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# **Co-management and adaptive co-management: two modes of governance in a Honduran marine protected area**

## **Abstract**

Selecting the best mode of governance for marine protected areas (MPAs) especially in developing countries has generated considerable controversy in the academic and policy literature during the last 20 years. In this article, two modes – co-management (CM) and adaptive co-management (ACM) – are analysed in detail, and an examination is made of an attempt to put these modes sequentially into practice in the first (2003-2009) and second (2008-2013) management plans, respectively, of the Cayos Cochinos MPA (CCMPA) in Honduras. Extensive fieldwork was carried out during 2006-2010 in three communities dependent on the CCMPA (Rio Esteban, Nueva Armenia, and Chachahuat) including key informant interviews, focus group meetings, household surveys, and participant observation. The paper's findings are (1) that while the first plan implemented some CM principles (such as sharing responsibility between government, stakeholders and NGOs) it failed to deliver other CM principles (such as transparency and accountability); and (2) that while the second plan increased participation and transparency, and used a more adaptive approach, it still left many stakeholders out of the decision-making process, and its processes of experimentation, monitoring and social learning were very limited. The fact is that CM and ACM are laudable objectives, but very difficult to implement in full.

**Keywords:** co-management; adaptive management; adaptive co-management; marine protected area; Honduras; Cayos Cochinos MPA

## **1. Introduction**

Marine protected areas (MPAs) have become de rigueur throughout the world as the preferred policy solution to the highly publicized problems of overfishing and degradation of marine habitats especially in coastal areas [1]. There are now nearly 7,000 MPAs globally [2], but they vary considerably in their effectiveness, generating considerable controversy over the best way in which they can be managed. In recent years, two modes of governance have been much trumpeted – co-management (CM) and adaptive co-management (ACM). CM means sharing decision-making between government (whether national and/or local) and other stakeholders (which may include resource users, local communities, environmental non-governmental organizations (NGOs), and scientists). CM is advocated because it brings stakeholder participation and therefore legitimacy and accountability to management, and (hopefully) fairness and transparency [3]. However, even if CM meets these criteria of good governance, it may fail to achieve the goals of ecological health and socio-economic well-being because the decision-making processes are insufficiently flexible in their responses to ecosystem change. In other words, there is insufficient adaptive capacity in the decision-making system. The concept of ACM is designed to remedy this deficiency by adding the principle of adaptive management (AM) to the principle of CM. AM brings a realization that marine ecosystems are such complicated phenomena that we have to live with uncertainty rather than vainly try to remove it. This means a strategy of ‘learning by doing’, which involves experimentation with different measures to see what works and to adapt policy in the light of the lessons learned. So ACM is a hybrid approach which combines the value of AM with CM.

This article explains the concepts of CM, AM and ACM, which are then applied to the Cayos Cochinos MPA in Honduras, where the first management plan (2004-09) was based on the concept of CM, and the second management plan (2008-2013) was based on the concept of ACM. It was found that while both plans fell short of the ideals of their respective concepts, the second plan was an improvement on the first in that it enhanced the quality of governance and introduced an adaptive approach which led to improved local livelihoods, though the health of the ecosystem was more compromised. In the conclusion, four recommendations are made to strike a better balance between MPA objectives by enhancing the quality of ACM in both its CM and AM principles. But achieving such a balance is no easy task.

## **2. Modes of governance**

### **2.1 Co-management (CM)**

As a concept, CM originated in the 1970s [4], though as a practice it has existed for centuries [5]. CM has often been [re-]introduced in marine resource management when conventional or top-down management has failed [6] [7], but it also owes its [re-]emergence to the ‘hollowing out’ of the state since the 1980s and the hiving off of many governmental functions to decentralized bodies, the voluntary sector, and private enterprise [8]. In this process, the idea of stakeholder participation became ubiquitous and pervasive, and evidence of CM’s [re-]introduction can be found across the world [9]. CM is usually portrayed as a mixture of top-down and bottom-up elements [10], in which the top-down element is the state [11] - though in some instances NGOs take the place of the state [12] – and the bottom-up element may include community leaders, resource users [13], conservation groups, academics, consumers, citizens, and/or other stakeholders [14]. The balance between the top-down and bottom-up elements may be struck differently in different situations: Wilson et al [15] describe a

continuum of CM from the most top-down version ('instructive' CM) to the most bottom-up version ('delegated' CM), reflecting Pomeroy [16: p257]'s view that there is not a single "best" form of co-management'.

Writers who advocate CM refer to both its intrinsic value and its instrumental value [4]. Its intrinsic value lies in its endorsement of the right that people have to be involved in decisions that deeply affect their livelihoods [17]; in its empowering quality [18][19][20]; and in its reinforcement of self-esteem [21]. Its instrumental value lies in enhancement of the legitimacy of management [22][5]; improvement in transparency and accountability of decision-making [23]; greater compliance with rules [6]; more extensive knowledge base for decisions [24]; lower cost of obtaining data [25]; smoother dispute settlement processes [13]; increased social capital [26]; and greater awareness of environmental issues [20].

However, several writers point out that CM is not a silver bullet that will solve all the problems of marine resource management, but rather a process within which solutions are likely to emerge [27][14]. Whether or not CM has actually delivered such solutions is a matter of controversy, because the relevant information is sparse and ambiguous [12][28]. Whilst some writers claim that there is evidence of positive ecological and socio-economic effects of CM [19], others argue that there are very few examples of successful CM [16][21].

According to the literature, the success of CM depends on the coincidence of several factors. For example, there has to be a trigger, such as a resource crisis, to stimulate a shift towards CM [16]. CM also needs political will [14], both initially and in the long-term [30], and this entails a mindset shift especially among government officials [21][32]. Also, there must be an external agent, as well as local leaders, to guide the change to CM [20][31], and many writers claim that CM has to have a legislative basis [34][15]. Others point to the need for financial support to strengthen stakeholder capacity for taking part in decision-making [32], and a

significant degree of social capital is also required [26] including equity in the distribution of resources [27]. Consequently, CM may take a long time – perhaps a decade - to become established [18][33][22][10][14]. Where many of the above factors are not present, CM may not be practicable [22]: several writers assert that we cannot expect CM to work in every situation [4][20][19], and Pomeroy et al [32] listed seven factors which have impeded the application of CM in the Caribbean region: rigidity of management stances; poor leadership of fishers; limited solidarity in fishers' groups; lack of trust in government; little organizational skill of fishers; no property rights to natural resources; and stakeholders' dependency on government. Many of these factors are relevant to the CCMPA.

## 2.2 Adaptive management (AM)

The concept of adaptive management (AM) was conceived as an antidote to two assumptions of conventional top-down national management of natural resources – 1) that the ecosystem can be perfectly comprehended; and 2) that the ecosystem will respond predictably to management intervention to prevent its instability. Both assumptions are contested by writers who claim that we cannot control the ecosystem, and that any attempt to do so will reduce its natural resilience and undermine its stability [35]. The only rational course is to accept uncertainty as a permanent condition rather than see it as an obstacle to be overcome, and use an adaptive strategy to assist the ecosystem to maintain or recover its natural resilience as a means of coping with uncertainty [36][37][38]. Originating in the 1950s, the idea of AM was elaborated by Holling, Hilborn and Walters during the 1970s, and although it has been interpreted in many different ways, it seems to have several basic elements. It is founded on the notion of complexity of socio-ecological systems (SESs): they are too uncertain, and unpredictable ('chaotic') to be controlled by computer-modelled top-down management

regulations [39][40][41][42][43][44][45]. AM prescribes adapting to, rather than trying to manipulate, SESs [46]. Another basic element of AM is diversity, since a variety of resources is necessary for AM to draw on to respond to changes in the SES [47]. Not only diversity of biological or genetic resources, but also diversity of economic and social resources, as well as political and cultural diversity, are needed to help SESs deal with disturbances [48][49].

Resilience is also a foundation stone of AM [39], signifying the capacity of a SES to withstand fluctuation and still maintain its identity [35]. Resilience does not mean that the SES's identity lies in a single, fixed or steady-state equilibrium [50]. This is the assumption held by conventional top-down national management, which aims to keep the SES at this equilibrium point by removing any threat to its stability, but such a strategy is self-defeating because in forcing the SES into a straitjacket (e.g. by imposing the goal of maximum sustainable yield (MSY) on fisheries) it risks distorting the system and producing a disequilibrium of crisis proportions [35]. By contrast, AM seeks to manage change rather than resist it, and sees many possible equilibrium points, not just one [51], or even no steady state at all but only a perpetual oscillation [52]. Resilience may be interpreted in ecological, economic, social, or even political terms, raising the possibility that some forms of resilience may be achieved without others [47]. Resilience is not a purely technical term, but carries normative overtones: AM seeks to promote resilience in a SES because it is judged to be worth supporting [53][46], and if an SES is judged not to be worth supporting, AM would not promote it. For example, the resilience of an ecologically degrading or politically tyrannous system would not be promoted by AM [54].

The notion of the adaptive cycle is another basic element of AM. Notwithstanding the uncertainty surrounding SESs, it is possible to detect a four-stage pattern in the changes they

undergo: growth; consolidation; collapse; and reorganization [55]. For some writers, however, this pattern is more metaphorical than real [56][57], which raises the question of what practical purpose the cycle serves. Of more obvious practical use is the related notion of adaptive capacity, which signifies that the degree of resilience depends on the extent of the capacity of the SES to adapt to changes [58]. This capacity may be ecological (i.e. passive and internal to the SES) and/or socio-political (i.e. active and external to the SES [59]).

Perhaps the most well-known element of AM is learning by doing, which enjoins managers to regard their role as a continuous learning activity rather than a search for a definitive solution [60]. In this activity the place of systematic feedback is central, informing successive iterations of policy making [39]. Also crucial is experimentation: management is regarded as a form of experiment, to find out what measures work [61][37][38]. This is ‘active learning’ which generates new data, by contrast to the ‘passive learning’ of studying existing data [62][63]. This contrast is linked to a wider distinction between reactive AM; passive AM; and active AM [43][64][65]. Reactive AM uses previous decisions as a guide [66]; passive AM analyses currently available data to make decisions [67]; while active AM obtains its own data from policy experimentation, and tests many hypotheses simultaneously.

There are, however, controversies surrounding the status of AM. One controversy is whether or not AM is scientific [68][69][64]. For some advocates, AM is common sense [36] or trial and error [70] or a subjective value-laden notion [53][46]. But other advocates reject these characterizations and insist that AM is a rigorous, objective, scientific approach to natural resource governance [71][72][20][73][74]. Another controversy is whether AM is, on the one hand, an abstract ideal [49][64] /rhetorical tool [75]; or, on the other hand, a practical guide to action [76]. There is also controversy over whether AM has been successful when it has been

introduced. Some commentators judge some AM projects to have been successful, but many other commentators express disappointment that its track record is so poor [77][37][78][69][79][64][73][80][81][82].

Reasons for AM's modest success include resistance from vested interests [82][80]; risk aversion by decision-makers [53][83][61][69][84][85]; ineffective leadership [77][37]; limited stakeholder involvement [86][87]; lack of social capital, including social networks [79][88][89]; weak learning mechanisms [86]; difficulties in conducting experiments [77][61]; excessive emphasis on technical, instead of socio-political, issues [90]; priority of the precautionary principle [81][64]; poor monitoring [75][91]; and absence of legal grounding [67].

It is worth noting that some of these reasons for AM's lacklustre record (including limited stakeholder involvement) led to ACM, while other reasons (including weak learning mechanisms) were obstacles to ACM as much as to AM. It is also worth noting that there are some circumstances in which AM is not required: for example, where it is clear what management measures need to be taken, or where monitoring cannot be carried out [92].

### 2.3 Adaptive co-management (ACM)

The concept of ACM emerged during the late 1990s [93], and it is usually defined as a combination of CM and AM [68][94][88][95]. For some commentators, CM and AM are inherently linked, in that CM implies AM [96][14], and AM implies CM [97][64][82]. For other commentators, ACM adds AM to CM to remedy its flaws [98][99][25][20], and ACM adds CM to AM to remedy its flaws [63][100][101][102]. Some writers claim that during the

last few years CM and AM have gradually been moving towards one another [98] and that the resulting ACM is more than the sum of the parts but a new synthesis [99][93]. The uniqueness of that synthesis lies in its integration of experimentation (AM) with empowerment (CM). The dominant partner is AM, because AM supplies the driver (adaptation) whereas CM supplies the means (legitimacy).

However, notwithstanding its theoretical appeal, ACM has proven difficult to put into practice [68]. Although there have been some success stories [103], many ACM projects have failed [104][105], while others have been only partially successful [106]. Several reasons for these failings can be identified. One reason is that ACM advocates find it hard to strike a balance between its two principles: AM, which focuses on ecological resilience; and CM, which focuses on human empowerment. When the focus is too much on AM, the importance of stakeholder engagement may be neglected; when the focus is too much on CM, the importance of learning processes may be neglected. Another reason is that ACM falls foul of the contemporary audit culture in which box-ticking displaces concentration on real improvement of the SES. Also, ACM projects frequently suffer from lack of financial resources to fund personnel to carry out the systematic monitoring processes required for AM. Moreover, ACM (like AM) takes a long time to be accepted, and stakeholders are often impatient to see its benefits.

The central question of this paper is how far do the concepts of CM and ACM help an understanding of the workings of the CCMPA?

### **3. The Cayos Cochinos MPA**

[Insert Figure 1 here]

Figure1. Map of the CCMPA boundaries before 2009 and three community sites (Source: [107] with inlay of Central America in which the Honduras north coast is shown by red box)

In Figure 1, the Cayos Cochinos MPA is indicated within the green dotted line, situated 15km north of the Honduran mainland. The CCMPA covers an area of 489.25km<sup>2</sup>, and was designated a Natural Marine Monument in 1993, managed by the Honduran Coral Reef Fund (HCRF), which imposed a no-take zone in the area within a radius of five miles of the central cay (island). This moratorium on fishing affected the Garifuna artisanal fishers who lived within or around the CCMPA area and relied on its resources for their livelihoods [108]. In 1999, after campaigning from black pressure groups, the moratorium was removed to allow the Garifuna to resume their subsistence fishing, and in 2003, the area was declared a statutory MPA, to be administered for the next 10 years on behalf of the nation by HCRF along with the Municipality of Roatan. In 2004, the first five-year management plan (2004-09), which was produced by HCRF with the help of WWF, had a co-management (CM) dimension in that an environmental NGO (HCRF) shared responsibility with a governmental body (Roatan Municipality), and claimed to involve the local community in decision-making. But the Garifuna were once more faced with environmental restrictions on their fishing activity, and resentment against the HCRF grew. A controversial decision by the HCRF in 2007 to allow an Italian television film company unrestricted access to the CCMPA to shoot a 'reality' show further fuelled Garifuna anger, and the consequent civil unrest led HCRF to produce a second management plan in 2008, one year earlier than envisaged. This plan (2008-2013) had an adaptive co-management (ACM) dimension in that it brought more flexibility between ecological and socio-economic goals, and more genuine stakeholder participation, than its predecessor.

The Garifuna are an ethnic minority group of traditional artisan fishers and natural resource users descended from Africans and Amerindians who settled along the Caribbean coastline of Central America during the 19<sup>th</sup> century. Honduras has the largest Garifuna population, with more than 40 settlements along its northern coastline and islands. The Garifuna have often been blamed for overfishing and damage to the marine environment which led to the establishment of the CCMPA in 1993, though the main cause was industrial fishing. Three of the six Garifuna communities connected to the CCMPA were selected for study – Rio Esteban, Nueva Armenia, and Chachuhuate – the first two are mainland settlements and the third is a cay settlement. Rio Esteban had 630 households and 2,800 residents, of whom 60% were Garifuna and 40% were Mestizos (mixed race), and was more reliant on farming than fishing. Nueva Armenia had 500 households and 2,800 residents, 80% of whom were Garifuna and 20% Mestizos, and was dependent on fishing. Chachahuat had 43 households and 100-300 residents (seasonally fluctuating), virtually all of whom were Garifuna, and was dependent on fishing and tourism. Natalie Bown undertook fieldwork in these communities for a total of 12 months spread over four years (2006-2010), conducting 51 key informant interviews, 34 individual fisher interviews, 320 household survey questionnaires, and 12 fisher focus group meetings. She played a participant observation role in attending two management plan revision meetings, and observed several other meetings between fishers and HCRF. She also obtained data on fish catches and landings as well as documentary archival material, from HCRF. The quantitative data were collated on an Excel database and subjected to SPSS statistical analysis, while the qualitative data were collated on an NVIVO database and analysed thematically.

The remainder of this section investigates how far the two management plans embodied the principles of CM and ACM, respectively; and how far they were successful in delivering the

triple objectives of MPAs - ecological health, socio-economic well-being, and good governance. The focus is on the impact of the management plans on the three case-studied communities – the coastal communities of Rio Esteban and Nueva Armenia, and the cayan (island) community of Chachahuat (see Figure 1).

### 3.1 Co-management in the CCMPA

How far did the first management plan embody the principles of CM? On the positive side, the first management plan involved sharing responsibility between its directing agent (HCRF), its local authority (Roatan Municipality), and its resource users (the Garifuna communities). This meant that several attributes of CM were incorporated, including a degree of stakeholder participation; some hollowing out of the state; and a mixture of top-down and bottom-up elements in decision-making. Moreover, the fact that the Honduran government authorised the plan gave it a legal basis and therefore legitimacy as a devolved authority, endorsing the principle of the right of people to be involved in the governance of their local natural resources. However, on the negative side, the CM arrangement was heavily one-sided in that HCRF monopolized power; the Roatan Municipality was largely a token partner; and the Garifuna communities were not empowered but confined to a consultative role. HRCF used liaison bodies such as the Community Commission to inform the public rather than listen to it, and favoured the ‘cooperative’ fisher groups over individual fishers and traditional community leaders (Patronato) in the consultative process. There was also a lack of transparency and accountability in HRCF’s financial dealings, evidenced in its secret deal over the reality show. Not surprisingly, therefore, fishers’ knowledge of the decisions made by HRCF was sketchy; their trust in the authority was low; and their compliance with the CCMPA’s conservation regulations decreased. Part of the reason for this patchy achievement

of CM was that some of the conditions necessary for its achievement were not in place. Although the plan was driven by a natural resource crisis, this did not induce a sufficient degree of political will to bring about a mindset change in government to ensure that the CCMPA co-management regime would be properly funded and closely enough monitored, and as a result, inequities in power and property rights were not addressed. Another factor was poor leadership and organizational skills among fishers, which was due to a lack of solidarity and weak social capital in their communities. Therefore, although there was CM in the first management plan, it was limited in both its extent and depth.

### 3.2 Adaptive co-management in the CCMPA

How far did the second management plan embody the principles of ACM? With regard to CM, on the positive side, the second management plan increased the degree of CM beyond that which existed in the first management plan. For example, the voice of the Garifuna was heard and acted upon by HRCF in the tighter control it exerted over the reality show and the more equitable compensation payments it delivered; in the greater recognition for Garifuna property rights over natural resources; in the more generous access to the CCMPA it allowed to individual fishers; in the stricter accounting procedures it imposed on its own financial arrangements; and in the enhanced public awareness of, and support for, the second management plan. So there was more empowerment, more transparency, more accountability, more equity, and more compliance with CCMPA regulations. There appeared to be an increase in political will and a mindset shift in favour of making CM work. However, on the negative side with regard to CM, HRCF remained in charge of the direction of the CCMPA, and the role played by the Garifuna communities was still subordinate rather than equal. Moreover, the quality of leadership and organizational skills among the Garifuna scarcely

improved; some of the inequities of treatment between ‘cooperative’ and individual fishers persisted (for instance in the way in which representatives were chosen); the level of trust in HCRF felt by stakeholders had barely risen; and rates of compliance by individual fishers with regulations in the CCMPA were little increased.

With regard to AM, on the positive side, the second management plan introduced some features of AM. For example, AM was discernible in the flexibility of HCRF’s attitude to access to the CCMPA and use of gear regulations; in its admission of uncertainty in experimenting with different community projects and livelihood pathways; in its acceptance of the complexity of SESs by not enforcing one-size-fits-all solutions on every community; in its learning by doing attitude to ecotourism initiatives; in its recognition of diversity in using fishers’ local knowledge to complement scientific knowledge; in its encouragement of environmental learning through efforts by NGOs; in its adaptive capacity in responding to Garifuna outrage against the reality show and allegations of financial malfeasance; and in its resilience in coping with external pressures from government agencies and international NGOs.

On the negative side with regard to AM, first, the HRCF was ineffective and slow in responding to stakeholder criticisms, giving the impression of risk aversion in protecting vested interests rather than fostering public engagement. Second, HRCF did not adapt well to unexpected events such as earthquakes, hurricanes and the military coup. For instance, its reaction to the military coup was to protect its own funds rather than the ecosystem. Third, there were weaknesses in the processes of social learning, in that the prevailing discourse remained heavily weighted in favour of scientific and technical expertise; data from fishers and NGOs was not always taken into account in decision making; insufficient learning

occurred to change public values; and lack of funding for monitoring the effects of measures inhibited institutional learning.

So although the second management plan contained many elements of ACM, it also fell short of an ideal ACM approach. The third management plan currently being prepared could make use of this foundation to create a more comprehensive ACM regime.

#### **4. Conclusion and recommendations**

In this article, an attempt has been made to identify the key features of co-management (CM) and adaptive co-management (ACM) and to apply these features to the governance of the Cayos Cochinos Marine Protected Area (CCMPA) in Honduras. It was found that the first management plan of the CCMPA (2004-09) implemented some but not all of the features of CM; while the second management plan of the CCMPA (2008-2013) implemented some but not all of the features of ACM. The conclusion is that ACM represented an advance over CM in that it produced an improvement in all three of the criteria commonly used to assess the value of MPAs – ecological health, socio-economic well-being, and good governance. However, ACM still fell short of its ideal, and the following four recommendations are made to enhance the quality of the CCMPA ACM. The first two recommendations relate to the CM side of ACM, and the last two relate to the AM side.

The first recommendation is to strengthen the capacity of stakeholders to take part in CCMPA decision making. This would dilute the cumulative impact of social inequality currently experienced in CCMPA governance; empower communities; enhance people's sense of ownership over, and duty towards, their marine resources; reduce current over-

reliance on a few individuals; and increase the range of information reaching the general public. The second recommendation is to improve the legitimacy credentials of CCMPA management by requiring HCRF to produce an annual audit of all its financial transactions (income and expenditure); an annual assessment of its performance in meeting the three MPA objectives of ecological health, socio-economic well-being, and good governance; and an annual paper trail that transparently reports all of its interactions with communities, national government, local municipalities, and other organizations. The third recommendation is to enrich the quality of adaptation by asking HCRF to carry out experiments with a more extensive range of policy measures drawing on the experiential knowledge of as many stakeholders as possible; to put in place a more comprehensive and robust system of monitoring the impact of management policies including opportunities for fishers to undertake self-monitoring; and to organize systematic and regular feedback meetings among stakeholders to evaluate the results of the monitoring and their implications. The fourth recommendation is to enhance the process of learning about the SES by a rolling programme of environmental training in both schools and communities. However, the difficulties of achieving ACM should not be underestimated: it is a daunting task, and realistically only an approximation to its objectives can be anticipated.

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## References

- [1] Caveen AJ, Gray TS, Stead SM, Polunin NVC. MPA policy: what lies behind the science? Marine Policy (In press, available online 19 May 2012).
- [2] World Database on Protected Areas. World Conservation Monitoring Centre's protected areas database, 2012. [homepage on the Internet], [cited 2012, February 5]. Available from <[www.wdpa-marine.org](http://www.wdpa-marine.org)>.
- [3] UN Economic and Social Commission for Asia and the Pacific. What is good governance? New York: United Nations; 2009.
- [4] Jentoft S. Co-management - the way forward. In: Wilson DC, Raakjær Nielsen J, Degnbol P, editors. The fisheries co-management experience. Dordrecht: Kluwer; 2003.
- [5] Jentoft S, McCay BJ, Wilson DC. Social theory and fisheries co-management. Marine Policy 1998;22(4-5):423-436.
- [6] Arthur RI. Developing, implementing and evaluating policies to support fisheries co-management. London: MRAG; 2005.
- [7] Jones PJS, Qiu W, De Santo E. Governing marine protected areas: getting the balance right. Technical Report, United Nations Environmental Programme. Nairobi: UNEP; 2011.

- [8] Plummer R, FitzGibbon J. Co-management of natural resources: a proposed framework. *Environmental Management* 2004;33(6):876-885.
- [9] Wilson DC, Raakjær Nielsen J, Degnbol P, editors. The fisheries co-management experience. Dordrecht: Kluwer; 2003.
- [10] Pomeroy RS, Berkes F. Two to tango: the role of government in fisheries co-management. *Marine Policy* 1997;21(5):465-480.
- [11] Pinkerton E. Toward specificity in complexity: understanding co-management from a social science perspective. In: Wilson DC, Raakjær Nielsen J, Degnbol P, editors. The fisheries co-management experience. Dordrecht: Kluwer; 2003.
- [12] Evans L, Cherrett N, Pems D. Assessing the impact of fisheries co-management interventions in developing countries: a meta-analysis. *Journal of Environmental Management* 2011;92(8):1938-1949.
- [13] Nursey-Bray M, Rist P. Co-management and protected area management: achieving effective management of a contested site, lessons from the Great Barrier Reef World Heritage Area (GBRWhA). *Marine Policy*, 2009;33:118-127.
- [14] Pomeroy RS, Rivera-Guieb R. Fishery Co-management: a practical handbook. Wallingford: CABI Publishing; 2006.

- [15] Wilson DC, Ahmed M, Siar SV, Kanagaratnam U. Cross-scale linkages and adaptive management: fisheries co-management in Asia. In: Project completion report: community-based fisheries management in South and Southeast Asia (CBFM-SSEA) project, Penang, Malaysia: the World Fish Center; 2007.
- [16] Pomeroy RS. The government as a partner in co-management. In: Wilson DC, Raakjær Nielsen J, Degnbol P, editors. The fisheries co-management experience. Dordrecht: Kluwer; 2003.
- [17] Hickey S, Mohan G, editors. Participation: From tyranny to transformation? Exploring new approaches to participation in development. London: Zed Books; 2004.
- [18] Jentoft S. Fisheries co-management as empowerment. *Marine Policy* 2005;29(1):1-7.
- [19] Cooke B, Kothari U, editors. Participation: the new tyranny? London: Zed Books; 2001.
- [20] McConney P, Pomeroy R, Mahon R. Guidelines for coastal resource co-management in the Caribbean: communicating the concepts and conditions that favour success. Barbados: Caribbean Conservation Association, University of the West Indies, Cave Hill; 2003.
- [21] Phillipson J. Widening the Net: Prospects for Fisheries Co-Management. Newcastle on Tyne: Centre for Rural Economy, Newcastle University; 2002.

- [22] Beem B. Co-management from the top? The roles of policy entrepreneurs and distributive conflict in developing co-management arrangements. *Marine Policy* 2007;31(4):540-549
- [23] Kooiman J. *Governing as governance*. London: Sage; 2003.
- [24] Alpizar MAQ. Participation and fisheries management in Costa Rica: from theory to practice. *Marine Policy* 2006;30(6):641-650.
- [25] Schusler TM, Decker DJ, Pfeffer MJ. Social learning for collaborative natural resource management. *Society and Natural Resources* 2003;16(4):309-326.
- [26] Jentoft S. The community: a missing link of fisheries management. *Marine Policy* 2000;24(1):53-59.
- [27] Jentoft S. Fisheries co-management: delegating responsibility to fishermen's organizations. *Marine Policy* 1989;13(2):137-154.
- [28] Sen S, Raakjaer Nielsen J. Fisheries co-management: a comparative analysis. *Marine Policy* 1996;20(5):405-418.
- [29] Levin SA. Self-organisation and the emergence of complexity in ecological systems. *Bioscience* 2005;55(12): 1075-1079.

- [30] Plummer R, Fennell D. Exploring co-management theory: prospects for sociobiology and reciprocal altruism. *Journal of Environmental Management* 2007;85(4): 944-955.
- [31] Pomeroy RS, Katon BM, Harkes I. Conditions affecting the success of fisheries co-management: lessons from Asia. *Marine Policy* 2001;25(3):197-208.
- [32] Pomeroy RS, McConney P, Mahon R. Comparative analysis of coastal resource co-management in the Caribbean. *Ocean and Coastal Management* 2004;47(9-10):429-447.
- [33] Chuenpagdee R, Jentoft S. Step zero for fisheries co-management: what precedes implementation. *Marine Policy* 2007;31(6):657-668.
- [34] Howard C, Arthur RI. Lessons for co-management: experiences from the FMSP Programme. London: MRAG; 2005.
- [35] Walker B, Salt D. Resilience thinking: sustaining ecosystems and people in a changing world. Washington, DC: Island Press; 2006.
- [36] Holling CS, editor. Adaptive environmental assessment and management. Caldwell, NJ: Blackburn Press; 1978.
- [37] Allen CR, Gunderson LH. Pathology and failure in the design and implementation of adaptive management. *Journal of Environmental Management* 2011;92(5):1379-1384.

[38] Taylor B, Kremsater L, Ellis R. Adaptive management of forests in British Columbia. Victoria, BC: British Columbia Ministry of Forests; 1997.

[39] Berkes F, Colding J, Folke C. Introduction. In: Berkes F, Colding J, Folke C, editors. Navigating social-ecological systems: building resilience for complexity and change. Cambridge: Cambridge University Press; 2003.

[40] Smith ME. Chaos in fisheries management. *Maritime Anthropological Studies* 1990;3(2):1-13.

[41] Finlayson C. Notes on chaos in fisheries management by Estellie Smith. *Maritime Anthropological Studies* 1991;4(1):91-97.

[42] Wilson JA, Kleban P. Practical implications of chaos in fisheries: ecologically adapted management. *Maritime Anthropological Studies* 1992;5(1):67-75.

[43] Walters CJ, Holling CS. Large-scale management experiments and learning by doing. *Ecology* 1990;71(6):2060-2068.

[44] Hilborn R. Living with uncertainty in resource management. *North American Journal of Fisheries Management* 1987;7(1):1-5.

[45] Walters CJ, Hilborn R. Ecological optimization and adaptive management. *Annual Review of Ecology, Evolution and Systematics* 1978;9:157-188.

[46] Walker B, Carpenter S, Anderies J, Abel N, Cumming G, Janssen M, Lebel L, Norberg J, Peterson GD, Pritchard R. Resilience management in social-ecological systems: a working hypothesis for a participatory approach. *Conservation Ecology* 2002;6(1), article 14, online:1- 17.

[47] Folke C, Colding J, Berkes F. Synthesis: building resilience and adaptive capacity in social- ecological systems. In: Berkes F, Colding J, Folke C, editors. *Navigating social-ecological systems: building resilience for complexity and change*. Cambridge: Cambridge University Press; 2003.

[48] Folke C, Carpenter S, Walker B, Scheffer M, Elmqvist T, Gunderson L, Holling CS. Regime shifts, resilience, and biodiversity in ecosystem management. *Annual Review of Ecology, Evolution and Systematics* 2004;35:557-581.

[49] Collaborative Adaptive Management Network. Defining collaborative adaptive management. *CAMNet Resources*. [home page on the Internet]. [cited 2011 July 7]. Available from < [www.adaptivemanagement.net](http://www.adaptivemanagement.net) >.

[50] Holling CS, Gunderson LH. Resilience and adaptive cycles. In: Gunderson LH, Holling CS, editors. *Panarchy: understanding transformations in human and natural systems*. Washington, DC: Island Press; 2002.

[51] Gunderson L. Ecological resilience - in theory and application. *Annual Review of Ecology, Evolution and Systematics* 2000;31:425-439.

[52] Gallopín GC. Linkages between vulnerability, resilience, and adaptive capacity. *Global Environmental Change* 2006;16(3):293-303.

[53] Ascher W. Coping with complexity and organizational interests in natural resource management. *Ecosystems* 2001;4(8):742-757.

[54] Walker B, Holling CS, Carpenter SR, Kinzig A. Resilience, adaptability and transformability in social-ecological systems. *Ecology and Society*, 2004;9(2), article 5, online:1-9.

[55] Abel N, Cumming DHM, Anderies JM. Collapse and reorganization in social-ecological systems: questions, some ideas, and policy implications. *Ecology and Society* 2006;11(1), article 17, online:1-25.

[56] Carpenter S, Walker B, Anderies JM, Abel N. From metaphor to measurement: resilience of what to what? *Ecosystems* 2001;4(8):765-781.

[57] Walker B, Gunderson L, Kinzig A, Folke C, Carpenter S, Schultz L. A handful of heuristics and some propositions for understanding resilience in social-ecological systems. *Ecology and Society* 2006;11(1), article 13, online:1-15.

[58] Fabricius C, Folke C, Cundill G, Schultz L. Powerless spectators, coping actors, and adaptive co-managers: a synthesis of the role of communities in ecosystem management. *Ecology and Society* 2007;12(1), article 29, online:1-16.

[59] Armitage D. Adaptive capacity and community-based natural resource management. *Environmental Management* 2005;35(6):703-715.

[60] Arthur RI. Adaptive learning in small waterbody fisheries in Lao PDR 1999-2002. MRAG Policy Briefing, London: MRAG; 2003

[61] Halbert CL. How adaptive is adaptive management? Implementing adaptive management in Washington State and British Columbia. *Reviews in Fisheries Science* 1993;1(3):261-283

[62] Williams BK. Passive and active adaptive management: approaches and an example. *Journal of Environmental Management* 2011b;92(5):1371-1378.

[63] Arthur R, Garaway C, Lorenzen K. Adaptive learning: a broadening of the concept of adaptive management and implications for its implementation. London: Renewable Resources Assessment Group, Imperial College; nd.

[64] Stankey GH, Clark RN, Bormann BT. Adaptive management of natural resources: theory, concepts, and management institutions. Gen. Tech. Rep. PNW-GTR-654. Portland, Oregon, US Department of Agriculture, Forest Service, Pacific Northwest Research Station; 2005.

[65] Gunderson L. Resilience, flexibility and adaptive management – antidotes for spurious certitude? *Conservation Ecology* 1999;3(1), article 7, online:1-7.

[66] Lindblom CE. The science of 'muddling through'. *Public Administration Review* 1959;19(2):79-88.

[67] Benson MH, Garmestani AS. Embracing panarchy, building resilience and integrating adaptive management through a rebirth of the National Environmental Policy Act. *Journal of Environmental Management* 2011;92(5):1420-1427.

[68] Huitema D, Mostert E, Egas W, Moellenkamp S, Pahl-Wostl C, Yalcin R. Adaptive water governance: assessing the institutional prescriptions of adaptive (co)-management from a governance perspective and defining a research agenda. *Ecology and Society* 2009;14(1), article 26, online:1- 19.

[69] Stankey GH, Bormann BT, Ryan C, Shindler B, Sturtevant V, Clark RN, Philpot, C. Adaptive management and the Northwest Forest Plan: rhetoric and reality. *Journal of Forestry* 2003;101(January/February):40-46.

[70] Hilborn R. Can fisheries agencies learn from experience? *Fisheries* 1992;17(4):6-14.

[71] Parma AM. What can adaptive management do for our fish, forests, food, and biodiversity? *Integrative Biology* 1998;1(1):16-26

[72] Murray C, Marmorek D. Adaptive management and ecological restoration. In: Freiderici P, editor. *Ecological restoration of southwestern Ponderosa pine forests*. Washington, DC: Island Press; 2003.

[73] Allen CR, Fontaine JJ, Pope KL, Garmestani AS. Adaptive management for a turbulent future. *Journal of Environmental Management* 2011;92(5):1339-1345.

[74] Woolmer A. Appropriate assessments and shellfisheries: adaptive management protocol. Grimsby: Seafish; 2009.

[75] Moir WH, Block WM. Adaptive management on public lands in the United States: commitment or rhetoric? *Environmental Management* 2001;28(2):141-148.

[76] Brunner RD, Steelman TA, Coe-Juell L, Cromley CM, Edwards CM, Tucker DW. Adaptive governance: integrating science, policy and decision making. New York: Columbia University Press; 2005.

[77] Walters CJ. Is adaptive management helping to solve fisheries problems? *Ambio* 2007;36(4):304-307.

[78] Smith CB. Adaptive management on the central Platte River: science, engineering and decision analysis to assist in the recovery of four species. *Journal of Environmental Management* 2011;92(5):1414-1419.

[79] Gray AN. Adaptive ecosystem management in the Pacific Northwest: a case study from coastal Oregon. *Ecology and Society* 2000;4(6), article 6, online:1-16.

[80] Walters C. Challenges in adaptive management of riparian and coastal ecosystems.

Conservation Ecology 1997;1(2), article 1, online:1-13.

[81] Bormann BT, Haynes RW, Martin JR. Adaptive management of forest ecosystems: did some rubber hit the road? Bioscience 2007;57(2):186-191.

[82] Johnson BL. The role of adaptive management as an operational approach for resource management agencies. Conservation Ecology 1999;3(2), article 9, online:1-7.

[83] Kofinas GP. Adaptive co-management in social-ecological governance. In: Chapin FS, Kofinas GP, Folke C, editors. Principles of ecosystem stewardship: resilience-based natural resource management in a changing world. New York: Springer; 2009.

[84] Allan C, Curtis A. Nipped in the bud: why regional scale adaptive management is not working. Environmental Management 2005;36(3):414-425.

[85] Lee KN, Lawrence J. Adaptive management: learning from the Columbian River Basin Fish and Wildlife Program. Environmental Law 1985-1986;16(3):p431-460.

[86] Schreiber ESG, Bearlin AR, Nicol SJ, Todd CR. Adaptive management: a synthesis of current understanding and effective application. Ecological Management and Restoration 2004;5(3):177-182.

[87] McLain RJ, Lee RG. Adaptive management: promises and pitfalls. Environmental Management 1996;20(4):437-448.

[88] Folke C, Hahn T, Olsson P, and Norberg J. Adaptive governance of social-ecological systems'. *Annual Review of Environment and Resources* 2005;30:441-473.

[89] Olsson P, Gunderson LH, Carpenter SR, Ryan P, Lebel L, Folke C, Holling CS. Shooting the rapids: navigating transitions to adaptive governance of social-ecological systems. *Ecology and Society* 2006;11(1), article 18, online:1-21.

[90] Blann K, Light SS. The key ingredients of an adaptive probe. *CAMNet Resources*. [home page on the Internet]. [cited 2011 March 15]. Available from <  
[www.adaptivemanagement.net](http://www.adaptivemanagement.net)>.

[91] Walters C, Goruk RD, Radford D. Rivers Inlet sockeye salmon: an experiment in adaptive management. *North American Journal of Fisheries Management* 1993;13(2):253-262.

[92] Williams BK. Adaptive management of natural resources: framework and issues. *Journal of Environmental Management* 2011a;92(5):1346-1353.

[93] Plummer R, Armitage DR. Charting the new territory of adaptive co-management: a Delphi study. *Ecology and Society* 2007;12(2), article 10, online:1-13.

[94] Armitage D. Building resilient livelihoods through adaptive co-management: the role of adaptive capacity. In: Armitage D, Berkes F, Doubleday N, editors. *Adaptive co-*

management: collaboration, learning, and multi-level governance. Vancouver: UBC Press; 2007.

[95] Pomeroy R. Conditions for successful fisheries and coastal resources co-management: lessons learned in Asia, Africa, and the wider Caribbean. In: Armitage D, Berkes F, Doubleday N, editors. Adaptive co-management: collaboration, learning, and multi-level governance. Vancouver: UBC Press; 2007.

[96] Carlsson L, Berkes F. Co-management: concepts and methodological implications. *Journal of Environmental Management* 2005;75(1):65-76.

[97] Garaway CJ, Arthur RI. Adaptive learning: a practical framework for the implementation of adaptive co-management – lessons from selected experiences in South and Southeast Asia. London: MRAG; 2004.

[98] Berkes F. Evolution of co-management: role of knowledge generation, bridging organizations and social learning. *Journal of Environmental Management* 2009;90(5):1692-1702.

[99] Berkes F, Armitage D, Doubleday N. Synthesis: adapting, innovating, evolving. In: Armitage D, Berkes F, Doubleday N, editors. Adaptive co-management: collaboration, learning, and multi-level governance. Vancouver: UBC Press; 2007.

[100] Smith CL, Gilden J, Steel BS. Sailing the shoals of adaptive management the case of salmon in the Pacific Northwest. *Environmental Management* 1998;22(5):671-681.

[101] Shindler B, Cheek KA. Integrating citizens in adaptive management: a propositional analysis. *Conservation and Ecology* 1999;3(1), article 9, online:1- 9.

[102] Blann K, Light SS. (2000) 'The path of last resort: adaptive environmental assessment and management (AEAM)', *CAMNet Resources*. [home page on the Internet]. [cited 2010 November 2]. Available from < [www.adaptivemanagement.net](http://www.adaptivemanagement.net) >.

[103] Olsson P, Folke C, Hahn T. Social-ecological transformation for ecosystem management: the development of adaptive co-management of a wetland landscape in southern Sweden. *Ecology and Society* 2004;9(4), article 2, online: 1-26.

[104] Gondo T. Adaptive co-management of natural resources: a solution or problem? *Journal of Human Ecology* 2011;32(2):119-131.

[105] Susskind L, Camacho AE, Schenk T. Collaborative planning and adaptive management in Glen Canyon: a cautionary tale. *Columbia Journal of Environmental Law* 2010;35(1):1-52.

[106] Schultz L, Duit A, Folke C. Participation, adaptive co-management, and management performance in the world network of biosphere reserves. *World Development* 2011;39(4):662-671.

[107] Andracka S, Bouroncle C, Garcia-Saez C. Plan de Manejo del Monumento Natural Marino Archipielago Cayos Cochinos, Honduras, 2004-2009. WWF Centroamerica and

Fundacion Hondurena para la Proteccion y Conservacion de los Cayos Cochinos; 2004.

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[108] Brondo KV, Bown N. Neoliberal conservation: Garifuna territorial rights and resource management in the Cayos Cochinos Marine Protected Area. *Conservation and Society* 2011;9(2):91-105.