A Resilience-based Framework for Evaluating Adaptive Co-management of the Sea Urchin Fisheries in Barbados and St. Lucia

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ABSTRACT

In Barbados and St. Lucia the management of the fishery for the white sea urchin (*Tripneustes ventricosus),* commonly referred to as sea egg, has proven problematic for many years. High cultural and economic values are placed on this fishery. High value in addition to the sedentary nature of these organisms, and their preference for shallow nearshore habitats, make sea urchins attractive for harvest and vulnerable to over exploitation. Several attempts at co-management have not yet yielded entirely successful outcomes. Perhaps what first needs to be done is to review these attempts, identify their faults and correct them. Attempting an entirely new approach which involves stakeholders in management decisions and focuses on learning by doing in situations of uncertainty may also contribute to a solution. This new approach, referred to as adaptive co-management, can be tailored to specific places and situations, engaging various organizations at different scales. This paper reports upon graduate research that aims to develop a modified version of the resilience-based framework of Plummer and Armitage (2007) for evaluating adaptive co-management. Changes made to the framework attempt to simplify the language, adapt it to the Barbadian and St. Lucia sea urchin fishery situation and provide a comprehensive way for resource managers with similar circumstances to evaluate the potential for developing adaptive co-management. Field methods for operationalizing the framework are presented. Recommendations are made to suggest ways in which the framework may be used as a basis for comparison across the Eastern Caribbean.

KEY WORDS: Adaptive co-management, resilience, white sea urchin, Barbados, St. Lucia

Marco Basado en Resiliencia para la Evaluacion del Manejo Adaptativo Colaborativo del Erizo de Mar de Barbados y St. Lucia

En Barbados y St. Lucia el manejo de la pesquería de erizo de mar (*Tripneustes ventricosus)* conocido vulgarmente como huevo de mar, durante muchos años ha sido problemático. Esta pesquería posee altos valores culturales y económicos. Este alto valor aunado a la naturaleza sedentaria de estos organismos, y su preferencia para hábitats de aguas bajas cercanas a la orilla y, hacen que el erizo de mar sea atractivo para cosechar y vulnerable a la sobrexplotación. Los resultados de varios intentos de co-manejo realizados no han probado ser completamente exitosos. Probablemente es necesario iniciar haciendo una revisión de estos intentos, identificar sus fallas y corregirlos. Intentar un enfoque totalmente diferente que involucre a las personas de interés (stakeholders) en las decisiones de manejo y enfocándose en aprender haciendo en situaciones inciertas podrían contribuir a la solución. Este nuevo enfoque, conocido como manejo adaptativo colaborativo, puede ser estructurado para lugares y situaciones especificas involucrando a varias organizaciones en diferentes escalas. Este escrito informa sobre investigación de posgrado que busca como desarrollar una versión del marco basado en resiliencia de Plummer y Armitage (2007) para evaluar el manejo adaptativo colaborativo. Los cambios efectuados al marco intentan simplificar el lenguaje, adaptarlo a la situación de la pesquería de erizos de mar en Barbados y St. Lucia y proveer una manera comprensiva para que los manejadores de recursos con situaciones similares evalúen el potencial para desarrollar manejo adaptativo colaborativo. Se presentan los métodos de campo para operacionalizar el cuadro. Las recomendaciones sugieren maneras en que el marco puede ser utilizado como base para comparaciones alrededor del Caribe Oriental.

PALABRAS CLAVES: Co-manejo adaptativo, resiliencia, erizo de mar, Barbados

Une Résilience Basée sur un Cadre pour Évaluer la Co-direction Adaptative de la Pêcherie D'oursins de Mer a la Barbade

A la Barbade, la gestion de la pêche de l'oursin blanc (*Tripneustes ventricosus*), communément appelé oeuf de mer, s'est avérée problématique pendant de nombreuses années. De grandes valeurs culturelles et économiques sont placées sur cette pêcherie. De grande valeur ajoutée à une nature sédentaire de ces organismes, et leur préférence pour les habitats côtiers peu profonds, rend les oursins attrayant pour les récoltes et vulnérables à une surexploitation. Plusieurs tentatives de co-gestion n'ont pas encore donné de résultats entièrement satisfaisants. Peut-être ce qui doit d'abord être fait est d'examiner ces tentatives, identifier leurs failles et les corriger. Tenter une approche entièrement nouvelle qui implique les parties prenantes dans les décisions de gestion et met l'accent sur l'apprentissage par la pratique dans des situations d'incertitude pourrait également contribuer à une solution. Cette nouvelle approche, dénommée co-gestion adaptative, peut être adaptée à des endroits et des situations spécifiques, engageant des organismes divers à différentes échelles. Ce document rend compte de la recherche universitaire qui vise à développer une version modifiée du cadre axé sur la résilience de Plummer et Armitage (2007) pour l'évaluation de la co-gestion adaptative. Les modifications apportées à la tentative de cadre à simplifier le langage, l'adapter à la situation de la pêcherie d'oursins de mer de la Barbade et de fournir une étude complète pour les gestionnaires des ressources avec des situations similaires, afin d'évaluer le potentiel de développement d'une co-gestion adaptative. Des méthodes de terrain pour l'opérationnalisation du cadre sont présentées. Des recommandations sont faites pour suggérer des manières dont le cadre peut être utilisé comme base de comparaison à travers les Caraïbes orientales.

MOTS CLÉS: Co-gestion adaptative, résilience, oursin blanc de mer, Barbade

INTRODUCTION

The management of the highly valued sea urchin fisheries in Barbados and St. Lucia face many challenges. Some of these challenges include heavy fishing pressure, illegal harvesting and the occurrence of natural disasters. These factors in addition to unavoidable fluctuating population levels from year to year have prompted the employment of various management approaches. Management strategies employed include closed seasons, gear restrictions and, in the case of St. Lucia only, size limits.

Other approaches attempted to involve resource users in a participatory arrangement referred to as co-management. This term is defined simply as "the sharing of power and responsibility between government and local resource users" (Berkes *et al.* 1991). Co-management seeks to eliminate the top down approach to management and allow multiple perspectives from all involved. This arrangement, although potentially very useful, has not yielded entirely successful outcomes. What seems to be lacking includes learning how to deal with uncertainty. This deficiency may be reduced through adaptive co-management.

Adaptive co-management (ACM), an emerging concept and practice, represents a potential innovation in natural resource governance under conditions of change, uncertainty and complexity (Plummer and Armitage 2007). Folke *et al.* (2002) define this concept as "a process by which institutional arrangements and ecological knowledge are tested and revised in a dynamic, on-going, self organized process of learning-by-doing." Key features of ACM include a focus on learning-by-doing, integration of different knowledge systems, collaboration and power sharing among community, national and regional levels, and management flexibility (Olsson *et al.* 2004). These attributes give rise to a more effective approach of resource governance which has the potential of fostering more robust social-ecological ecosystems.

Although ACM may be an effective approach, there is not yet much supporting evidence from consistent application, monitoring and evaluation. In addition, there have been recent critiques regarding the likelihood of beneficial ACM outcomes. Partly to address these issues, Plummer and Armitage (2007) developed a resilience-based evaluative framework for ACM. They state that the framework is intended to facilitate systematic learning from experience and encourage cross-site comparisons.

While the development of an evaluative framework is a step in the right direction, modifications may need to be made in order to adapt it to the variety of situations to be evaluated. In addition, the academic language used in constructing and explaining the framework in Plummer and Armitage (2007) needs to be modified to encourage resource managers and other stakeholders to employ the framework if practical and participatory application is intended.

The following discourse outlines a modification to the resilience-based framework for evaluating ACM that can be used for the sea urchin fisheries in Barbados and St. Lucia. The paper highlights changes made to the original framework and the main reasons behind those changes. In addition, field methods for operationalizing the evaluative framework are presented in an integrated package suitable for applied interdisciplinary research on these small-scale fisheries.

ORIGINAL EVALUATIVE FRAMEWORK

The original framework (Figure 1) is positioned within the complex adaptive system worldview through the lens of resilience. It proposes factors for the components of ecological sustainability, livelihoods and process. The factors in the framework are meant to be forward looking rather than oriented to measures of the current state or condition of the system. In addition, the factors were chosen to facilitate systematic learning from experience and promote cross site comparison. It is anticipated that the assessment of these factors will assist with the evaluation of performance and outcomes of the system.

This framework is scale-specific and emerges from a local perspective. According to Plummer and Armitage (2007) it is not necessary to have a comprehensive framework for sustainability evaluation or a framework to evaluate large-scale regional processes. Rather the framework starts from the perspective of more specific co-management cases where the focus of concern is typically a relatively well defined resource such as a fishery.

As seen in Figure 1, there are three focal components for evaluation in adaptive co-management processes: an ecological component, a livelihoods component approached using the sustainable livelihoods approach (SLA) framework, and a process component that draws attention to the role of institutions and power. These components are introduced below.

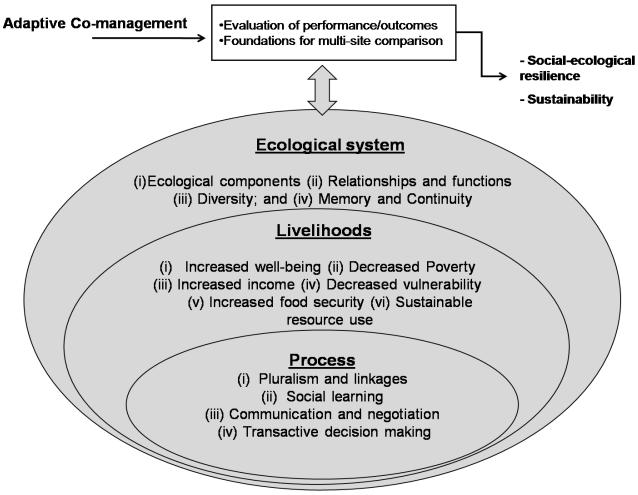

Figure 1. Adaptive co-management evaluative framework (Source: Plummer and Armitage 2007)

Ecological System

The ecological component is placed within the framework to reinforce the measurement of beneficial ecological outcomes as a key component of ACM evaluation. Directing the focus of ACM evaluation towards ecological outcomes poses a particular challenge given the state of knowledge of most ecosystems. Evaluation efforts should be directed, therefore, at identifying those ecological attributes and functions that are of particular importance in the specific system in recognition of the time and resources constraints faced by most resource managers and other stakeholders (Plummer and Armitage 2007).

The factors under this component were chosen based on the need to ensure that ACM processes maintain or build resilience. In addition, they appear useful in terms of framing the evaluation focus of ACM. The factors were sourced from Cummings *et al*. (2005). This paper uses resilience to examine key dimensions of complexity and change, and suggests that the resilience of a given system is dependant on four elements, which they recommend as the four factors to be assessed.

The first factor 'ecological components' can be used to identify the components that make up the system such as specific habitats/ecosystem types, temporal and spatial distribution of the sea urchins, species (e.g. consumers and producers), and hydrological and biophysical features (e.g. currents, geomorphology etc).

The second factor, 'relationships between components and their functions' refers to nutrient cycles (pollution), food webs (harvest pressure and predation), and trophic interactions which link organisms to one another and their hydrological and biophysical environment.

The third factor 'diversity' seeks to determine biological diversity (which is the key source of renewal in the system) and response diversity (the diversity of responses to environmental change among species contributing to the same ecosystem function).

The final factor 'memory and continuity' in the framework by Plummer and Armitage (2007) provides a surrogate for the ability of the system to maintain itself through time and space.

Livelihoods

A livelihood can be defined simply as a means of support. It can also be defined as the set of strategies employed by an individual and households to make or gain a living, as determined by capabilities, tangible and intangible assets (Chambers and Conway 1991). Livelihoods are shaped by factors which generate both internal and external forces upon individuals engaged in ACM. This component was included in the framework based on the assumption that individuals will pursue a range of livelihood outcomes, including income generation, vulnerability reduction, health, and well-being if resources are well managed.

The livelihoods component utilizes the SLA as a sub-framework. The SLA framework emerged in the 1990s in response to the failure of development interventions to appropriately conceptualize the cross scale and complex economic, social, ecological and behavioural choices confronting predominately rural, agricultural producers (Chambers and Conway 1991, Scoones 1998, Carney 1998). Since then the SLA has been adopted by a range of development actors including banks and development agencies and provide a reasonably coherent framework for evaluating linked economic-social outcomes associated with ACM.

As outlined by Farrington *et al.* (1999), the sustainable livelihoods framework provides an analytical structure that is useful in reconciling complexity and interconnections among economic–social outcomes and governance interventions such as adaptive co-management. In the context of this framework, the SLA is used to identify factors to evaluate adaptive co-management outcomes concerning economic benefits and incentives, and rationality in the choice of economic or livelihood strategies.

There are some criticisms of the livelihood approach (Ellis 2000) as currently applied in the field. Some of these criticisms indicate that the approach is too broad and encompassing to be meaningful for understanding key components and processes in specific locations (Farrington *et al.* 1999, Longley and Maxwell 2003).

Despite the limitations, Farrington *et al.* (1999) note that the sustainable livelihood approach can be used not only for project and programme design, but for monitoring, review and evaluation purposes as well. A fundamental challenge for evaluating the livelihoods outcomes of ACM is to recognize that access to particular livelihoods in particular instances is bound up by property relations and rights, and configurations of power (Plummer and Armitage 2007). Thus, the notion of endowments and entitlements in the livelihood context (Leach *et al.* 1999), draws attention to the need to link adaptive co-management evaluation to social relations, institutions, and organizations, each of which have specific meanings and connotations (see North 1990, Ellis 2000).

The framework provides six overarching factors (see Figure 1) and examples of secondary factors to consider when examining livelihood outcomes associated with ACM. The examples of secondary factors include livelihood assets, vulnerability context and policies, institutions and processes. Understanding the outcomes of ACM in either single or multi-case contexts will require attention to broad economic insights highlighted in the livelihood approach, allowing for the elaboration of detailed criteria and indicators to suit specific places (Plummer and Armitage 2007).

Process

The factors under the process component were formulated by first distinguishing ACM from the many other potential forms of management. Specificity is

important because if evaluation is to be meaningful it must appraise reality against intended goals and or outcomes (Conley and Moote 2003). An alternative approach contended by Carlsson and Berkes (2005) is to start from the assumption that co-management is a continuous problem solving process rather than a fixed state, involving extensive deliberation, negotiation and joint learning with problem solving networks.

The factors (see Figure 1) placed under the process component were the four most important characteristics of ACM gathered from the literature. These characteristics distinguish ACM both structurally and functionally from other forms of collaborative management. They were selected taking into account the centrality of collaboration to co-management as well as social learning specifically in ACM.

Plummer and Armitage (2007) suggested using the cooperative natural resource management assessment framework to permit methodical consideration of contextual factors. The framework suggest that five elements namely context, conditions, representation, power and process should be assessed in order to determine the nature of the arrangement. Although this framework will assist in describing co-management as a formal arrangement it neglects the functional side of co-management and the conditions of ACM.

Examples of secondary factors of concern are given in Plummer and Armitage (2007) which will help in the evaluation of the process component. They provide requirements which would give rise to the factors being evaluated. Evaluating these factors will identify any discrepancies within any ACM system. When these inconsistencies are recognized, then the necessary actions can be taken to rectify the situation.

MODIFIED FRAMEWORK

The modified evaluative framework adapted for use in current graduate research was developed with the intention of evaluating the potential for ACM in the sea urchin fisheries in Barbados and St. Lucia. Modifications made (see Figure 2) in an attempt to simplify the language used, adapt it to the Barbadian and St. Lucian situations and suggest ways for operationalizing the framework which had not yet been field-tested. The changes also intend to provide a comprehensive way for resource managers with similar situations beyond these two study sites to evaluate the potential for developing ACM.

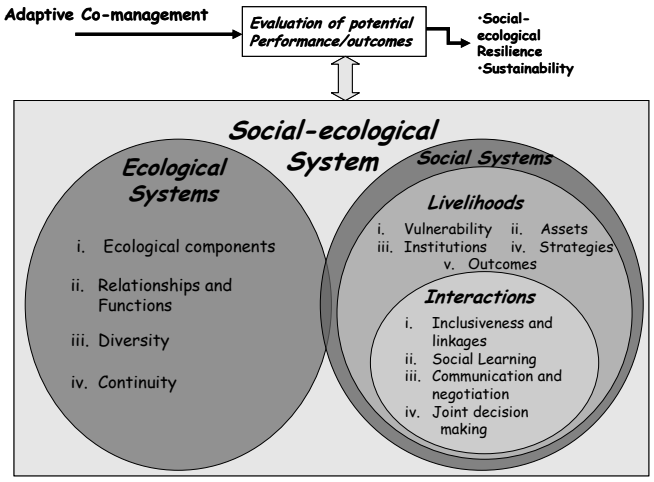

Figure 2. Modified evaluative framework for adaptive co-management

The proposed factors are placed under three components namely ecological systems, livelihoods and interactions. The last component was renamed to clarify the part of the process being evaluated.

Ecological System

All the factors under the ecological component remain the same except 'memory and continuity' which was reduced just to continuity. This modification was made because in order to measure ecological memory for the system being evaluated an in depth genetic analysis will be required. Due to time constraints associated with the graduate research this factor will not be assessed.

In the modified framework only biological diversity will be assessed, since the measurement of response diversity is not within the scope of feasible research. However, it may be possible to include information on possible climate change impacts, for example, from available literature.

Livelihoods

In the context of this modified framework, the SLA is used to identify factors to evaluate ACM outcomes concerning economic benefits and incentives, and rationality in the choice of economic or livelihood strategies. The factors in the livelihood component in the original framework have been replaced by the five main components of the SLA framework to foster a comprehensive analysis. These five factors are explained in more detail below.

The first factor, vulnerability forms the external environment in which people exist and gain importance through direct impacts upon people's asset status (Devereux 2001). It comprises trends (i.e. demographic trends; resource trends; trends in governance), shocks (i.e. human, livestock or crop health shocks, natural hazards, like floods or earthquakes, economic shocks, conflicts in form of national or international wars), and seasonality (i.e. seasonality of prices, products or employment opportunities) and represents the part of the framework that lies

furthest outside stakeholder's control (Kollmair and St. Gamper 2002).

An accurate and realistic understanding of individual's assets is crucial to analyse how they endeavour to convert their assets into positive livelihood outcomes (Bebbington 1999). People require a range of assets (which include human, social, natural, physical and financial capital) to achieve their goals, whereas no single capital endowment is sufficient to yield the desired outcomes on its own. For this reason, it is important to determine assets and determine the particular combination of capital. It is also informative to assess if the combination changes after a perturbation such as a moratorium on fishing (extended closed fishery). In addition, evaluating the potential for substitution between different capitals, for instance a replacement of a lack of financial capital through a better endowment with social capital, would also assist in explaining sustainable livelihoods.

The third factor 'institutions' refers to the mechanisms of social order and cooperation that govern the behaviour of a set of individuals. They are responsible for shaping livelihoods and are of central importance at all levels. In addition, institutions effectively determine access, terms of exchange between different types of capital, and returns to any given livelihood strategy (Shankland 2000, Keeley 2001).

Livelihood strategies comprise the range and combination of activities and choices that people undertake in order to achieve their livelihood goals. They have to be understood as a dynamic process in which people combine activities to meet their various needs at different times.

Livelihood outcomes are the achievements of livelihood strategies, such as more income (e.g. cash), increased well-being (e.g. non material goods, like self-esteem, health status, access to services, sense of inclusion), reduced vulnerability (e.g. better resilience through increase in asset status), improved food security (e.g. increase in financial capital in order to buy food), and a more sustainable use of natural resources (e.g. appropriate property rights).

Interactions

The final component has been renamed 'interactions' and the factors have been renamed to assist understanding. The factors (see Figure 2) chosen for this last component are four of the most important conditions thought to favour successful ACM. The factors are explained in further detail below.

Inclusiveness refers to the inclusion of all the stakeholders into the ACM system which results in better representation of the diversity of interests and multiple perspectives on the problem domain. Linkages refer to connections across multiple scales and levels (local, regional etc). However, this research only looks at connections at the local to national scales.

Social learning involves shared actions (e.g. experiments, surveys) being undertaken by decision makers and resource users and active questioning of the governing norms and protocol in which values and polices are embedded.

Communication and negotiation refers to the extent to which there is dialogue between actors which builds consideration and appreciation. This results in the development of shared understanding.

Joint decision making entails decisions being reached through dialogue which contains diverse inputs from all actors involved. Throughout decision making, equity and efficiency is promoted by allowing the use of multiple types of information accepted via multiple systems of knowledge. This factor previously referred to as 'transactive decision making' in Plummer and Armitage (2007) was renamed in the modified framework for simplicity.

OPERATIONALIZING THE FRAMEWORK

The original framework did not suggest ways for making the framework operational. Instead, it provided other generic outcome factors which may assist in evaluating the main factors. Until now, no one has attempted to field test this framework. For this reason, the framework and methods used to apply it may be adjusted occasionally with the intention of producing the most comprehensible method of evaluation. In order for resource managers to employ this framework it is important that the format is also comprehensive. Resource managers, especially those managing small scale fisheries in the Eastern Caribbean, have a preference for clear and concise methods due to the occurrence of time constraints and lack of resources. The following discourse provides methods which may be used to operationalize the framework.

Ecological Systems

Methods for evaluating the first component may include an extensive review of literature describing the ecological components, relationships between components, biological and response diversity; and the response of the fisheries after a disturbance. Traditional and local knowledge is also an important source of information. Fishers and other persons involved in the fisheries that possess and wish to share ecological knowledge can be interviewed.

Geographic Information Systems (GIS) can be employed as a tool to visualise ecological information in a simplified and interactive way. This method can foster rich discussion among stakeholder ensuring that multiple interests are represented. Presenting data in a comprehensive form will allow all types of stakeholders to understand the scientific information. A clear understanding of scientific information is a starting point in the process of joint decision making. In the case of Barbados and St. Lucia, GIS will be used to map the distribution of the sea urchins, the habitat that they favour and their proximity to

the communities being studied. This method would assist with easy identification of ecological components that make up the system. In addition, it will aid in the calculation of the habitat favoured by the sea urchins in the study sites so that accurate population estimates can be made.

The option of using Google earth to make the resulting information interactive can be explored. Having such a resource available can expose younger generations to the importance of fisheries management.

Another method which may be used to evaluate the ecological component is social network analysis (SNA). Mapping networks featuring individuals as actors and possession of ecological knowledge as the relationship between them will reveal how knowledge is disseminated and may even explain how misconceptions originate.

Livelihoods

The livelihood component can be evaluated by analyzing the livelihoods of the resource users using in-depth interviews designed with the intention of capturing information pertaining to the factors outlined earlier. Other methods such as time use analyses, seasonal calendars and focus groups will be used to supplement the information gathered from the questionnaires.

Interactions

The main methods that can be employed to evaluate this component are co-management institutional analysis and SNA. This method examines the structure of social relationships in a group to uncover the formal and informal connections between people. These relationships are often ones of communication, trust, awareness, decision making, hierarchical links, and the flow of money. In a social network the nodes represent people and groups while the links show relationships or flows between the nodes (Ehrlich and Carboni 2005).

In the case of the sea urchin fisheries In Barbados and St. Lucia, social networks will be constructed with those actors and relations associated with the factor being measured. In most cases these are the persons and organizations who participate in management and problem solving activities. The construction of these social networks involves identifying the actors from stakeholder consultations in the traditional fishing areas and structured interviews at respective agencies. Determining the relationships between actors requires using a questionnaire to quantify the extent in which the actors are connected.

For example, when evaluating the factor 'communication and negotiation' a social network can be constructed using the stakeholders in the sea urchin fisheries as the actors and frequent dialogue as the relations. Other relationships between actors may include communication, trust, awareness, decision making, hierarchical links and the flow of money. The analysis will include drawing network maps to visualize the relationships and focusing on properties of networks such as density and centrality.

CONCLUSION

The modified framework is a valuable tool for evaluation of an ACM initiative because it takes into consideration the conditions which determine the success of such an initiative. For this reason, a modified framework fitted to the Eastern Caribbean situation will be used in graduate research. It is expected that the evaluative framework will provide a basis for consistent comparison across the Eastern Caribbean. The possibilities of initiating an evaluative mechanism adapted to the Eastern Caribbean situation will provide an innovative management strategy which can ensure that the needs of future generations are met by influencing how decisions are made.

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