A GUIDE TO SOCIOECONOMIC ASSESSMENTS FOR ECOREGION CONSERVATION

This document provides a flexible guide to socioeconomic assessments for ecoregion conservation. Four essential tasks are introduced: 1) stakeholder analysis, 2) analysis of threats and opportunities, 3) defining possible interventions, and 4) monitoring and evaluation. Each of these tasks contributes to the ultimate goal of designing, implementing, and constantly improving conservation actions at an ecoregion scale.

This guide is presented as a basis for building understanding about the key elements of socioeconomic assessment and how to move forward in defining them. More details can be added, particularly regarding the methodology behind each task.

Socioeconomic assessments should be inextricably linked to the biodiversity conservation priorities of an ecoregion. Although biological and socioeconomic work can proceed concurrently in ecoregion conservation, it is important to emphasize at the outset that the latter builds on the former. Broadly speaking, a biodiversity vision generates biological priorities for an ecoregion, while a socioeconomic assessment informs the development of conservation strategies that define how those biological priorities will be achieved.

The term "socioeconomic assessment" can be misleading because it implies something static, such as a final evaluation or report. That, however, is not how ecoregion conservation works. The visionary, evolutionary, and long-term perspective of ecoregion conservation requires a dynamic approach to conservation planning and action across an ecoregion. As such, it is important to gather information about the socioeconomic characteristics of an ecoregion throughout the ecoregion conservation process.

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This includes examining the actions, motivations, and influence of individuals and institutions that affect biodiversity, have a strong stake in biodiversity, or may support its conservation.

Socioeconomic information gathering and analysis is an iterative process. You start by gathering information. Then you analyze, act, and take stock of progress made—all against the ultimate yardstick of a biodiversity vision. Based on rigorous monitoring and evaluation of the actions taken, it is possible to extract lessons, adapt, refine or redesign the process.

Two Primary Goals of Socioeconomic Assessments

The ecoregion conservation approach developed by WWF requires that socioeconomic assessments support two overarching goals:

1. *Quick response to threats and opportunities:* Beginning at the earliest possible stage in an ecoregion, it is important to be able to identify and respond to threats and opportunities that affect biodiversity conservation. Many ecoregions are undergoing rapid change, with threats and opportunities emerging that cannot wait for a full biodiversity vision and conservation plan to be completed. As such, the ability to detect threats and opportunities and to respond quickly must be maintained throughout the life of conservation efforts in an ecoregion.

2. *Strategic planning and action:* The design and implementation of conservation strategies should serve the ambitious goals of the biodiversity vision for an ecoregion. This requires that the strategy focuses on addressing, at the necessary scale, the socioeconomic drivers of biodiversity change. To do this organizations must set their sights on developing sharply defined and ambitious targets for action. Ecoregion conservation is not only about capitalizing on opportunities and doing the possible. It is about creating opportunities and doing the seemingly impossible.

At the beginning of some ecoregion processes, the need to respond to imminent threats and opportunities will require the design of a near-term game plan and a set of actions before a final biodiversity vision has been defined. In these instances the key tasks of a socioeconomic assessment will be more focused if based on a preliminary biodiversity vision. (As outlined in WWF's *Workbook for Conducting Biological Assessments and Developing Biodiversity Visions for Ecoregion-based Conservation; Part I: Terrestrial Ecoregions*, available by request from meseret.taye@wwfus.org.)

A preliminary vision can be a broad statement of biological objectives or the actual delineation of a few priority areas that will definitely be part of the final biodiversity vision. Whereas the final biodiversity vision may have dozens of priority biodiversity targets that need to be considered in relation to socioeconomic issues, a preliminary biodiversity vision may identify only two or three that require urgent attention. Consequently, the socioeconomic assessment process can begin by focusing on the development of a conservation strategy for those two or three priority targets.

Regardless of whether the socioeconomic

assessment is serving the need for an interim action plan or for a long-term conservation strategy, the four tasks outlined should be undertaken.

In discussing conservation goals and strategies, a word of caution is merited about the so-called "no-brainers" for quick conservation action. Though extremely important, they may be more complicated than first meets the eye. The immediate threat to biodiversity may be obvious (e.g., the forest is being clear-cut), but determining the most cost-effective near-term intervention requires good information, sound judgement, and an understanding of any long-term trade-off it may entail. Without that information and understanding you may end up forging partnerships that you later regret, or committing to a long-term funding commitment for a project that will later emerge, based on assessments and the final biodiversity vision, as a lower priority than other projects. In short, you do not want to save a tree only to lose the forest.

Getting Started: Gaining a General Understanding of the Ecoregion

As a general precursor to addressing the two overarching goals of ecoregion conservation, initial information gathering should help build a broad understanding of the major biodiversity conservation issues and associated socioeconomic dynamics across an ecoregion. It is important to be generally informed about the array of conservation issues and interest groups in the ecoregion and the economic, cultural, and political environment in which they work. Sound decisions, effective partnerships, and a solid information network are best achieved when this broader context is understood.

Regardless of whether it is an ecoregion where organizations have been active or not, the first questions that need to be asked inevitably involve "who"—Who has the information needed to conduct the biological assessment and understand what is causing biodiversity change? Who is having the greatest impact on the state of biodiversity in the ecoregion (because of their attitudes or practices)? Who are the influential institutions (government, private and community sector) that need to be engaged in dialogue and action? Who has the power to affect, for better or worse, the management of those natural resources of greatest relevance to conservation at the ecoregion scale? Who is likely to win or lose when actions to protect biodiversity are implemented?

The degree of effort that needs to go into answering these initial questions will vary greatly depending on the complexity of, and an organization's experience in, the ecoregion. Where they are new to the ecoregion, this information gathering will be important as staff and partners begin to identify reliable sources of information. Even in ecoregions where organizations have been active for many years, the larger-scale, more ambitious approach of ecoregion conservation will require a review of the broader landscape of stakeholders, development and business activities, and other factors. In-depth analysis is not needed at this stage, just a basic knowledge of the major players and the overarching social and economic factors that may affect biodiversity. This broad perspective will enable program staff and partners to recog-

nize and respond quickly to threats and opportunities that may arise.

Key Tasks of Socioeconomic Assessments

As previously mentioned, socioeconomic assessments consist of four interrelated tasks: 1) stakeholder analysis, 2) analysis of threats and opportunities, 3) defining possible interventions, and 4) monitoring and evaluation. These tasks involve overlapping activities and do not need to be conducted in the sequential order in which they are presented; often parts of them will be conducted simultaneously.

Task 1: Stakeholder Analysis

Understanding the wide range of stakeholders and stakeholder interests across an ecoregion is key to the long-term success of ecoregion conservation. The three basic questions a stakeholder analysis can answer are: Who knows what? Who controls what? Who can help to change negative patterns of behavior? This is not a process that begins and ends within a discrete time interval. Rather, it is an ongoing activity that must be periodically revisited. Understanding stakeholders and their interests is essential to establishing an information network that will help in the identification and evaluation of emerging threats and opportunities. Engaging a wide range of stakeholders in a consultative fashion can also contribute to the development of participatory forms of governance, collaboration or partnership that will sustain ecoregion conservation efforts over the long term.

Broadly speaking, stakeholders include people, institutions, and social groups that are involved in, or affected by, decision making regarding biodiversity conservation issues in the ecoregion. Three stakeholder categories are relevant to ecoregion conservation planning and action.

1. *Knowledge Holders:* There are three main subcategories:

   (a) Those with both specialized and general knowledge of biodiversity and the conservation landscape in the ecoregion who can contribute to the biological assessment and help prepare the biodiversity vision. If an interim biodiversity vision is prepared, experienced biodiversity generalists and conservationists are needed to help identify these outstanding biodiversity priorities of an ecoregion that will inevitably be part of the final biodiversity vision. Experienced generalists can also help identify the specialists needed for the comprehensive biological assessment and final biodiversity vision. Although the focus is on biology, stakeholder analysis is crucial here because of 1) the need to cultivate cooperation from data-rich government agencies, nonprofit institutions, university centers, and others; and 2) the importance of developing participation and buy-in by key partners and other stakeholders to ecoregion conservation and the resulting biodiversity vision.

   (b) Those who have knowledge regarding the most important social, economic, and political factors and trends that may be affecting priority biodiversity features. These knowledge

sources can map and explain the human infrastructure and land-use activities in the ecoregion and identify the most important laws, policies, agreements, and economic forces that are governing and influencing natural resource use and management. They can also help identify power holders and power brokers.

(c) Those with knowledge of resource and biodiversity management practices in the ecoregion. For example, which fisheries, forest, or mining management practices are compatible with biodiversity conservation and socioeconomic sustainability? What is the restoration potential of degraded lands?

When identifying knowledge holders, don't forget to look to staff and partners who have been working on conservation and development projects in the ecoregion.

2. *Influential Stakeholders:* The three principle subcategories are:

   (a) Those who own, directly manage, or harvest resources, or exert strong control over large holdings or resource stocks. These include entities (e.g., individual, corporate, public agency, etc.) and relatively homogeneous groups of stakeholders (e.g., an association of small-scale farmers or fishers who vote as a block).

   (b) Those who strongly influence the allocation, management, and use of natural resources. Again, this may be individual entities or powerful consortia (e.g., elected officials, land management agencies and key people in them, corporate heads, major political contributors, powerful nonprofit interest groups). It is also important to understand the laws, policies, political alliances, and cultural norms that create or favor centers of influence.

   (c) Those who are marginalized. These are significant stakeholders in terms of their dependence on, desire to gain access to, or influence over land, water, and natural resources, but are thwarted from doing so because of their status in society. Examples include indigenous peoples who have lost and wish to regain large land areas or small-scale fishers who have lost fishing rights to industrial fishers.

3. *Potential collaborators:* "Collaborator" is used loosely here to include any individual, organization, or group that can contribute information to the ecoregion conservation process, is willing to participate in a consultation process, or will work with other stakeholders as a partner in carrying out a specific project or program. Collaborators are not necessarily allies or groups that share similar values, but they are willing to exchange information and views on a regular basis. An effective network of collaborators can often help generate quick responses to threats and opportunities. The term "partnership" implies a closer working relationship with groups or entities (public or private) whose objectives in an ecoregion are complementary to the conservation goals for the ecoregion.

   Reversing biodiversity loss at the scales required by ecoregion conservation may require close collaboration or partnerships with and among industry, the pri-

vate sector, resource owners and harvesters, government development agencies, foreign affairs departments, policy fora, and others. Many of these are stakeholders who have traditionally been outside the orbit of conservation-based collaborations.

A number of different tools and approaches can be used to gather information about stakeholder groups and build collaborative relationships or partnerships for conservation. Which tools or approaches are chosen will be determined by the profile of the ecoregion and the goals that the organizations are trying to achieve (see Annex I).

Task 2: Analysis of Threats and Opportunities

The analysis of threats to and opportunities for biodiversity conservation requires strong interdisciplinary work that combines the knowledge and skills of the ecological and social sciences and conservation practitioners. As suggested previously, the greater the degree to which a biodiversity vision has been defined for an ecoregion, with clearly articulated goals and targets, the greater the precision and ultimate effectiveness of socioeconomic information gathering and analysis. It is against the biodiversity vision that threats and opportunities should be assessed.

It is useful to think of threats to biodiversity as consisting of two parts: 1) the "stress" that is leading directly to biodiversity loss or degradation; and 2) the "pressure," which is the cause or source of the stress. Examples of stress are over-fishing, excessive clear-cutting, invasion of exotic species, and high pollution levels in a stream. The pressures driving these might be, respectively, an overcapitalized fishing fleet, an open-access forest policy, inadequate inspection of imported plants, and high effluent releases from a mining operation. Pressures can further be divided into "proximate" and "ultimate" (the latter often called "root causes"). Thus, the overcapitalized fishing fleet is a relatively proximate pressure, while the government subsidy that led to more boats being purchased is closer to an ultimate pressure. The cause of the subsidy, such as the government's desire to improve its balance of payments by exporting more fish, comes even closer to identifying ultimate pressures.

One needs to combine an analysis of stresses and pressures with an ecological analysis to fully assess the severity of a threat. For example, an examination of a potential threat, such as the emergence of a new market for a species of fish, will provide information about the imminence and magnitude of that threat (e.g., how fast and to what degree might consumer demand grow and with what effects on the size and practices of the fishing fleet). Ecologists then need to analyze what effects the change in fishing practices (e.g., change in mesh size or the species and size of fish caught) will have on the fish stocks and marine biodiversity.

Combining the severity of threat with the relative priority of the biodiversity feature that is threatened is one way of ranking the need for conservation actions. (See Annex II for a matrix that can help rank the relative importance of threats to biodiversity.)

(For more information on "root causes" see WWF's *The Root Causes of Biodiversity Loss*,

eds., Wood, Stedman-Edwards, and Mang, available at www.earthscan.co.uk.)

Pressures

Two categories of pressure worthy of specific attention within a socioeconomic assessment are demographic patterns and trends and resource use patterns and trends.

1. *Demography:* Although demographic change clearly has important implications for biodiversity conservation, determining what demographic information and associated pressures are relevant to conservation planning is difficult. Moreover, the most relevant data on demographic change may be difficult or impossible to obtain at the level of an entire ecoregion or priority area within an ecoregion.

   However, there are various values that can serve as proxies for detailed demographic information. For example, identifying the remoteness of a priority area from population centers may be extremely useful and easy to map. Remote areas are typically (but not always) more intact than areas close to human settlements, less hunted or fished, and characterized by ecological processes that are likely to fluctuate more naturally than in heavily used or managed areas.

   It is possible to develop a map that overlays priority habitat blocks of various sizes and calculates how far removed these are from existing and proposed roads, pipelines, railroad lines, areas of conflict and so on. This type of map can help predict which areas will remain remote over the next ten years and which formerly remote areas are likely to become more accessible.

   Using values such as these can help establish the conservation potential of unique landscapes within an ecoregion (see Annex III).

   Once these proxies for demographic information have been mapped and it is determined whether or not they pose a threat to conservation goals and targets, it is possible to begin identifying those pressures that are reshaping the demographic landscape. Development policies, job migration, new technologies, and increased consumer demand for natural resources are all pressures that could be identified as a result of this process.

2. *Resource Use:* An analysis of socioeconomic pressures and trends can help answer two fundamental questions about resource use patterns across an ecoregion.

   (a) Are there socioeconomic incentives in place that will cause relevant stakeholders to maintain an area in a natural or semi-natural state, convert it to alternative uses, or restore a converted landscape to its natural condition?

   An analysis of the opportunity costs associated with any incentives will lead to an enhanced understanding of pressures at work in the ecoregion.

   (b) If the area is maintained in a natural or semi-natural state, will it be managed in ways that maintain biodiversity? There are two reasons why it may not:

1. Over harvesting of high value wild species can cause ecosystem degradation. Common driving forces behind this are high market demand combined with open access or high market demand combined with secure ownership and high discount rates. Other activities, such as pollution, mining, and global warming may also cause degradation.

2. Specialization in production of the most valuable wild species commodity (e.g., stocking tropical timber stands with mahogany or northern streams with Atlantic salmon) can cause ecosystem simplification. Driving forces may include global markets for wild species of high commodity value combined with inadequate compensation to landowners for the noncommodity values of the natural ecosystem.

(For more information on threat analysis process and methodologies see TNC's *The Five-S Framework for Site Conservation*, available for download from the library at www.consci.org.)

Task 3: Defining Possible Interventions

Once the major threats are understood (relative to the goals and targets of the biodiversity vision, or pre-vision) the challenge is to determine how they can be reduced or eliminated, or transformed into opportunities to support biodiversity gains. Some local threats may be susceptible to short-term, local interventions that can bring about immediate results (e.g., creating a conservation easement on a local stand of forest that is about to be logged), while interventions to change more ultimate threats may require action at a wider scale and over longer time horizons (e.g., creating consumer demand for sustainably harvested timber).

In addition to determining how a threat can be addressed, it is also important to identify which stakeholders are best placed to address it. Ultimate threats may best be tackled from outside the ecoregion and in collaboration with governments and institutions like the World Bank, multilateral agencies, or other international NGOs. In those instances, it will be important to work in partnership with partners around the world to identify which stakeholders can help bring about necessary changes in economic policies, trade practices, consumption patterns and the like. By comparison, local threats will be better addressed by working with stakeholders in the ecoregion whose knowledge, influence, and willingness to collaborate make conservation action possible. The institutional cooperation and level of stakeholder participation achieved will in large part be shaped by the information gathering and analysis that has been pursued from the outset of the ecoregion conservation process.

The greater the need to incorporate diverse stakeholder interests in the implementation of a chosen intervention (because they are knowledgeable, important or influential), the more likely it is that some trade-offs will need to be negotiated. This may result in some conservation goals being postponed or ultimately abandoned in favor of more widely acceptable options.

Task 4: Monitoring and Evaluation

Effective ecoregion conservation requires a good understanding of the state of biodiversity in an ecoregion, the positive and negative pressures affecting that state, and the responses that society can bring to bear to reduce the negative pressures and increase the positive ones. As a result, monitoring and evaluation (M&E) are crucial components of ecoregion conservation.

The goals of M&E for ecoregion conservation are to:

1. Assess progress in meeting biodiversity goals of the conservation strategy (short-term) and biodiversity vision (long-term) of each ecoregion.
2. Adjust and increase the effectiveness of interventions as the validity of assumptions and actions are tested.
3. Improve the quality and effectiveness of performance by active organizations and their partners through adaptive management.
4. Provide a measure of the socioeconomic value of biodiversity within an ecoregion.
5. Ensure the effective (targeted) and efficient use of resources.
6. Provide a useful communication tool for awareness raising, education, and capacity building for ecoregion conservation.

A common framework for M&E used by WWF is the "Pressure–State–Response" (PSR) model. Variations on PSR include the "Driving Force–Condition–Societal Response" model and the more detailed "Driving Force–Pressure–State–Impact–Response" model. Regardless of the terminology, the basic concept is that a set of carefully selected indicators allows you to track changes in 1) human activities that affect the environment (the "pressure" or "force"), 2) the condition of the environment (the "state"), and 3) how society or some segment of society responds to change the pressure or driving force (the "response"). Periodic monitoring then allows one to see if and how the state of the environment is affected by the response. The inclusion of "impact" as a fourth set of indicators in some models provides an understanding of how changes in the environment are affecting socioeconomic conditions, which in turn elicit the societal response to improve those conditions.

The pressure-state-response (PSR) model (see Annex IV) and the driver-state-impact-response (DSIR) model (see Annex V) offer good examples of how monitoring and evaluation models can help track progress towards meeting the goals and targets of a biodiversity vision. The PSR and DSIR models also provide a useful framework for implementing and monitoring the major components of socioeconomic assessment, effectively linking the analysis of threats and opportunities discussed in Task 2 with the definition of possible interventions discussed in Task 3.

(For more information see BSP's publications on analysis and adaptive management, available at www.bsponline.org.)

Conclusion

Whatever the size or diversity of an ecoregion it is important to recognize that socioeconomic considerations and perspec-

tives are part of the ecoregion conservation process from day one. As such, initial information and intelligence gathering (about stakeholders, threats, and opportunities) are central to the process. This is not a prescription for endless data collection and analysis. Rather, the socioeconomic information gathering and analysis will lead to an understanding of the context in which ecoregion conservation is to be implemented; it will inform the development of appropriate action for conservation; and it will support ongoing learning and adaptation.

As the ecoregion conservation process evolves in an ecoregion more detailed socioeconomic analyses are likely to be needed. These finer scale assessments will help to meet the challenges associated with the achievement of biodiversity targets in the long term, the identification of priority areas and targets for conservation, the emergence of key issues and threats, and the ongoing changes in an ecoregion.

It is important to remember that the goal of any socioeconomic assessment (broad or specific) is to help move an ecoregion from the articulation of a biodiversity vision to the realization of its goals and targets.

For more information on ecoregion conservation or socioeconomic assessments, please contact Sheila O'Connor at sheila.oconnor@wwfus.org or Bronwen Golder at bgolder@xtra.co.nz. To request copies of this publication, contact erbcinfo@wwfus.org.

ANNEX 1: STAKEHOLDER ANALYSIS

The goal of stakeholder analysis is to:
- identify stakeholders by category.
- develop a strategic view of the situation and the relationship between stakeholders and identified objectives.
- clarify stakeholder interests and roles.
- guide the design of collaboration approaches.

The range of tools and approaches that can be used to undertake a stakeholder analysis is extensive, so think carefully about the nature and complexity of your ecoregion to help you decide which tools will best meet your needs.

For example, in the Fynbos ecoregion of South Africa the following tools were used to analyze stakeholders and secure their participation in the ecoregion conservation process:
- A database profiling stakeholders according to their knowledge, influence, or openness to collaboration
- Stakeholder meetings, presentations, and briefings for different stakeholder audiences
- Distribution of information about the process to stakeholder audiences (via radio, press articles and pamphlets)
- Questionnaires and newsletters to promote the exchange of information across the ecoregion
- Focus groups and in-depth interviews to gather and share knowledge
- Workshops to engage stakeholders in strategy development
- Report back meetings with stakeholders who contributed information and ideas
- Steering committees and working groups that can help identify stakeholder collaboration and intervention opportunities, threats, and necessary trade-offs

Further information on stakeholder assessments, collaboration tools, and approaches is included in WWF's resource book *Stakeholder Collaboration: Building Bridges for Conservation*, available upon request from erbcinfo@wwfus.org.

ANNEX II: MATRIX FOR RANKING IMPORTANCE OF THREATS TO BIODIVERSITY

One can construct a matrix to rank the relative importance of threats to biodiversity features in the ecoregion. In this matrix features that fall in category 1 would deserve highest priority in terms of assessing opportunities for action, while those ranked 4 and 5 would be of very low priority. (One can readily incorporate into this table an analysis for ranking opportunities for biodiversity gain.)* Ecoregions will vary greatly in terms of how detailed and complex they make this type of threat analysis, depending on the number and complexity of priority biodiversity features and diversity of threats in the ecoregion. In many, if not most, cases more than one threat will be acting on a single biodiversity priority, and a single type of threat may be affecting multiple biodiversity priorities.

Severity of threat → Biodiversity feature ↓	High	Moderate	Low
Highest Priority	1	2	3
High Priority	2	3	4
Moderate Priority	3	4	5

This matrix can be based on varying degrees of underlying data about threats, depending on the amount of spatially explicit information available for an ecoregion. In cases where such information is readily available, it would be useful to obtain or develop maps that show the 4–5 large-scale threats that are recognized as having the most significant impacts on high priority biodiversity features at the ecoregion level. This in turn will inform selection of those unique and priority landscape units for which biodiversity goals and targets are set.

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*Though somewhat an artificial distinction, it may be useful to think of basically two types of interventions: 1) those that abate or eliminate threats to biodiversity; and 2) those that result in net gains for biodiversity. For example, an action that reduces excessive logging pressure on an important forest is abating a threat. In contrast, a high-priority area that is losing people and thus is undergoing restoration of its natural vegetative cover may present the opportunity for organizations to support policies favoring the emigration and to accelerate the restoration process.

ANNEX III: USING SOCIOECONOMIC VALUES TO HELP SHAPE A BIODIVERSITY VISION

The vision process in the Southwest Amazon moved from the delineation of subregions (using climate variability within the ecoregion, e.g., rainfall and temperature), to landscape units (using soils and vergetation types), to unique landscape units (i.e., unique combination of climate, soils, and vegetation). The vision goals of representation were established for unique landscape units, while large intact habitat blocks and connectivity were mainly considered at the ecoregion level. Socioeconomic variables were also incorporated into the development of the biodiversity vision. These variables included roads, population centers, deforested areas, indigenous reserves, and forestry concessions. These and other variables were included in the analysis as data layers.

In order to nominate areas for the creation of protected areas (IUCN I-II), the ecoregion team assessed the conservation potential of each site. This potential was assessed by considering the following criteria and applying positive and negative values in each case.

- Remoteness of the priority areas (positive)
- Proximity to protected areas (positive) and clearings (negative)
- Proximity to roads (negative)
- Proximity to population centers (negative)
- Proximity to areas of conflict and/or land tenure issues (negative)

When nominated areas proposed by the ecoregion team coincided with areas independently nominated by governments, these were given a positive value. When the nominated areas coincided with indigenous territories they were not included because of the potential for conflict. Forestry areas were considered positive in terms of the biodiversity analysis based on the assumption that they operate under close canopy and sustainable management.

The identification of roads, population centers, and land tenure issues (which are often reflected in land use patterns) allowed the ecoregion team to identify those areas where threats are absent and it is therefore likely that they can realize conservation goals and targets for the ecoregion (due to the absence of threats).

ANNEX IV: MONITORING AND EVALUATION

The pressure–state–response (PSR) model can be an effective learning tool for ecoregion conservation. The three variables in the PSR model are pressure, state and response.

The ***pressure variable*** is what describes the underlying cause of the threat. The pressure may be an existing problem (e.g., soil erosion in cultivated uplands, increased sewage due to beach tourism) or it may be the result of a new project or investment (e.g., air pollution from a new thermal plant, loss of mangrove forest from port development). Whatever the cause, pressures affect the state of the environment and elicit responses to address these issues. To cite an example from the Gulf of California, studies reveal that use of inappropriate fishing gear exerts significant pressure on marine mammals. Use of such gear then becomes the pressure in the PSR model.

The ***state variable*** usually describes some physical, measurable characteristic of the environment. In the context of ecoregion conservation, it usually refers to those biodiversity features that we would like to conserve in an ecoregion. In the case of target populations of marine mammals in the Gulf of California defining state indicators is fairly straightforward, although we need sufficient information about these populations to determine target levels at which they can be sustained. These targets can then become an explicit part of our biodiversity vision. Many components of biodiversity are measurable, and often on a regular basis using satellite imagery or population indices. Careful selection of biodiversity indicators to be monitored is crucial for tracking the state of biodiversity in an ecoregion.

The ***response variables*** are the policies, investments, or other actions introduced to improve the state, either by acting directly on it or by reducing negative pressures (or increasing positive ones). In the case of the Gulf of California socioeconomic analysis could reveal a range of strategies to diminish the pressure on marine mammals, such as outlawing current fishing gear or creating economic incentives for fishermen to change their gear. Upon selecting one option, its effectiveness in diminishing the pressure and stress it causes on marine mammals then becomes the response.

Changes in stakeholder behavior that lead to an increase in desired responses (such as the adoption of fishing gear that reduces by-catch) should lead to reduced stress (such as reduced by-catch of aquatic mammals), which should result in positive effects on the state. But these are assumptions that must be tested over time.

See pages 15–16 for an example of how the PSR model can be applied to an ecoregion (in this case, the Gulf of California).

Pressure-State-Response Model for the Gulf of California

PROJECT/ ISSUE	GOAL	PRESSURE INDICATORS	STATE INDICATORS	RESPONSE INDICATORS
FISHING PRACTICES: SHRIMP BOTTOM TRAWLERS	Maintain and improve population, diversity, and size of benthic species	• Area trawled (km^2) in shrimping grounds • Trawlable area under use (percent)	• Relative bycatch species abundance (tons or populations) • Size of bycatch (cm) • Bycatch/shrimp catch ratio (tons bycatch per year/tons shrimp catch per year)	• Number of permits or other restrictions • Use and effeciency of bycatch reduction technology • Reduction of trawling effort (percent of 2000 level) • Area of exclusion zones (km^2) • Market price of shrimp ($/kg) and percent exported
FISHING PRACTICES: ARTISINAL FISHERIES	Sustainable use of marine resources by artisinal fisheries	• Number of boats and number and type of fishing gear • Intensity of fishing effort by location • Bycatch of marine mammals (number/year) • Price of target species, e.g. shark fin, sea cucumber, lobster, scallops, jaiba, at market ($/kg)	• Stock of target species, e.g., snapper, octopus, swimming crab, shrimp, etc (tons or populations) • Age structure of populations (life tables of 3-4 target species)	• Evidence of out-of-season fishing • Number of fishing concessions • Fish certified (tons and percent of production) by species • Area of no-fishing zones (km^2) • Number of permits per location per fishery • Number of products per fishery • Number of staff, budget, and technical capacity of regional fisheries authorities
FISHING PRACTICES: OTHER COMMERCIAL FISHERIES	Sustainable use of marine resources by commercial fisheries	• Size of sardine catch (tons/year) • Size of squid catch (tons/year)	• Stocks of sardine (tons) • Stocks of squid (tons)	
FISHING PRACTICES: SPORTS FISHING	Sustainable use of marine resources by sports fishers	• Size of sailfish and marlin catch (number or tons/year) • Number of trips (per year per state/location)	• Abundance of sports fishing species, especially marlin and sailfish (population or tons) • Size of fish caught (cm)	• Reports from sport fishers (number/year)

Pressure-State-Response Model for the Gulf of California (cont.)				
PROJECT/ ISSUE	GOAL	PRESSURE INDICATORS	STATE INDICATORS	RESPONSE INDICATORS
CONSERVE REGIONAL WETLANDS	Conservation of critical habitat and freshwater inflows to maintain ecological processes	• Conversion of wetlands to shrimp aquaculture, marinas, etc. (ha/year and total area) • Pollution/water quality, e.g., industrial effluent, agricultural runoff, organic compounds (BCOD), heavy metals or inorganics (mg/l) • Freshwater withdrawals for human purposes (km^3/year) and inflow to Gulf (km^3/year) by catchment area • Number of households using mangrove wood	• Area, fragmentation, and isolatedness of mangroves (hectares and fragmentation index) • Area of other coastal ecosystems, e.g., mud flats, coastal lagoons, wetland vegetation, estuarine habitat, etc. (hectares) • Mangrove quality (tree species diversity) • Abundance of waterfowl and shorebirds (populations or breeding pairs) • Presence of larvae of breeding fish and other key species (e.g., *Leptocephalus* sp.) • Presence of corvin breeding near estuaries	• Area under active management regime (hectares and percent of original area) • Capacity of responsible agencies (number of staff, finding and technical capacity) • Level of public participation in management planning • Freshwater flow assigned to environmental use (percent of total flow) per catchment area • Freshwater allocation for human use (percent of total flow) per catchment area
MANAGEMENT CAPACITY FOR PROTECTED AREAS	Maintain healthy island ecosystems, including terrestrial and marine components	• Fishing pressure (number of fishing boats) • Presence of exotic species (rodents, cats, goats, buffel grass)	• Abundance of key species, e.g., sea lions, sea birds, especially endemics (populations, breeding pairs) • Composition of benthic biota (populations) • Presence of sea bass larvae • Aggregation of reproductive fish (presence /absence)	• Establishment of marine protected areas • Management plan implementation (e.g., eradication programmes) • Management capacity (number of staff, equipment, mandate/authority, funding) • Public support for MPAs
CETACEAN CONSERVATION AND AWARENESS	Maintain Gulf of California as globally-critical cetacean habitat	• Squid catch (tons/year) • Red tides (number/year)	• Abundance of selected whale and dolphin species, especially top predators (populations)	• Number employees and revenue of whale-watching industry ($/year)
	Maintain viable vaquita population	• Vaquita bycatch (number/year)	• Abundance of vaquita (populations)	• Fraction of range protected (percent of total) • Proportion of fishing boats with excluder devices (percent fishing within vaquita range)

ANNEX V: THE DRIVER–STATE–IMPACT–RESPONSE MODEL FOR MONITORING AND EVALUATION

Another model for M&E is the "Driver–State–Impact–Response" model (DSIR). The terms of this model (a variation on the PSR model) are defined as follows:

- *Drivers* (or driving forces) create or act on stresses that directly affect biodiversity. Drivers can either increase or decrease stress. Examples of drivers creating stress are industrial activities that lead to environmental pollution and increased rates of road building and human immigration into intact habitats. Examples of drivers working to decrease stress are government policies to improve management of parks or a conservation organization's decision to reintroduce an extirpated species.

- *State* refers to those features of biodiversity identified as important in the biodiversity vision. A key task is to determine if and to what extent changes in biodiversity are a consequence of changes in the drivers and resulting stresses we have identified as important.

- *Impact* is a measure of how biodiversity (the "state") affects the welfare of society both within and beyond the ecoregion in both monetary and non-monetary terms. Impacts may be positive (e.g., revenues from fisheries) or negative (e.g., illness from pollution). Monitoring will track the natural capital of biodiversity and ecological processes, and its flow of products and services. Where possible, these values will be calculated in monetary terms. Many values, such as human health and the aesthetic and spiritual value of biodiversity, cannot and should not be reduced to only monetary measures and thus other indices will be needed. As such, this account may be divided into a monetary ledger and social (non-monetary) ledger.

- *Response* refers to how key segments of society (e.g., government agencies, social and economic drivers, WWF, and other nonprofits) are responding to the state and associated impact variables. To judge if and to what extent ERBC efforts are making a difference, M&E must be able to differentiate between ecoregion conservation-induced changes in drivers and changes brought about by other factors.

Criteria for Selecting Indicators under the DSIR model

Drivers—at least one indicator for each key driver and the stress it creates that:
- enables differentiation between changes brought about by ecoregion conservation interventions (one form of societal response) and those caused by other societal responses.
- is sufficiently sensitive to provide an early indication of positive or negative change.
- can provide a continuous assessment over a wide range of change.
- is easy and cost-effective to measure, collect, and/or calculate.

State—indicators that are:

- relevant, within context of each ecoregion's biodiversity vision, to the four primary goals of biodiversity conservation—representation, viable populations of all species, ecological and evolutionary processes, large intact habitats.
- able to differentiate between natural changes and human-induced changes.
- selected based on expected linkage to socioeconomic drivers (i.e., able to evaluate predicted cause-and-effect relationship between drivers and biodiversity).
- sufficiently sensitive to provide an early indication of positive or negative change.
- capable of providing a continuous assessment over a wide range of change.
- easy and cost-effective to measure, collect, assay, and/or calculate.

Impact—socioeconomic values of biodiversity that are:

- focused on natural capital, goods and services based on biodiversity and ecological processes.
- capable of tracking both use (e.g., consumptive, non-consumptive, functional benefits, option value) and non-use values (e.g., existence value, bequest value).
- capable of tracking both monetary values and nonmonetary measures of human wellbeing that depend on biodiversity and ecological processes in the ecoregion (e.g., nutrition and health, maintenance of cultural traditions that depend on native biodiversity).
- sufficiently sensitive to provide an early indication of positive or negative change.
- capable of providing a continuous assessment over a wide range of change.
- easy and cost-effective to measure, collect, and/or calculate.

Response—indicators that:

- measure the impact of interventions by WWF and its partners (as a matter of priority).
- track the actions of other influential stakeholders (e.g., major government land-use policy players).
- are easy and cost-effective to measure, collect, and/or calculate.

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