the lifespan and reproductive phase of older fish can be seen as a natural safeguard against potential recruitment failure in the future. Finally, estimate the L_{50} (length at 50% maturity) by relating fish length to maturity status or Gonadosomatic Index (GSI) using logistic regression.

- **Catch discarded:** refers to the proportion of the total organic material of animal origin in the catch, which is thrown away for whatever reason. It does not include postharvest waste such as offal. Some reasons for discard include: i) Fishers faced with restrictions on their total catch (due to management, market, or physical constraints) may choose to discard less valuable species and size classes. By doing so, they create space on board for more valuable catch; ii) Sometimes the catch sustains damage during fishing operations, making it less marketable. In such cases, fishers may discard it; iii) fishers unintentionally catch non-commercial species (by-catch of non-target fish species and sizes, birds, reptiles,

crabs, mammals, ...), which they often discard; iv) When the quota for a particular species is exceeded, especially in multispecies fisheries, fishers may continue fishing for other species even if it means discarding individuals of the over-quota specie. These data (discards and incidental mortality) are important for assessing the impact of fishing on the ecosystem and on non-target, associated, and dependent species.

Data required: this is the most challenging fisheries related data collection and the sampling design from the fishery stock assessment must be specific to account for it. As fish are discarded before landing, discard must be monitored during the fishing activity or depending on fishers' level of awareness for recording. Despite the difficulties, it is very important information in terms of the sustainability of fishing.

How to measure and evaluate: Discard is measured as the percentage of the catch biomass discarded (includes juveniles of the target species plus other species) before reaching the landing site, with 0% as target. Damage/spoilage is measured as the percentage of the landed catch biomass that shows signs of spoilage. In addition, by-catch can be monitored following the three groups: legal and marketable, non-marketable, and illegal.

Additional environmental and freshwater biodiversity-related indicators

- **Environmental factors** within the basin, such as hydrology, connectivity, and climate, define the characteristics of freshwater ecosystems and aquatic species (e.g., species composition, population dynamics, behavior) and are key drivers of the fishery. Environmental information used alongside stock data (such as catch and effort) is essential for freshwater fisheries management, particularly when there is a direct link between environmental conditions and landings. This is especially relevant for large riverine fisheries or floodplain fisheries. Key limnological and meteorological data can be applied in a wide range of analyses, including ground verification of data obtained through remote sensing.

  Data required. A variety of variables provide information on freshwater habitats and ecosystems and should be collected systematically to complement catch and effort information. Key variables include water level, flooded area, and topographic data for river and floodplain fisheries; seasonal changes in flow regimes; gradients of temperature and dissolved oxygen; and water quality indicators such as pH, turbidity, and nutrient (N, P) concentrations. Incorporating ecological indicators—such as the presence and trends of rare and endangered species, as well as changes in fish community composition—can greatly enhance the assessment of stock status and ecosystem health.

  How to measure and evaluate. Environmental variables can be measured using gauging stations, satellite imagery, hydrological maps, automatic sensors, and scientific surveys, with modern sensor–computer interfaces enabling frequent, low-cost, and reliable data collection. Evaluation involves comparing results against historical baselines, ecological thresholds, and seasonal patterns to detect anomalies, assess habitat conditions, and understand their influence on fish populations and landings. Many datasets, including

meteorological and hydrological information, are collected by institutions through maps, satellite images, and automated recording stations, while scientific research provides additional insights. These data, gathered and stored at shorter intervals than crews can manage, offer a valuable source of information and can partially replace costly research platforms.

Evaluating the diversity and structure of the fish community can reveal broader impacts of fishing and environmental change that may not be captured by single-species metrics. Furthermore, the use of independent fisheries surveys—such as scientific trawl or gillnet surveys conducted separately from commercial or artisanal fishing activities—can provide unbiased data on fish populations and habitat conditions. These independent data sources help validate trends observed in fishery-dependent indicators and reduce potential biases associated with changes in fishing effort, targeting, or reporting.

A list of additional environmental indicators related to Freshwater Ecological Integrity (FEI) and Key Ecological Attributes (KEAs), including connectivity, hydrologic regime, water quality, habitat, and biotic composition, can be accessed in TNC's Durable Freshwater Protection MEL Framework.

SAMPLING DESIGN FOR ECOLOGICAL INDICATORS

To accurately assess fish-related indicators, a well-structured sampling design is essential. The following principles and steps will help ensure reliable, comparable, and meaningful data collection:

1. Core Data Requirements

- Catch/Landings Data: All fish-related indicators should be derived from systematic catch or landings surveys.
- Effort Data: Recording fishing effort (e.g., gear type, duration, number of trips) is mandatory for standardizing data and evaluating fishing trends.

2. Importance of Long-Term Monitoring

- Avoid Short-Term Snapshots: Studies conducted over brief periods provide only a limited view and may misrepresent the fishery.
- Commit to Long-Term Monitoring: Continuous data collection over years or decades reveals patterns, seasonal fluctuations, and gradual changes in stock status.

3. Consistency in Sampling Design

- Standardized Protocols: Use consistent sampling methods to ensure data comparability over time.
- Adaptability: While consistency is critical, protocols should allow flexibility to accommodate environmental changes or logistical constraints.

- Data Quality First: Poor-quality data can be more harmful than no data. If accuracy cannot be guaranteed, do not collect the data.

4. Align Design with Management Objectives

- Define Clear Objectives: Sampling design should address specific management questions and conservation goals.
- Minimum Information Protocols: Establish protocols that outline essential data points (species, size, weight, effort, location, time).
- Integrate Multiple Variables: Fisheries assessments rarely rely on a single indicator. Combine catch data with other factors such as:
    - Water quality
    - Habitat condition
    - Climate impacts
    - Anthropogenic stressors

5. Key Aspects for Sampling

- Representative Coverage: Ensure samples reflect the proportion of fishers and fishing effort across all sub-areas.
- Seasonal and Hydrological Variation: Collect data across different seasons and hydrological phases (drought, flooding, flood peak, ebb).
- Establish Baselines: Use historical data or respondent recall to create reference points for comparison.

Example of fishing effort and operation monitoring on Lake Tanganyika

Fishing operations indicators have been applied through regional projects on Lake Tanganyika, collecting data on vessels, gears, crews, and fishing effort. These efforts enabled compliance monitoring, detection of illegal practices, and co-management development, while integrating biological and socioeconomic information to reveal how fishing units adapt to fisheries management efforts. The following two projects demonstrate how multiple indicators are needed to inform fisheries management.

2020-2024: LATAFIMA (Lake Tanganyika Fisheries Management Project) Funded by the EU to promote sustainable fishing and regional cooperation among riparian countries. It built capacity to combat IUU fishing through monitoring, control, and surveillance, frame surveys, and improved data management. Key monitoring activities included vessel and gear monitoring, observer programs, landing site inspections, and electronic tracking with GPS and logbooks. Recommendations focused on enforcing vessel registration, eliminating illegal gear, upgrading landing facilities, and strengthening co-management structures.

2011–2024: Lake Tanganyika Authority (Recent Fisheries Frame Surveys) involved basin-wide censuses of fishing units, recording vessel characteristics, crew size, and gear types. Spatial mapping identified hotspots of illegal fishing and conflicts between artisanal gillnetters and purse seiners. The findings provided evidence for harmonized regional policies and strengthened co-management strategies, ensuring long-term sustainability of the fishery.

Social outcomes

EXAMPLE OF OUTCOME STATEMENT

By 2030, communities in fisheries management areas report equitable distribution of benefits and improved fisheries-related employment opportunities.

By 2030, at least 80% of communities in fisheries management areas experience improved food security and gender equity.

MENU OF INDICATORS

Direct social benefits from fisheries

- **Distribution of benefits and power/influence across actors of the fish value chain:** is measured as the proportion of benefits (monetary and other material benefits) flowing to different stakeholders, and the extent to which ownership in the fishery is concentrated among a few stakeholders or widely distributed. Includes spatial location of benefits in that equitable local benefits are more likely to foster sustainability.

  Data required: value addition (in monetary terms) at each node of the value chain, margins made by each actor of the value chain, number of contacts (suppliers and sellers/clients) that each key node of the value chain regularly interacts with, perceptions of fishers and fish workers of the power influences across the value chain, and extent to which benefits from the fishery (profits, cash, access to fishing opportunities) are concentrated within a few hands or equally distributed among stakeholders.

  How to measure and evaluate: A mapping and analysis of the fish value chain can generate all the data needed for this indicator. A fish value chain analysis will detail operations (what and how much) and actors (who) at each stage of the supply chain, enabling to measure changes in the market value of the fish product(s) as it moves from fishers to consumers. It also helps understand who has ownership and power, and how profits are distributed across nodes of the value chain. In addition, the concept of Equitable Distribution of Fisheries Benefits involves assessing the ratio of fishers to owners, patrons, buyers, or processors. A lower ratio, such as having fewer fishers relative to a larger number of recipients or owners, contributes to greater equitability. Local owners are more likely to promote sustainable practices, while corporate owners located remotely tend to have the opposite effect. Therefore, maintaining a lower fishers-to-owners ratio is beneficial for overall equitability.

- **Range of employment opportunities from fishing and fish-related activities (paid and unpaid, full-time and part-time) including for women and youth** measures the extent to which a change in the fisheries management structure can affect opportunities available for women and men in the fishery. Given the prevalence of informality in the inland fisheries sector, it is important that all occupations derived from fisheries are included, i.e. those

that generate an income, and those that generate non-monetary benefits, such as fish as food. Quantifying the unpaid time and work typically carried out by women will also help understand better the full contribution of women to freshwater fisheries.

Data required: compare before and after improved fisheries management or implementation of co-management: number of hours worked each day (paid or unpaid) in fish-related occupations and across the year (to account for seasonal variations) that women, men, young girls and young men engage in; change in the nature of the fish-related roles and occupations fulfilled by women (i.e. the extent to which these roles and occupations are commercial in nature); number of new intrants (disaggregated by gender and age) in all fish-related occupations; number of individuals (disaggregated by gender and age) leaving fish-related occupations for alternative livelihoods outside the fishery or becoming part-time fishers.

How to measure and evaluate: These variables can be collected either as part of a baseline survey, a new data collection survey (which can then be compared to the baseline) or through recalls from fishers and fish workers comparing the situation before fisheries management was in place and now. Qualitative, observational information by project staff, as well as anecdotes from co-management participants, can serve as complementary data.

Ranges or scales can be proposed to respondents to elicit their answers, for example, by asking if the number of hours worked each day has increased at lot (>25%), a little (+10% to 25%), is the same, or has decreased a lot (>25%), or a little (-10% to 25%), if the number of fishers leaving the fishery after a number of years is "very high" to "very low", and so on for the variables listed above. If the employment opportunities provided by the fishery are on a downward trend, and most fishers leave after a short time, this suggests a lack of long-term commitment on their behalf and low opportunities for income and stability in the fishing activity. In contrast, upward employment trends indicated by a larger number of fishers and fishworkers[4] intrants and/or fishing full time will denote the positive prospect of fishing as long-term profession and a few people seeking alternative employment.

The greater presence of women in commercially-oriented activities in the fish value chain can be a sign of greater equity and empowerment as typically women become sidelined when fishing and fish-related activities grow in scale and become more capital intensive. Similarly, a change in the nature of the tasks performed by women and girls compared to those performed by men and boys can be indicative of either a reduction or an increase in discrimination in access to employment opportunities.

[4] Fishworkers are defined as people who may not catch fish but know about the fishery and could be involved in management of the fishery, e.g. fish buyers, sellers, boat owners etc.

- **Food Security in Community/ Nutritional quality of available fish products in community:** food security covers availability (quantities of fish available for consumption), access (ability of people to fish or purchase fish for consumption at reasonable prices), utilization (quality fish of high nutritional value in terms of proteins and micronutrients) and stability (minimization of the negative impacts of weather events, economic and/or political turmoil on the other three variables). We hypothesize that fisheries management could increase food security through increasing catches, making more fish available for consumption, improving the reliability of the catch, ensuring a steady supply of high-quality fish products, and increasing revenue for fishers and other community members, improving their ability to purchase food and reducing the likelihood of food insecurity.

  Data required: Quantities of fish marketed locally or further afield (market distance depending on local geographies) and taking into account seasons, quantities of caught fish versus purchased fish that are consumed in the household (disaggregated by gender and age), fish consumption (disaggregated by gender and age) compared to meat products and other food staples, fish product prices (including seasonal variations).

  How to measure and evaluate: data can be sampled through household surveys and dietary recall interviews, market monitoring and vendor interviews, and catch records and community-based monitoring systems. Comparing these variables before and after improvements in fisheries management, can be done either through a comparison of baseline data and data generated by a new survey, or through respondents' recall information. Qualitative, observational information by project staff, as well as anecdotes from co-management participants, can serve as complementary data. Data ranges and multiple-choice answers can be used to facilitate data collection. The more fish is marketed and consumed locally, the more stable fish prices are, the higher the quality of consumed fish products is, and the fewer variations in these parameters there are, the greater is the contribution of the fishery to food security. It is also important to consider gender and intra-household food distribution aspects to assess if family members, in particular children and lactating mothers, are also becoming more food secure.

Indirect social benefits from fisheries

While indirect, these indicators are equally important to consider.

- **Change in educational attainment (disaggregated by gender):** Education includes any transfer of knowledge, either through formal or informal means. Evaluating improvements in education requires a multifaceted approach that encompasses various aspects such as training, that measures the effectiveness of training programs in enhancing capacity; schooling, assessing the accessibility and inclusivity of schooling within a community; and literacy that tracks the improvement in literacy rates within a population, signifying the ability to read and write at a specified age level. Tracking educational attainment within fisher households helps assess how fisheries interventions contribute to broader social development. Training should include workshops, technical training, and informal knowledge-sharing sessions related to fisheries management, monitoring, conservation, and value chain improvements.

Data required: For schooling, evaluation data can encompass enrollment rates, dropout rates, demographic data of students from fisher members rates especially among adults in fisher households, and availability of resources for special needs education. For literacy, data can be literacy tests results, age-specific literacy rates, and number of literacy programs and interventions. To the exception of data to evaluate training that can be collected from participants directly to assess student performance before and after training and/or number of ongoing professional development opportunities, data for schooling and literacy should be compiled from available statistics (secondary data).

How to measure and evaluate: to evaluate training, the practitioners have to conduct surveys and assessments to gauge teacher satisfaction and competency post-training, and student performance metrics to evaluate the outcome of training on educational outcomes can be student performance before and after training and/or number of ongoing professional development opportunities after training. Schooling data needs to be compared before and after the implementation of the fisheries management. Literacy data should show an increase following implementation of improved fishery management. Qualitative, observational information by project staff, as well as anecdotes from co-management participants, can serve as complementary data.

- **Change in gender equity and women's empowerment from fisheries management and value chains improvements:** this intends to measure the transformative impact that improved fisheries management and value chains conducted with gender equity in mind can have on the lives of women.

  Data required: Quantitative data should include the number of women members of co-management committees, and the number of women who are active in key management positions (i.e. president, executive secretary, treasurer). However, this needs to be complemented by other qualitative indicators, such as, (i) the extent to which women (members and non-members of co-management committees) make inputs in productive (fishery-related) decisions; (ii) the extent to which women own fishery-related assets; (iii) the extent to which women have access to financial services; (iv) the extent to which women control how household income is used; (v) how many hours of a woman's day are dedicated to a productive activity and how many to household and caring responsibilities; (vi) the extent to which women feel respected in their household and community and self-confident; (vii) the extent to which women have the right to control their own life (e.g. say when they don't agree, decide how to use their own time, where they go, who they meet); (viii) the extent to which women can work with other women and/or men, be recognized in their role in the household or community, and be able to improve the lives of others.

  How to measure and evaluate: The data for these indicators is typically qualitative and collected through interviews which should be conducted with both men and women but separately. It is important that women's involvement in all spheres of freshwater fisheries (pre-harvest, harvest and post-harvest, as well as supportive services such as enforcement and monitoring) be considered in the collection of information. Indicators (i) to (v) embody instrumental agency (production, resources, income, time), while indicators (vi) and (vii)

embody intrinsic agency (self-worth, independence), and indicator (viii) embodies collective agency (ability to lead and influence social change).

Data for variables (i) to (viii) can be collected by using Likert scales (e.g. 0 = very low extent/occurrence to 5 = very high extent/ occurrence). The higher the values, the greater the empowerment. Ideally this data should be collected as part of a baseline before fisheries management improvements or at the beginning of fisheries management improvements, and against which changes can be measured when a new survey is conducted. However, recall information from respondents comparing the situation before improved fisheries management arrangements were in place and after, can also be used if a baseline is not available. Average scores from the Likert values can be compiled for each domain of agency and will help identify where more engagement for transformative change in equity and empowerment may be required.

- **Perception of Well-being and Quality of Life**: this complementary indicator aims to capture how individuals and households within fishing communities perceive their overall well-being and quality of life. Unlike material or economic indicators, this measure emphasizes subjective and culturally grounded dimensions of well-being, which may include—but are not limited to—economic security, time spent with family, access to natural resources, cultural identity, autonomy, and community cohesion.

  Because perceptions of well-being are inherently context-specific, it is essential to first engage with communities to co-define what constitutes well-being in their local context. This participatory process ensures that the indicator reflects locally meaningful values and priorities.

  Data Required: To assess this indicator, the following types of data are needed: i) Community-defined dimensions of well-being (e.g., cultural practices, food sovereignty, social cohesion, autonomy, environmental health); ii) Individual and household-level perceptions of satisfaction with current quality of life, perceived changes in well-being over time, perceived benefits (or losses) from fisheries management or conservation interventions. Data must be disaggregated by gender, age, and livelihood role (e.g., fishers, processors, traders); iii) Qualitative narratives or testimonials that provide context to quantitative responses.

  How to Measure and Evaluate: To measure and evaluate this indicator, the first step is to develop a perception-based survey instrument that reflects the well-being dimensions identified by the community. This tool can include Likert-scale questions and other culturally appropriate formats to capture subjective experiences. Surveys should be administered at the household or individual level, ensuring inclusive representation across gender, age groups, and different roles within the fishery sector. To enrich and contextualize the quantitative findings, qualitative methods such as semi-structured interviews and storytelling can be employed, allowing for deeper insights into local perceptions and lived experiences. Over time, data should be analyzed to identify trends—particularly before and after the implementation of fisheries management or conservation interventions—to assess perceived changes in well-being. Finally, triangulating these findings with other

indicators, such as income levels, food security, and governance quality, will help provide a more comprehensive understanding of the social outcomes of fisheries management on community well-being. Qualitative, observational information by project staff, as well as anecdotes from co-management participants, can serve as complementary data.

Additional social benefits indicators

A list of additional indicators related to social benefits and outcomes from conservation strategies can be accessed in TNC's VCA Framework Measures Guidance Document and People Metrics Guidance.

SAMPLING DESIGN FOR SOCIAL INDICATORS

When designing a sampling strategy for social outcomes in fisheries, it is essential to consider both spatial and temporal dimensions to ensure the data collected is representative and meaningful. Spatially, sampling should encompass a diverse range of geographic areas and stakeholder groups, including different communities, roles within the fish value chain, and varying levels of access to resources and services. This helps capture the full spectrum of experiences and outcomes, particularly for marginalized groups such as women and youth.

Temporally, the design must account for seasonal variations in fishing activity, employment, and food availability. Conducting surveys at multiple points throughout the year—especially during high and low fishing seasons—can reveal important patterns and changes. Establishing a robust baseline before any management interventions, followed by regular follow-up assessments, allows for the evaluation of trends and impacts over time.

Sampling size and frequency should be sufficient to ensure statistical reliability while remaining feasible within logistical constraints. Stratified sampling is recommended to ensure representation across key demographic and occupational groups, with a suggested minimum of 30 to 50 individuals per group or community. This approach supports meaningful disaggregation of data by gender, age, and role.

The type and quality of data are also critical. A mixed-methods approach that combines quantitative data—such as income levels, hours worked, and fish consumption—with qualitative insights from interviews and focus groups, provides a more comprehensive understanding. Data validation through triangulation and consistent collection protocols enhances reliability and credibility.

Equity and inclusion must be central to the sampling design. This means not only disaggregating data but also evaluating if the impacts are being transformative, for example, empowering woman for decision making. Sampling design must ensure that unpaid and informal contributions, particularly those of women and youth, are recognized and measured. Participatory methods can help ensure that the data collected reflects community realities and priorities.

Finally, ethical considerations are paramount. Researchers must obtain informed consent, ensure confidentiality, and respect local norms and customs. Engaging communities in the design and interpretation of the data fosters trust and ownership, ultimately leading to more effective and sustainable fisheries management.

For additional information on ethics, equity, and human rights considerations in monitoring and data collection, check out VCA MEL training Module 2.

For additional training on developing and implementing social surveys (including sampling design, sample size determination, questionnaire design), check out VCA MEL training Module 4 and Freshwater Fisheries survey template (draft).

For additional training on using key informant interviews and focus groups to obtain social data, check out VCA MEL training Module 3.

Economic outcomes

EXAMPLE OF OUTCOME STATEMENT

By 2030, communities in fisheries management areas enhance economic sustainability by reducing poverty and promoting income diversification—making communities more resilient and better equipped for long-term resource stewardship.

By 2030, 50% of communities in fisheries management areas report stable fishing profits and improved benefit-cost ratio of operating fisheries management arrangements.

MENU OF INDICATORS

Direct economic benefits from fisheries

- **Benefits over costs (BC ratio) of operating and maintaining co-management arrangements (disaggregated by stakeholders):** evaluates the economic efficiency of co-management systems in freshwater fisheries by comparing the total economic benefits generated to the total costs required to operate and maintain these arrangements. Disaggregating by stakeholders in the fisheries co-management, if possible, would allow a better understanding about the distribution of benefits and cost across actors (communities, government, NGOs, etc.).

  The Benefit-Cost (BC) ratio is a standard economic tool used to assess whether the financial returns of an initiative justify its expenditures. Economic benefits may include increased fishery productivity, higher market value of catches, reduced enforcement costs, and improved livelihoods. Costs typically include administrative expenses, monitoring and enforcement, stakeholder coordination, and capacity-building efforts. A BC ratio greater than 1 indicates that the economic benefits exceed the costs, suggesting that the co-management system is financially viable and potentially scalable.

Data required: To assess the economic benefits over costs (BC ratio) of operating and maintaining co-management arrangements, it is essential to gather data that captures both the financial returns and the expenditures associated with these systems. On the benefits side, this includes increased revenue from improved fish stocks and larger harvests and higher fish prices from improved fish quality or better market access. Additional economic gains may come from value-added processing, diversification of income sources, and the monetized value of ecosystem services when available. On the cost side, it is necessary to account for all management costs, such as conflict resolution costs, enforcement and patrolling costs, and what is lost to illegal fishing. Operational expenses, such as staff salaries, logistics, communication, monitoring and surveillance activities, training programs, stakeholder meetings, and the opportunity costs of time invested by participants in co-management processes also need to be considered. These data can be sourced from project budgets, project expense reports, annual financial reports, community surveys, and economic valuation studies.

How to measure and evaluate: To measure and evaluate the indicator, the total quantified economic benefits are divided by the total quantified economic costs over a defined period, typically annually. The resulting benefit-cost ratio indicates the economic efficiency of the co-management arrangement. A ratio greater than 1 suggests that the benefits outweigh the costs, indicating a financially viable and potentially sustainable system. A ratio close to 1 reflects marginal returns and may point to the need for optimization or additional support. If the ratio is below 1, it implies that the costs exceed the benefits, raising concerns about the long-term viability of the arrangement and highlighting the need for review or external investment. It is however important to bear in mind that some costs and benefits may be intangible (non monetarised) and data for them may be challenging to quantify or obtain. This indicator is relatively simple to compute and valuable for informing decisions, comparing management options and guiding funding allocations, and evaluating the return on investment in participatory fisheries governance, but should be considered alongside all the other indicators.

Note that an assessment of the costs and benefits of a fishery co-management arrangement over several years will involve computing the 'net present value' (NPV) of the benefits minus the costs by discounting them. The NPV represents the net value of benefits that will be gained in the future in today's terms.

- **Average percentage of income derived from fishing vs. non-fishing sources:** Measures the proportion of household income that comes from fishing activities compared to other income sources. It reflects the degree of economic dependence on fishing and the extent of income diversification within fishing communities. A high percentage of income from fishing suggests greater vulnerability to ecological, regulatory, and market shocks, while a more balanced income portfolio indicates increased resilience and adaptive capacity. Income diversification is a key strategy for managing risk in fishing communities. For example, households with access to non-fishing income—such as wage labor, tourism, agriculture, etc. —are better equipped to cope with seasonal closures, declining fish stocks, climate change impacts or price fluctuations. These alternative income streams

can stabilize household finances and reduce pressure on fishery resources, contributing to more sustainable management.

Data required: Total annual household income derived from formal or informal sources, based on income from fishing (earnings from fishing) and non-fishing sources activities (e.g.: wage or salaried employment; agriculture or livestock; tourism or ecotourism; government transfers or subsidies; small businesses or crafts). Data can be collected through household surveys, census data, or structured interviews with fishers. It is important to ensure that income data are disaggregated by source and, where possible, by gender and household role.

How to measure and evaluate: calculate the percentage of income derived from fishing and non-fishing sources for each household. This is done by dividing the fishing income by the total household income and multiplying by 100 to obtain the percentage of fishing income. Similarly, divide the non-fishing income by the total income and multiply by 100 to determine the percentage of non-fishing income. Once these values are calculated for all surveyed households, compute the average percentages across the entire community or the defined fisheries management area. A high percentage of fishing income—typically above 80%—indicates strong dependence on fishing and low resilience to external shocks, suggesting a need for targeted support and diversification strategies. A moderate percentage, between 40% and 60%, reflects a more balanced income structure, often supported by government transfers or subsidies, and suggests greater adaptive capacity. In contrast, a low percentage of fishing income—below 30%—may indicate high income diversification or a shift away from fishing as the primary livelihood. In such cases, strategies to enhance the value of fish and fishery products may be necessary to improve the economic viability of fishing activities.

- **Rate of change in fishing profitability**: measures the rate at which profitability in freshwater fisheries changes over time. It captures both upward and downward trends in profits, recognizing that large or rapid changes in either direction can signal instability and unsustainability. Unlike indicators that assume linear utility (i.e., more profit is always better), this metric acknowledges that non-linear utility applies in fisheries: sudden increases may reflect overexploitation or market distortions, while sharp declines may indicate ecological stress, regulatory impacts, or economic collapse. Profitability is a key component of economic sustainability. However, sustainable fisheries should exhibit relatively stable profitability over time, allowing fishers to plan, invest, and adapt. Volatility in profits—whether due to fluctuating catch volumes, prices, input costs, or policy changes—can undermine long-term viability and discourage responsible management. This indicator helps identify such volatility and supports early intervention.

  Data required: The following data are needed over a consistent time series (e.g., annually): Total revenue from fishing activities, by year; Total costs of fishing operations, by year (including fuel, gear, labor, maintenance, licenses, etc.).

  How to measure and evaluate: To measure the Rate of Change of Profitability, the first step is to calculate annual profitability. For each year, profitability is determined by subtracting

total fishing costs from total fishing revenue and then dividing the result by the total costs. This yields a profitability ratio, which reflects the profit margin for that year. For example, a ratio of 0.25 indicates a 25% profit margin.

The second step involves calculating the rate of change in profitability from one year to the next. This is done by subtracting the previous year's profitability from the current year's profitability, dividing the result by the previous year's profitability, and multiplying by 100. The outcome is the percentage change in profitability year-over-year. In terms of evaluation, stable profitability—defined as a change of approximately ±5–10% per year—suggests a healthy and resilient fishery with predictable economic returns. A large positive change, greater than 20%, may indicate short-term gains that could stem from overfishing, speculative markets, or unsustainable practices. Conversely, a large negative change, less than –20%, may point to economic stress, declining fish stocks, or rising operational costs, all of which are potential warning signs of fishery collapse. High volatility, characterized by frequent and significant swings in profitability, signals systemic instability and low resilience. This indicator is particularly valuable when used alongside biological and social metrics to assess the overall sustainability of a fishery.

Indirect economic benefits from fisheries

While indirect, these indicators are equally important to consider.

- **Poverty index:** Assess the economic vulnerability of fishers by comparing their average income to the national poverty threshold. High levels of poverty among fishers can significantly undermine the sustainability of fisheries. When income is insufficient to meet basic needs, individuals are more likely to prioritize immediate survival over long-term resource management, potentially leading to overfishing, environmental degradation, and resistance to conservation measures. Conversely, once income surpasses the poverty line, additional gains have a diminishing impact on sustainability, reflecting a non-linear relationship between poverty and sustainable practices. Assessing poverty solely through income levels can offer a limited view of the challenges faced by fisher households. In some contexts, where livelihoods are deeply intertwined with ecological cycles and social structures, a multidimensional approach provides a more accurate and meaningful understanding of vulnerability. Therefore, it is recommended that this indicator be analyzed in conjunction with other critical dimensions such as access to education, health services, housing, and social inclusion—factors that directly influence the sustainability of fisheries and the well-being of those who depend on them.

  Data required: the average annual income from fishing (ideally disaggregated by gender), the official national poverty line, and optionally, the national average income for contextual comparison. All income figures should be adjusted for inflation to ensure consistency over time.

  How to measure and evaluate: The index is calculated using the formula: (average fishing income minus the national poverty line) divided by the national poverty line. This yields a

normalized value that indicates how far above or below the poverty line fishers' incomes are. Positive values indicate income above the poverty line, while negative values indicate income below it. When fishing income is equal to or above the poverty line, the impact on sustainability is considered neutral. In the most severe cases, where income is more than 30% below the poverty line, this indicates a high risk to sustainability. This indicator should be evaluated periodically—annually or biennially—depending on data availability. It can be disaggregated by gender or socioeconomic profile to identify particularly vulnerable groups. Tracking trends over time can reveal the effects of policy changes, market dynamics, or management interventions. For a more comprehensive assessment of fisher well-being, this index should be used alongside other social indicators, such as access to education, healthcare, and infrastructure.

Additional economic benefits indicators

- "Fishery economic vulnerability index" which measures the exposure to economic risks (market, climate, regulation).
- Access to financing and credit (similar at UNICAS in Perú). It represents the percentage of fishers with access to microcredit or investment funds.
- Opportunity cost of fishing: what other activities could fishers engage in if they did not fish?

A list of additional generic indicators related to economic benefits and outcomes from conservation strategies can be accessed in TNC's VCA Framework Measures Guidance Document and People Metrics Guidance.

SAMPLING DESIGN FOR ECONOMIC INDICATORS

For indicators like the Benefit-Cost (BC) ratio, the sampling should focus on collecting financial and operational data from co-management institutions or project implementers. This includes administrative records, budgets, and expenditure reports, as well as estimates of economic benefits such as increased revenue, reduced enforcement costs, or improved livelihoods. Since this data is often centralized, a full census of relevant financial documents is preferable to sampling. However, if benefits are estimated through community-level outcomes (e.g., increased income or reduced conflict), then household-level data should also be sampled accordingly.

In contrast, indicators such as the average percentage of income from fishing vs. non-fishing sources, the rate of change in fishing profitability, and the poverty index require household-level data collection. As already mentioned in the sampling design for social indicators, data collection should ensure representation across different types of fishing households—by location, gender, and socioeconomic status. Stratified random sampling is recommended to capture this diversity and allow for disaggregation of results. For example, income data should be collected from both male- and female-headed households, and from households with varying degrees of dependence on fishing.

Because these indicators often involve sensitive financial information, it is important to use trained enumerators and ensure confidentiality to improve response accuracy. Moreover, since some indicators track changes over time—such as profitability trends or poverty levels—the sampling design should include baseline and follow-up surveys with comparable samples. Panel data (repeated measures from the same households) is ideal for capturing trends, though cross-sectional data can also be used with appropriate controls.

All income and cost data should be adjusted for inflation and standardized to a common time frame to ensure comparability. Where possible, triangulation with secondary data sources—such as national statistics, market price records, or previous studies—can help validate findings and strengthen the robustness of the analysis.

Finally, as for the compilation of data for economic indicators, ethical considerations are paramount. Researchers must obtain informed consent, ensure confidentiality, and respect local norms and customs. Engaging communities in the design and interpretation of the data fosters trust and ownership, ultimately leading to more effective and sustainable fisheries management.

For additional information on ethics, equity, and human rights considerations in monitoring and data collection, check out VCA MEL training Module 2.

For additional training on developing and implementing social surveys (including sampling design, sample size determination, questionnaire design), check out VCA MEL training Module 4 and Freshwater Fisheries survey template (draft).

For additional training on using key informant interviews and focus groups to obtain economic data, check out VCA MEL training Module 3.

Governance outcomes

EXAMPLE OF OUTCOME STATEMENT

By 2030, communities engaged in co-management of fisheries strengthen governance by increasing fisher participation in decision-making, promoting equitable access to resources, and securing legal recognition—laying the foundation for inclusive, fair, and sustainable resource management.

By 2030, communities engaged in co-management of fisheries strengthen governance by improving transparency and accountability and reducing conflicts among stakeholders.

MENU OF INDICATORS

According to the Inland Fisheries Guide, 'management' is defined as the process of designing and implementing formal and informal rules for the activities of fishing communities and stakeholders (i.e., what decisions are made and how activities promote compliance). 'Governance' relates to how decisions are made in fisheries and who is involved. Management and governance are two

complementary aspects of freshwater fisheries co-management. As mentioned earlier, compliance tends to focus on management activities, whereas here we focus on governance. However, several implementation and compliance indicators (see Sections 2.1 and 2.2 above) are directly connected and can inform governance outcome indicators.

- **Change in fishers' sense of empowerment and ability to actively participate in decision-making (disaggregated by gender, type of fishing, and other relevant social identities):** evaluates the degree to which fishers are included in the governance and management of fisheries. Inclusive governance is a cornerstone of sustainable fisheries management, as it fosters legitimacy, compliance, and equity. When fishers are actively involved in decision-making, they are more likely to support and uphold regulations, contribute local knowledge, and engage in long-term stewardship of resources. Conversely, exclusion can lead to mistrust, conflict, and unsustainable practices. This indicator recognizes that governance is not binary but exists along a spectrum—from top-down control to fully participatory, equitable co-management. It also acknowledges that the quality of participation matters: being consulted is not the same as having decision-making power.

  Data required: for a good understanding of just governance, several types of data need to be collected: i) institutional and legal documents to understand the formal governance framework: fisheries management plans, co-management agreements, legal mandates, and policy documents that define roles, responsibilities, and rights of different actors. These documents reveal whether participatory mechanisms are formally recognized and how authority is distributed. ii) records of stakeholder engagement: meeting minutes, attendance lists, consultation reports, and memoranda of understanding. Such records help determine the frequency, consistency, and depth of fisher involvement in governance processes. They also indicate whether participation is limited to consultation or extends to shared decision-making. iii) perceptions of those with a stake in the fishery, collected through interviews, focus groups, or surveys with fishers, fishworkers, community leaders, government officials, and other stakeholders. These methods provide insight into how governance is perceived and experienced on the ground. Key questions might explore whether fishers feel heard, whether their input influences decisions, and whether they trust the institutions involved. Data must be disaggregated by gender, age, ethnicity, and type of fisher (e.g., commercial vs. subsistence).

  How to measure and evaluate: analysis assesses how participatory mechanisms are implemented and whether they result in meaningful inclusion. For example, a fishery may have a co-management committee on paper, but if meetings are irregular or dominated by government officials, the governance may not be truly inclusive. Interpretation should consider the balance of power among stakeholders, the transparency of decision-making processes, and the degree to which fishers can influence outcomes. Governance is considered more just when fishers are not only consulted but also share authority, have access to information, and can hold other actors accountable. Conversely, governance is less just when participation is symbolic, decisions are made unilaterally, or power is concentrated in a single institution. Qualitative, observational information by project staff,

as well as anecdotes from co-management participants, can serve as complementary data.

- **Number of conflicts (resolved and unresolved) in the fishery:** Conflict often arises when access to resources is poorly regulated, when different user groups have competing interests, or when governance structures fail to mediate disputes fairly. For co-management systems to be successful, they must not only acknowledge the existence of such conflicts but also demonstrate the capacity to address and resolve them in a fair, timely, and sustainable manner. Building on the implementation indicator that tracks the existence of a conflict resolution mechanism, this indicator focuses on the effectiveness of that mechanism in practice. It evaluates whether the presence of a grievance or conflict resolution system is translating into tangible reductions in conflict and improvements in stakeholder relationships.

  Data required: To assess this, data about the number of conflicts or grievances reported within a given year and the number or percentage of those conflicts that were resolved within the same period must be collected. These data should be gathered through a combination of administrative records (e.g., logs of complaints submitted to community leaders, co-management committees, or local authorities), interviews with stakeholders involved in or affected by disputes about their perceptions of conflict occurrence (frequency, intensity) and satisfaction with resolution mechanisms, and reviews of meeting minutes or mediation outcomes. Also, data about the start and ending of the conflict provide information about the amount of time that the conflict took to be solved.

  How to measure and evaluate: The analysis should focus on both the quantitative trends—such as a decrease in the number of reported conflicts or an increase in resolution rates—and the qualitative aspects of conflict resolution, including stakeholder satisfaction, perceived fairness, and the durability of agreements reached. A high resolution rate, especially when paired with positive feedback from stakeholders, suggests that the co-management system is not only responsive but also trusted and effective in maintaining social cohesion. Conversely, a persistent or rising number of unresolved conflicts may indicate that the mechanism is either underutilized, lacks legitimacy, or is not adequately resourced. In such cases, further investigation is needed to understand barriers to access, power imbalances, or procedural weaknesses. The average time that the conflict spent to be solved can provide insight into the effectiveness of governance mechanisms, community cohesion, and the capacity for collective decision-making within fishing communities.

- **Level of transparency and accountability in decision-making regarding fisheries management:** When decisions are made openly, documented clearly, and shared with all participants, it builds trust, enhances accountability, and ensures that all stakeholders—especially fishers—understand and can engage with the management process. Transparent leadership also helps prevent conflicts, prevents decision-making from being dominated by a small group of powerful individuals, and promotes equitable participation. In co-management settings, where responsibilities are shared between communities and

government or other institutions, transparency is essential to ensure that decisions reflect collective interests and are implemented fairly.

Data required: review of co-management committee meeting minutes is necessary to verify whether decisions are being formally recorded, whether attendance and voting outcomes are documented, and whether these records are accessible to all stakeholders. Also, an anonymous questionnaire survey should be conducted to capture the perceptions of co-management participants regarding the transparency of leadership and decision-making processes. This includes whether they feel informed, whether they believe decisions are made fairly, and whether they have access to meeting outcomes.

How to measure and evaluate: Evaluation should combine objective and subjective measures. From the document review, assess whether meeting minutes are consistently produced, whether they include key elements such as agenda items, decisions made, responsible parties, and follow-up actions, and whether they are made available to all participants in a timely manner. The presence of a publicly accessible archive or distribution system (e.g., community notice boards, digital platforms) is a strong indicator of transparency. From the perception survey, analyze responses to questions about participants' awareness of decisions, their understanding of how decisions are made, and their trust in the leadership. High levels of agreement with statements such as "I am informed about decisions made by the co-management committee" or "Decisions are made in a fair and open manner" suggest strong transparency. Discrepancies between documented practices and stakeholder perceptions may indicate communication gaps or issues with accessibility. Qualitative, observational information by project staff, as well as anecdotes from co-management participants, can serve as complementary data.

- **Change in use and control rights in fisheries (disaggregated by gender, ethnicity, and stakeholder type):**
  In many contexts, access to and control over fisheries resources are historically unequal, often favoring dominant social groups while marginalizing women, ethnic minorities, and small-scale fishers. Monitoring changes in these rights is essential to ensure that co-management systems are promoting social justice and inclusive development. Changes in use rights (such as who is allowed to fish, where, and when) and control rights (such as who makes decisions about resource management and enforcement) can reflect shifts in power dynamics, governance reforms, or the outcomes of participatory processes. Disaggregating this information by gender, ethnicity, and stakeholder type allows for a more nuanced understanding of who benefits from management changes and who may be left behind.

  Data required: both qualitative and quantitative data are needed. This includes legal and policy documents outlining formal rights and responsibilities, records of co-management agreements or customary tenure arrangements, meeting minutes and participation logs from decision-making bodies. Surveys or interviews with stakeholders to capture perceptions of access, influence, and fairness. Data must be disaggregated by gender, ethnicity, and stakeholder category (e.g., fishers, traders, processors) if it is the case.

How to measure and evaluate: Evaluation should begin with a baseline assessment of existing rights and how they are distributed among different groups. This can be followed by periodic reviews to identify any changes in access, participation, or decision-making authority. Key questions include: Have women or minority groups gained formal recognition of their fishing rights? Are they represented in co-management bodies? Do they feel their voices are heard and respected?

Document reviews can reveal formal changes in rights, while perception-based surveys and interviews provide insight into how these changes are experienced in practice. For example, even if women are formally included in a management committee, they may still face barriers to meaningful participation due to social norms or lack of capacity.

The analysis should look for both positive and negative trends. An increase in the number of underrepresented stakeholders with recognized rights or leadership roles suggests progress toward equity. Conversely, if rights are being consolidated among a few powerful actors, or if certain groups report reduced access or influence, this may indicate emerging inequalities or governance failures.

- **Legal/gazetted recognition of co-management arrangements.** Legal or gazetted recognition of co-management arrangements is essential for ensuring the legitimacy, stability, and enforceability of shared governance systems in fisheries. When co-management bodies and agreements are formally acknowledged through national legislation or published in official government gazettes, they gain legal standing that protects the rights and responsibilities of all stakeholders involved. This formalization strengthens accountability, supports conflict resolution, and integrates community-based management into broader policy frameworks. It also helps secure long-term support and funding, while safeguarding the participation of marginalized groups such as small-scale fishers and Indigenous communities.

  Data required: it is necessary to collect and review national and subnational legal texts, such as fisheries laws, decrees, and regulations that explicitly reference co-management. Official gazette publications should be examined to verify whether specific co-management bodies or agreements have been formally registered or endorsed. Additionally, co-management agreements or charters signed by government authorities can serve as evidence of recognition. Interviews with government officials and community representatives can provide further insight into the legal status of these arrangements and how recognition is implemented in practice.

  How to measure and evaluate: The indicator can be evaluated as a binary measure (recognized: yes/no), but it is often more useful to assess the degree of legal integration, such as whether recognition is national or local, whether it includes enforcement powers, and whether it is supported by operational guidelines and funding mechanisms.

- **Level of Government Participation:** reflects the degree of institutional legitimacy and implementation capacity behind a fisheries agreement, based on the relationship established between the different levels of government governance and the participating

communities. In Amazonian contexts—where governance is often shared and agreements rely both on community organization and public recognition—this indicator helps reveal whether there is solid institutional backing for enforcement, technical support, integration with public policies, and continuity of actions. Active government involvement, whether through municipal, regional, or federal agencies, strengthens trust between actors, ensures compliance with agreed rules, and opens doors for investments, regional programs, and long-term initiatives. Conversely, weak or irregular participation often generates legal uncertainty, overburdens communities, and makes it difficult to consolidate management norms.

Data required: it is necessary to gather information on which government institutions are involved, how they participate, how frequently they are present, and what types of resources are actually mobilized. This includes activities such as enforcement, monitoring, technical assistance, logistical support, planning meetings, training initiatives, and articulation with existing policies and programs. It is also essential to understand community perceptions of governmental engagement, the clarity of institutional responsibilities, and the continuity of support over time. These elements can be captured through interviews, analysis of meeting records and official documents, direct observation of activities, and field reports.

How to measure and evaluate: The evaluation considers three main aspects: the breadth of institutional participation (how many and which institutions are involved and in what capacities), the intensity and continuity of their actions (frequency of visits, predictability of activities, and long-term stability), and the level of operational capacity demonstrated (mobilization of personnel, equipment, financial or logistical support). The greater the coordinated and consistent presence of government actors, the higher the degree of institutionalization and resilience of the agreement. A high level of participation indicates strong political and technical backing, better enforcement conditions, increased legal security, and integration with public programs. An intermediate level suggests partial support, still dependent on punctual initiatives and vulnerable to discontinuity. A low level signals significant risks, such as weak legitimacy, difficulty enforcing rules, and fragility in maintaining community-led efforts.

Thus, this indicator helps assess whether the agreement is truly embedded in a robust governance environment or whether it still relies predominantly on local organization. It provides valuable guidance for strengthening institutional partnerships, reinforcing governance arrangements, and promoting long-term sustainability of fisheries initiatives.

SAMPLING DESIGN FOR GOVERNANCE INDICATORS

When evaluating governance outcomes in fisheries co-management projects, careful attention must be given to the sampling design to ensure that the data collected is representative, inclusive, and capable of capturing the complexity of governance dynamics. Given the nature of the indicators—such as fisher participation in decision-making, transparency, conflict resolution,

equity in access to rights, and legal recognition—the sampling strategy should reflect the diversity of stakeholders involved in the fishery.

It is essential to include a broad range of actors in the sample, such as small-scale and commercial fishers, women and men, Indigenous and minority groups, community leaders, government officials, and other resource users like traders or processors. This diversity allows for a more accurate understanding of how governance arrangements are experienced across different social and institutional groups.

The sample should also be disaggregated by gender, ethnicity, and stakeholder type to assess whether governance processes are inclusive and equitable. For example, when evaluating changes in use and control rights, it is important to understand how these changes affect different groups, particularly those who have historically been marginalized.

Because the indicators rely on both qualitative and quantitative data, a mixed-methods approach is recommended. Structured surveys can be used to gather perceptions of transparency, participation, and fairness, while in-depth interviews and focus groups can provide richer insights into power dynamics, conflict resolution processes, and the legitimacy of co-management structures. For qualitative methods, purposive sampling may be used to ensure that key voices are included, while for surveys, stratified sampling can help ensure statistical representativeness across stakeholder groups.

The sample size will depend on the number of communities involved and the diversity of actors, but it should be sufficient to allow for meaningful comparisons and trend analysis. For perception surveys, a minimum of 30–50 respondents per stakeholder group is often recommended. For qualitative interviews, 10–20 interviews per group may be adequate, depending on the complexity of the context and the point at which thematic saturation is reached.

Because governance indicators often track change over time, the sampling design should allow for baseline and follow-up assessments using comparable groups. This longitudinal approach is critical for evaluating whether co-management interventions are leading to improvements in participation, equity, and institutional effectiveness.

Finally, as for the compilation of data for governance indicators, ethical considerations are paramount. Researchers must obtain informed consent, ensure confidentiality, and respect local norms and customs. Engaging communities in the design and interpretation of the data fosters trust and ownership, ultimately leading to more effective and sustainable fisheries management.

For additional information on ethics, equity, and human rights considerations in monitoring and data collection, check out VCA MEL training Module 2.

For additional training on developing and implementing social surveys (including sampling design, sample size determination, questionnaire design), check out VCA MEL training Module 4 and Freshwater Fisheries survey template (draft).

For additional training on using key informant interviews and focus groups to obtain governance data, check out VCA MEL training Module 3.

Example of Application in the Amazon: Community-Led Fisheries Monitoring in the Manicoré River (Amazonas, Brazil)

The community-led fisheries co-management system implemented in the *Território de Uso Comum (TUC) do Rio Manicoré*, in the central Brazilian Amazon, offers a concrete example of how freshwater fisheries indicators can be used to guide decision-making, strengthen governance, and ensure adaptive management. Created in 2024 and grounded in a collective land-use concession (CDRU), the TUC organizes 16 communities around a shared Fisheries Agreement, a participatory Monitoring Plan, and a governance structure led by CAARIM (a local organization) and a multi-community Management Committee.

Within this system, indicators aligned with TNC's global inland fisheries framework—implementation, compliance, and outcome—serve as the backbone of the monitoring strategy.

Implementation indicators, such as the number of outreach activities, the creation of the Internal Regulation, and the installation of informational signs, track whether agreed management actions are being put into practice. The establishment of the Internal Regulation, for example, formalized procedures for decision-making, meeting frequency, and monitoring responsibilities, directly reflecting the "existence of a co-management plan" indicator from this guidance.

Compliance indicators are integrated through community-based reporting. Each community maintains occurrence forms documenting infractions (e.g., use of prohibited gear, fishing during closed periods), allowing the Management Committee to evaluate trends in rule adherence. This directly mirrors global indicators such as "number of illegal fishing events," "mechanisms for conflict resolution," and "self-enforcement systems."

Outcome indicators—ecological, socioeconomic, and governance-related outcome indicators—are generated through participatory data collection using standardized forms. Daily landing records provide CPUE, size-structure, and species-composition data, which support evaluation of trends in stock condition and ecosystem health. Socioeconomic indicators, including fish consumption frequency and household income derived from fishing, are assessed through household surveys. Governance outcomes are evaluated through community perception surveys that measure participation, trust, and the level of government involvement—an especially relevant indicator in the Manicoré context, where collaboration with municipal and state agencies (SEMA/AM, SEMAS-Manicoré) is essential for enforcement and policy alignment.

Example of Application in the Amazon: Community-Led Fisheries Monitoring in the Manicoré River (Amazonas, Brazil)

This Amazonian example illustrates how the fisheries indicators proposed in this document can be operationalized in real community-based management settings. It shows that indicators not only provide data but also structure participatory processes, improve accountability, strengthen local institutions, and support the adaptive cycle of "monitor → reflect → decide → adjust." As a result, communities gain greater autonomy in resource governance, while governments and partners gain reliable, co-generated information to guide long-term conservation efforts.

Link to fisheries monitoring plan and associated guides:
https://tnc.box.com/s/snklpd8gcia7x1zn3fau96mq1u6a73ll

4. Criteria for selecting indicators for fisheries sustainability

This section presents a structured approach to selecting indicators for monitoring fisheries sustainability, drawing on the framework proposed by Boyd & Charles (2006) and adapted to reflect the multidimensional nature of fisheries systems. The process is designed to ensure that selected indicators are not only theoretically sound but also contextually relevant and practically feasible for implementation at the local level. It unfolds in three sequential stages: evaluation of general indicator quality, assessment of context-specific relevance, and examination of data-specific feasibility.

4.1 General indicator quality criteria

The first stage involves assessing all proposed indicators—whether drawn from literature, expert consultation, or developed by the project team—against a set of general quality criteria. These include measurability, relevance to sustainability, clarity of interpretation, sensitivity to change, simplicity, timeliness, and the presence of reference values. Indicators that fail to meet basic standards of measurability or clarity are excluded early in the process. The remaining indicators are then evaluated for their conceptual strength—how well they reflect key sustainability dimensions such as economic viability, social equity, ecological integrity, and governance quality. This step is inherently interpretive and benefits from a combination of theoretical grounding, empirical evidence, and stakeholder input.

4.2 Context-specific (relational) criteria

In the second stage, indicators are assessed in relation to the specific characteristics of the fishery system they are intended to monitor. This includes evaluating their potential to influence policy decisions, their appropriateness to the spatial scale of the management unit, and their practical applicability within the community or institutional context. An indicator is considered contextually strong if it can inform real-world management decisions, is observable and actionable at the local level, and can be implemented with the resources and capacities available to the community. This step ensures that indicators are not only theoretically desirable but also operationally meaningful.

4.3 Data-specific and quality criteria

The final stage focuses on the feasibility and reliability of data collection. Indicators are evaluated based on whether they are appropriate for the temporal scale of monitoring, scientifically valid, accurate and precise, well-documented, current, and directly measurable. The quality of data sources—whether from household surveys, administrative records, or participatory assessments—is also considered. Indicators that require data that is unavailable, outdated, or prohibitively expensive to collect may be deprioritized unless alternative methods or proxies can be identified.

This three-tiered evaluation process ensures that selected indicators are not only conceptually robust but also grounded in the realities of local fisheries governance and management. It

supports the development of a monitoring system that is both rigorous and responsive to the needs of communities, managers, and policymakers.

We also summarize, in relative terms, the levels of importance, complexity, and cost of the proposed common indicators in the table below.

Outcomes	Indicators	Level of importance	Level of complexity	Cost
Implementation	See Section 2.1	High	Low	Low
Compliance	See Section 2.2	High	Medium	Medium
Ecological	Spatiotemporal distribution of catch	High	High	High
	Change in fishing effort and/or fishing gear	High	High	High
	Species composition of catch	High	Medium	Medium
	Size of fish in catch	High	Low	Medium
	Size relative to size at maturity	Medium	Medium	Medium
	Catch discarded	Medium	High	High
	Environmental factors	Medium	Medium	Medium
Social	Distribution of benefits and power/influence across actors of the fish value chain	Medium	High	High
	Range of employment opportunities from fishing and fish-related activities (paid and unpaid, full-time and part-time), including for women and youth	High	Low	Medium
	Food security in community/ Nutritional quality of available fish products in community	Medium	High	Medium
	Change in educational attainment (disaggregated by gender)	Medium	Medium	Medium
	Change in gender equity and women's empowerment from fisheries management and value chains improvements	High	High	Medium

	Perception of well-being and quality of life	High	High	Medium
Economic	Benefits over costs (BC ratio) of operating and maintaining co-management arrangements (disaggregated by stakeholders)	Medium	High	High
	Average percentage of income derived from fishing vs. non-fishing sources	High	Medium	Medium
	Rate of change in fishing profitability	Medium	High	High
	Poverty index	Medium	Medium	Low
Governance	Change in fishers' sense of empowerment and ability to actively participate in decision-making (disaggregated by gender, type of fishing, and other relevant social identities)	High	Medium	Low
	Number of conflicts (resolved and unresolved) in the fishery	High	Low	Low
	Level of transparency and accountability in decision-making regarding fisheries management	Medium	Medium	Medium
	Change in use and control rights (disaggregated by gender, ethnicity, stakeholder type)	High	High	Medium
	Legal/gazetted recognition of co-management arrangements	Medium	Low	Low
	Level of government participation	Medium	Low	Low

5. Key resources and bibliography

Key resources

- Anderson, J.L., Anderson, C.M., Chu, J., Meredith, J. (2014). Fishery Performance Indicators. Version 1.2.
- Boyd, H., & Charles, A. (2006). Creating community-based indicators to monitor sustainability of local fisheries. *Ocean and Coastal Management*, *49*(5–6), 237–258. https://doi.org/10.1016/j.ocecoaman.2006.03.006
- Cochrane and Garcia. (2009). A Fishery Manager's Guidebook. Second Edition. FAO and Wiley-Blackwell.
- FAO. (2021). Ecosystem approach to fisheries implementation monitoring tool. In *Ecosystem approach to fisheries implementation monitoring tool*. FAO. https://doi.org/10.4060/cb3669en
- Pomeroy, R.S., Oh, K., Martone, E., Westlund, L., Josupeit, H. & Son, Y. 2022. Guidebook for evaluating fisheries co-management effectiveness. FAO. https://doi.org/10.4060/cc2228en

Bibliography

Andrade, B. de S., Freitas, C. E. de C., Petesse, M. L., & Siqueira-Souza, F. K. (2022). Evaluation of fisheries management strategies using a biotic integrity index in floodplain lakes in the lower Solimões River, Amazonas, Brazil. *Acta Amazonica*, *52*(4), 289–298. https://doi.org/10.1590/1809-4392202201461

Arantes, C. C., Castello, L., Basurto, X., Angeli, N., Sene-Haper, A., & McGrath, D. G. (2022). Institutional effects on ecological outcomes of community-based management of fisheries in the Amazon. *Ambio*, *51*(3), 678–690. https://doi.org/10.1007/s13280-021-01575-1

Boyd, H., & Charles, A. (2006). Creating community-based indicators to monitor sustainability of local fisheries. *Ocean and Coastal Management*, *49*(5–6), 237–258. https://doi.org/10.1016/j.ocecoaman.2006.03.006

Bennet, N.J., Relano, V., Rounbedakis, K., Blythe, J., Andrachuk, M., Claudet, J., Dawson, N., Gill, D., Lazzari, N., Mahajan, S.L. Muhl, E.-K., Riechers, M., Strand, M., & Villasante, S. (2025). Ocean equity: from assessment to action to improve equity in ocean governance. *Frontiers in Marine Science*, 12:1473382. Doi: 10.3389/fmars.2025.1473382

Blythe, J.L., Claudet, J., Gill, D. *et al.* (2026) The Ocean Equity Index. *Nature*, https://doi.org/10.1038/s41586-025-09976-y

Charles, A. Trevor. (2023). *Sustainable fishery systems*. John Wiley & Sons, Inc.

European Fisheries Control Agency. (2018). *Guidelines on indicators to measure compliance in fisheries*.

FAO. (1997). *Fisheries management*.

FAO. (2021). Ecosystem approach to fisheries implementation monitoring tool. In *Ecosystem approach to fisheries implementation monitoring tool*. FAO. https://doi.org/10.4060/cb3669en

Gokhale, S., Blomquist, J., Lindegren, M., Richter, A., & Waldo, S. (2024). The Role of Non-fishing and Partner Incomes in Managing Fishers' Economic Risk. *Marine Resource Economics*, 000–000. https://doi.org/10.1086/731762

Governing for transformation towards sustainable small-scale fisheries. (2025). FAO. https://doi.org/10.4060/cd4289en

Hockings, M. (2003). Systems for assessing the effectiveness of management in protected areas. In *BioScience* (Vol. 53, Issue 9, pp. 823–832). American Institute of Biological Sciences. https://doi.org/10.1641/0006-3568(2003)053[0823:SFATEO]2.0.CO;2

Jepson, M., & Colburn, L. L. (n.d.). *Development of Social Indicators of Fishing Community Vulnerability and Resilience in the U.S. Southeast and Northeast Regions*. https://www.researchgate.net/publication/260038260

Kasperski, S., & Holland, D. S. (2013). Income diversification and risk for fishermen. *Proceedings of the National Academy of Sciences of the United States of America*, *110*(6), 2076–2081. https://doi.org/10.1073/pnas.1212278110

Lorenzen, K., Cowx, I. G., Entsua-Mensah, R. E. M., Lester, N. P., Koehn, J. D., Randall, R. G., So, N., Bonar, S. A., Bunnell, D. B., Venturelli, P., Bower, S. D., & Cooke, S. J. (2016). Stock assessment in inland fisheries: a foundation for sustainable use and conservation. In *Reviews in Fish Biology and Fisheries* (Vol. 26, Issue 3, pp. 405–440). Springer International Publishing. https://doi.org/10.1007/s11160-016-9435-0

McDougall, C., Kruijssen, F., Sproule, K., Serfilippi, E., Rajaratnam, S., Newton, J. and Adam, R. (2021). Women's Empowerment in Fisheries and Aquaculture Index (WEFI): Guidance Notes. Penang, Malaysia: CGIAR Research Program on Fish Agri-Food Systems (FISH).

Pitcher, T. J., Lam, M. E., Ainsworth, C., Martindale, A., Nakamura, K., Perry, R. I., & Ward, T. (2013). Improvements to Rapfish: A rapid evaluation technique for fisheries integrating ecological and human dimensionsa. *Journal of Fish Biology*, *83*(4), 865–889. https://doi.org/10.1111/jfb.12122

Pomeroy, R. S. , Oh, K. , Martone, E. , Westlund, L., Josupeit, H., & Son, Y. (2022). Guidebook for evaluating fisheries co-management effectiveness. In *Guidebook for evaluating fisheries co-management effectiveness*. FAO. https://doi.org/10.4060/cc2228en

Smith, S. L., Karasik, R., Stavrinaky, A., Uchida, H., & Burden, M. (2019). Fishery Socioeconomic Outcomes Tool: A rapid assessment tool for evaluating socioeconomic performance of fisheries management. *Marine Policy*, *105*, 20–29. https://doi.org/10.1016/j.marpol.2019.03.009

The Nature Conservancy. (2021). *Monitoring the Voice, Choice, and Action (VCA) Framework: Practitioner Guidance on Common Human Well-being and Environmental Measures*. Version 1 (January 2021).

The Nature Conservancy. (2023). A practical guide on community-based co-management of inland fisheries. Arlington: TNC.

Treakle, T., Abbott, J. K., & Holland, D. S. (2023). *Not by Fishing Alone: Non-Fishing Employment and Income for US West Coast Fishers*.

Appendix: Glossary

Terms	Definitions
Baseline	The value of an indicator against which changes can be measured. An indicator value prior to our outside of the implementation of a project. Note: Baselines can be used to make Before-After or Control-Impact comparisons. This value is sometimes referred to as a comparator.
Evaluation	The systematic and objective assessment of an ongoing or completed activity to determine its relevance, effectiveness, outcome and impact. An important part of the adaptive management cycle where we make sense of what the data is telling us and use it in decision-making.
Co-management	A partnership arrangement in which government, the community of local resource users (fishers), external agents (NGOs, research organizations), and sometimes other fisheries and coastal resource stakeholders (boat owners, fish traders, credit agencies or money lenders, tourism industry, etc.) share the responsibility and authority for decision-making in the management of a fishery, particularly as it relates to the access and/or withdrawal of fishing resources. For co-management to take place the state has to be willing to devolve management, exclusion and/or transferability or alienation rights to individuals, groups and communities. Thus co-management encompasses various types of partnering arrangements and degrees of power-sharing, and can be instructive, consultative, cooperative or delegated (based on FAO, 2013; Berkes et al., 2001; Sen and Nielsen, 1996; Schlager and Ostrom, 1992).
Fishing unit	The unit of assessment for recording fisheries data. Depending on the location and context, the definition of fishery units may (or may not) rely on one or more of the following elements: • Target fish species, groups of species, or stock (including geographic area or location); • Fishing method, gear and/or vessel type; • Fishing fleet / groups of vessels or individual fishing operators pursuing the fishing operation(s) • Management units
Gender	Refers to socially defined roles, responsibilities and behaviors that are assigned to women and men (FAO, 2007a).
Impact	The positive or negative, primary or secondary, direct or indirect, intended or unintended effects of a project or program. Longer-term than an outcome.
Indicator	Context-specific quantitative variables or qualitative statements that provide simple, precise, and reliable means to establish baselines, and to measure ecological or socio-economic changes over time.

	Note: 'Measure,' 'indicator,' and 'metric' are sometimes used interchangeably within the conservation community. We recommend using them distinctly - Specifically, an 'indicator' is the context-specific means of informing a 'measure.'
Metric/Measure	A standard means of assessing the size, amount, degree, or quality of something. Composed of a value and a unit of measure. Note: 'Measure,' 'indicator,' and 'metric' are sometimes used interchangeably within the conservation community. We recommend using them distinctly - Specifically, a 'measure' is informed by context-specific 'indicator(s).'
Outcome	Major measurable effects of strategies (and activities undertaken) within the scope and time frame of a project. More specific and shorter-term than an impact. Also includes unintended or negative effects.
Output	A discrete deliverable over which the project or program implementers have control, for example a report, training, or workshop.
Qualitative data	Data that can be observed, described, and recorded, but is not measured in objective, numeric terms. Note: in some cases, qualitative data can be converted to numeric data (e.g., ordinal scales) and then analyzed statistically
Quantitative data	Data that can be objectively measured and expressed numerically, and thus analyzed statistically.
Target	The value of an indicator that a project or program aims to achieve over time through implementation.
Unit of Measure	Standard unit or system of units by which a measure is expressed.