A community-based approach to sustainable ornamental fishing on coral reefs, Bali, Indonesia

James Barclay Frey

A Thesis submitted to the Faculty of Graduate Studies of
The University of Manitoba
in partial fulfillment of the requirements of the degree of

Master of Natural Resources Management (M.N.R.M.)

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Abstract

The marine aquarium trade has played an important role in shaping the ecological state of coral reefs in Indonesia and much of the Asia-Pacific. The use of cyanide by ornamental fishers in Buleleng District, Bali, in the 1980s and 1990s has resulted in a precipitous decline in the ecological health of reefs. Cyanide-free harvesting techniques were introduced after 2000, along with reef restoration measures. This thesis examines social and ecological processes in the fishing village of Les, Bali, in ending the use of cyanide and the resulting ecological restoration. An emphasis on conservation-development (with livelihood objectives) was important in securing interest and cooperation across stakeholder groups. Adaptive approaches to governance and knowledge co-production were also important. The strategy used at Les is now being exported to other communities across Indonesia, and provides a promising example of a marine resources-based conservation-development initiative that may be implemented at other, similar communities.

Acknowledgements

That a single document can embody the experiences of almost two years of coursework and research is both unbelievable and immensely satisfying. At times, the process of completing this thesis has seemed to occur at roughly the same rate as the formation of the corals I swam among and wrote about. In hindsight, however, it all seems to have happened rather quickly. Life, I suppose, is like that.

Of course, none of it would have been possible without the immeasurable help of many people, and this is a space for me to thank them. I will begin with my sincerest thanks to the eternal Creator, who has sustained me and my family through this time, and whom I trust to sustain us into the future.

My deep gratitude also goes out to my wife, Jessica, for her patience and buoyant good humour, and for her willingness to listen (even through dry and mostly one-sided conversations). Without her support, I would not have made it this far.

The remainder of my family has rallied around me, also, and I thank them for that: my father, who worked with me in Bali to collect data (this thesis is as much yours as mine!); my two sons, who have good-naturedly accepted my promises that a summer of baseball will follow the completion of this thesis; and all the other family members who supported Jessica while I was conducting field research.

My advisor, Dr. Fikret Berkes, has not only my thanks, but my admiration and friendship as well. In him, I have found a mentor and a stone upon which I have sharpened my skills and my intellect. Thanks also to the other members of my committee for their support and their input, and to the administrative staff at the NRI (especially Jackie Rittberg) for their immense help.

And finally, I thank the wonderful people I have had the opportunity to know during my time in Indonesia: Dr. Arif Satria, for his support of my research; Dr. Nazrina Zuryani; Humayra Muswar and Arif Dian Pratama; everyone at the Indonesian Nature Foundation; and of course, my dear friends at Desa Les, especially I Made Partiana, I Nengah Arsana, and Ni Loh Nariasih Without you, I would have no thesis at all. *Terima kasih dan matur suksma!*

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Table of Contents

List of Tables

List of Figures

List of Boxes

List of Acronyms

ARS	Artificial reef structure
LINI	Indonesian Nature Foundation (Yayasan Alam Indonesia Lestari)
MAC	Marine Aquarium Council
MAMTI	Marine Aquarium Market Transformation Initiative
MAT	Marine aquarium trade
MMAF	Ministry of Marine Affairs and Fisheries (Indonesia)
NGO	Non-governmental organization
NTZ	No-take zone
OAP	Ocean and Air Police
PA	Protected area
SCUBA	Self-contained underwater breathing apparatus
SSHRC	Social Sciences and Humanities Research Council of Canada
YBN	Yayasan Bahtera Nusantera (NGO)

Glossary of Terms

Adat	Customary village authority; one of two village-level authorities (see *dinas*).
Dinas	Administrative village authority; one of two village-level authorities (see *adat*).
Kelompok nelayan ikan hias	Ornamental fishers' association
Losmen	Homestay (similar to bed-and-breakfast)
Potas	Potassium cyanide (also sodium cyanide)
Proyek	Lit: 'project'; construction work
Roti buaya	Lit: 'crocodile bread'; a type of artificial reef structure

Definitions

Adaptive governance	An approach to resource use and control across stakeholder groups that relies on networks to solve problems and create opportunities (Folke et al. 2005; Berkes 2010b).
Capacity-building	Increases to or development of a resource management system's capacity, including norms; rules; institutions; leadership; knowledge; relationships, skills, financial capital; and other resources (Prabhu et al. 2007).
Collaborative action	Processes between coordinated stakeholders concerned with actions that have material results (Prabhu et al. 2007).
Commons	Natural and human-constructed resources which share two characteristics: (1) the exclusion or the control of access of potential users is difficult; and (2) each user is capable of subtracting from the welfare of all others (Ostrom et al. 1999).
Communicative action	Processes of communication between stakeholders for the purpose of establishing understanding or meaning (Habermas 1981).
Communities of practice	Groups of individuals who share a common concern for something they do (Wenger 1998).
Deliberation	Processes for communication between various parties, in which issues are discussed and considered, information and viewpoints are exchanged, and outcomes are assessed (Berkes 2007).
Institution	'Rules-in-use'; strategies for governance of common-property resources (e.g. restrictions on harvesting) (Ostrom 1990; Berkes 2010b).
Knowledge co-production	Processes or mechanisms that help bring together local and traditional knowledge with scientific knowledge to enable learning (Armitage et al. 2011).
Learning loops	A theoretical framework for understanding learning (single-, double-, and triple-loop) that emphasizes learning which addresses underlying worldviews of participants (Argyris & Schon 1978; Armitage et al. 2008).
Marine aquarium trade	Trade in ornamental marine species; includes fishers, distributors, exporters, importers, and consumers.

Marine transformation	"Radical or abrupt changes in linked ecosystem services and human well-being" (Armitage & Berkes 2009)
Networks	Linkages between stakeholder groups across vertical (organizational) and horizontal (spatial) scales (Berkes 2004).
Self-organization	The development of complex adaptive systems, in which multiple outcomes are possible (Holling 2001).
Social capital	A concept that describes the interconnected issues of trust; reciprocity; shared rules, norms and sanctions; and connectedness (Pretty & Ward 2001; Pretty & Smith 2004; Berkes 2010b).
Social learning	Learning among individuals that occurs in a social context (e.g. a context of power-related issues, or long-standing conflicts). This type of learning is ideally both reflexive and anticipatory (Prabhu et al. 2007)
Transformation	See *Marine transformation*.

Chapter One
Introduction

1.1 Background and research problem

This thesis focuses on adaptive governance and knowledge co-production around ecological restoration and community-based conservation in Buleleng District (Buleleng), Bali, Indonesia. Over the past several decades, the coral reefs in this region were severely degraded by a range of human activities (including destructive fishing practices, mining of coral for building materials, and anchoring of ships) (Sukarno et al. 1986; Reksodihardjo-Lilley & Lilley 2007). An important source of damage to coral reefs in Buleleng, and across the Indo-Pacific region in general, is activity associated with the marine aquarium trade, and perhaps most notably, the use of potassium or sodium cyanide (henceforth referred to as cyanide) by fishers to capture ornamental species (Rubec et al. 2001). Fishers' use of cyanide has severe side-effects for corals and other reef species, and has been instrumental in degrading and even killing entire coral reef systems.

Observations in Bali by Berkes (2010a), published in the Bulletin of Marine Science formed a strong working hypothesis for this research. That fieldwork identified Les, a community in Tejakula Sub-district (eastern Buleleng), as a location where local collectors of ornamental species had seriously degraded their coral reefs through the use of cyanide. This damaging practice occurs concurrently with other activities that are harmful to coral reefs (Hughes et al. 2003), some of which will be discussed in Chapter Three.

After a period of declining reef health, fish populations, and fisher incomes, ornamental fishers in the community became involved with local NGOs, who proposed to teach new, environmentally sustainable harvesting techniques (Berkes 2010a). Over time, a consensus emerged among fishers and other community members that something should be done to address the damages to reefs, resulting in two types of action: (1) acquisition of new equipment and a period of learning to use that equipment; and (2) reef restoration.

Referring to integrated conservation and development projects, Berkes (2007) states that project planners typically emphasize one objective (i.e., either conservation or development) over the other, and rarely allocate equal importance to both. In the case of the project at Les, livelihood-centred (i.e., development) objectives were initially prioritized so as to provide fishers with incentive to become involved (Berkes, personal communication). Ultimately, both conservation and development objectives were coupled, and fishers themselves did not see the two as separate objectives. This research sought to confirm the initial perception of Berkes (2010a:244) that restoration and other activities at Les have not occurred "for 'conservation' in the scientific sense but for improved livelihoods." In this case, healthy coral reef systems were seen as foundational to achieving improved livelihoods.

The experience at Les is important enough that other groups have learned from it, as is discussed in Chapter Four and other parts of this thesis.

1.2 Purpose and objectives of the research

The research is one of the case studies undertaken for the Social Sciences and Humanities Research Council of Canada (SSHRC) proposal, "Marine Transformations and Adaptive Governance." That project is led by Dr. Derek Armitage of University of Waterloo, and by my advisor, Dr. Fikret Berkes of the Natural Resources Institute, and aims to look at how coastal-marine systems are being transformed in the sense of radical shifts and in terms of governance shifts or transformations toward more environmentally sustainable decision-making (Armitage & Berkes 2009).

Additional research linkages include other graduate student projects at the Community-Based Resource Management Centre, which is related to Dr. Berkes' Canada Research Chair (CRC). Recent work at this CRC has included ten graduate student theses based on cases of the United Nations Development Programme Equator Initiative, which focuses on biodiversity conservation, linked with local social and economic development (Berkes 2007; Seixas & Davy 2008; Seixas & Berkes 2010). My project has also been shaped, in part, by the advice and priorities

of Dr. Arif Satria, Bogor Agricultural University, Indonesia, who has carried out previous work on similar community-based topics in Lombok (Satria & Matsuda 2004; Satria et al. 2006a; Satria et al. 2006b; Satria 2007; Satria & Adhuri 2010).

The purpose of my research was to examine the processes and outcomes of joint-learning in Buleleng, Bali, and at the community of Les in particular, to determine whether transformations toward more environmentally sustainable decision-making have occurred. This examination began with the pre-restoration period, and followed activities throughout the restoration phase into the present (i.e., from a state of disorganization to one of organization). Further context was gained by looking at the community's planned future activities regarding conservation. The case is important because it was thought to demonstrate community-level action and problem identification by the local users themselves, involving an ongoing period of learning and team-building, as well as the formation of partnerships to achieve integrated coastal conservation-development.

The three main objectives of the research were:

1. To characterize transformation in the social-ecological system under study—that is, to document the work done by the community and its partners to restore coral reef systems previously damaged.
2. To examine adaptive governance and knowledge co-production (fishers' knowledge plus external knowledge) in the context of reef restoration.
3. To explore the implications of the case study findings on conservation-development for the marine aquarium trade and reef restoration activities elsewhere.

The scope of the research is on the level of the community and the institutions that played a role in organizing and enabling reef restoration. Although some attention will necessarily be given to the ecological aspects of reef restoration (such as coral cover and overall fish populations), these observations serve primarily to highlight learning outcomes, as well as to substantiate the community's claims that restoration is occurring successfully.

1.3 Study area

Indonesia is a Southeast Asian nation, consisting of approximately 17 500 islands and 81 000 km of coastline (Nontji 2002). Located in the zone of strong solar illumination, Indonesia's coastal areas are home to a high proportion (~15%) of the world's total coral reef resources. Consequently, many coastal communities in Indonesia are dependent upon coral reef systems for their livelihoods.

The study occurred in Buleleng, Bali, Indonesia, which comprises 144 km of coastline (Yahya et al. 2008). Despite the prominence of Bali as a tourist destination, communities in this region continue to represent some of the poorest in nation, and suffer from lack of access to health care, education, and land (Reksodihardjo-Lilley & Lilley 2007). The options for income generation are limited, with many individuals engaging in subsistence fishing and farming activities. Over the past several decades, the marine aquarium trade has provided fishers with an important source of livelihood. However, as noted above, this trade (and the negative harvesting practices associated with it) has an important role in shaping the ecological state of the reefs.

1.4 Research methods

The project occurred in a participatory manner, undertaken cooperatively with local fisher and community groups, NGOs, local enterprises, and researchers from Bogor Agricultural University. The research was qualitative in nature, and collected primary and secondary data using a case approach.

To collect appropriate and meaningful data, research methods included semi-structured and key informant interviews; participant observation and diving transects; focus groups; timeline reconstruction; document review (including NGO and community documents); and network diagramming. For most interviews and focus groups, a translator was employed, using a double-translation method (i.e., the interviewer's questions were translated into Indonesian or Balinese, and the response was translated into English). This method allowed for a greater range of inquiry during interviews, as well as improved follow-up questions.

The data obtained in the field were triangulated, verified, and crosschecked with the community and other stakeholders to confirm their validity and accuracy, as detailed in Chapter Two.

1.5 Research significance and limitations

The research fits well with other ongoing activities in the Indo-Pacific region (especially Indonesia, Fiji, and the Philippines), where a number of communities are undertaking coral reef and other coastal ecological restoration projects. However, the examination of coral reef-related issues from a community-based perspective, using a case study approach that prioritizes both ecological and sociological factors, is a relatively new approach, and not well represented in the literature. The main lines of inquiry present in the literature can be broadly summarized as (1) purely ecological, and acknowledging human-induced transitions (cf. Clark & Edwards 1995; Ablan, McManus & Viswanathan 2004; Bellwood et al. 2005; (2) policy-oriented, and often developed for government or research organizations (Mascia 2002; Mangubhai et al. 2011); and (3) community-oriented. This research addresses this third, less well-examined focus.

Importantly, the research makes use of NGO and community data, much of which remains unexamined in scholarly publications. The research therefore provides an important linkage between researchers of community-based marine resource conservation and the remarkable events unfolding across Buleleng.

The proposed research has both theoretical and practical significance. As part of the SSHRC-funded "Marine Transformations and Adaptive Governance" project, this study further develops an understanding of marine transformations—that is, "radical or abrupt changes in linked systems of people and nature with uncertain (and often undesirable) consequences for ecosystem services and human well-being" (Armitage & Berkes 2009). This case, however, is unique in that it provides a rare example of a positive transformation—one in which stakeholders have identified an ecological threat, and have proactively addressed the situation.

A. Theoretical contributions of the research include an improved understanding of: (1) the formation of vertical and horizontal institutional linkages as related to knowledge formation and learning processes (Folke et al. 2005; Berkes 2009); (2) adaptive governance and knowledge co-production as important processes facilitated by bridging organizations (Armitage et al. 2008a; Berkes 2009); and (3) the role of social capital and trust-building in multi-level governance (Pretty & Smith 2004; Pahl-Wostl 2009).
B. Practical contributions of the research include: (1) applications to policy regarding ecosystem restoration; (2) determining partnership needs and capacity-building requirements for stakeholder groups engaged in ecosystem restoration and transformation of social-ecological norms and values (Berkes 2010a; Berkes 2010b); (3) examining the role of reef restoration in reinforcing the new social-ecological paradigm developing across Buleleng; and (4) increasing awareness of conservation-related issues related to the marine aquarium trade.

The scope of the study is necessarily limited to the examination of adaptive governance and knowledge co-production in the context of coral reef restoration efforts. Although the activities in Buleleng have strong ecological components (such as coral growth rates, and increases in local fish populations and diversity), the study is not explicitly ecological. Similarly, although ornamental fishing and reef restoration activities have strong economic components, the study is not explicitly economic. Nevertheless, some consideration of the ecological and economic situation was necessary to support the stakeholders' own assessment that ornamental fishing livelihoods are being supported, and that reef restoration is occurring successfully. With this in mind, the study will incorporate limited economic and ecological measurements of livelihoods and reef restoration in order to supplement and add context to the processes of adaptive governance and knowledge co-production.

This thesis provides some historical perspective as it relates to the social-ecological transitions observed in Buleleng (beginning in the 1960s). However, a

limitation is the absence of consistent policy change over time. Another limitation is that only one ornamental fish exporter responded to my request to meet for interviews. (Anecdotally, exporters are hesitant to meet with people with whom they have not established relationships of trust.) Finally, a limitation of this research resulted from translation services. As I do not speak Indonesian (*Bahasa Indonesia*) or Balinese, I made use of several local translators. Translation occurred during interviews, with my question translated into the local language, and the response translated into English. Consequently, response data are approximations of meaning, and not direct quotations.

1.6 Organization of thesis

This thesis has been organized into six chapters, this being the first. Chapter Two details the study area, as well as the methods used to collect, record, and analyze data. The literature review, rather than comprising its own separate chapter, has been embedded within the three objectives-based chapters. This feature is designed to directly pair theoretical concepts and practical examples developed by other researchers with the findings of this research. Chapter Three presents a narrative which describes the social-ecological transformation that has occurred (and continues to occur) in Les and other communities. Chapter Four uses a conceptual model to examine aspects of adaptive governance and knowledge co-production in the context of coral reef resources. Chapter Five explores the implications of the research on conservation-development for the marine aquarium trade and coral reef restoration efforts in general, and provides nine recommendations to guide the formation of policy in these areas. Finally, Chapter Six discusses the major findings of the research, and provides conclusions, as well as cross-cutting themes and areas for further research.

Fishing boats on the beach at Desa Les, Bali.

Ornamental fish packaged in plastic bags for international transport. The remainder of the bag is filled with oxygen to prolong the viability of the fish.

Chapter Two

Study area and research methods

This chapter provides an overview of the study area and research methods used to conduct the research. The underlying philosophical approach is examined, and the strategies for data recording, analysis, and validation are presented. Finally, opportunities for dissemination of research findings are provided.

2.1 Study area

The study occurred in Buleleng District, Bali, Indonesia. Data collection (primarily in the form of semi-structured and key informant interviews, and participant observation) occurred at 11 different coastal communities across Buleleng (*Figure 2.1*). The primary community of focus in this study was Les, where the majority of the data was obtained.

The primary site, Les, was selected based on observations made during fieldwork by Berkes (2010a), as detailed in Chapter One. Nine other sites were selected based on the presence of ornamental fishers' associations, or because high numbers of ornamental fishers were present in those communities. I was provided with access to those sites by a "gatekeeper" (Creswell 2009), an ornamental fisher from Les who also acted as my translator. One additional site (a tourist-oriented site where ornamental fishing is prohibited) was identified through online research conducted prior to my arrival in Bali.

Les (properly, Desa Les) is located at approximately 8˚08'08" S, 115˚22'10" E, roughly 4 km from Tejakula (the Sub-district Seat), and 35 km from Singaraja (the District Seat). The community has approximately 7 450 residents[1] (including youths), and is predominantly Hindu (>99%) (Ministry of Interior [Indonesia] 2009). Like many rural communities in Indonesia, the population is characterized

[1] Actual population levels vary according to season and availability of local employment, with some "residents" working at locations across Bali, particularly in construction (*proyek*) and fishing.

by a high proportion of young (<25 years of age) individuals. A summary of the main livelihood activities for the community is represented in *Table 2.1.*

Table 2.1: Main livelihood activities at Les by population (adapted from Ministry of Interior 2009)

Livelihood	Approximate number of adults
Farming activities[2]	3 850
Employees of private companies	850
Civil servants and other government employees	110
Ornamental fishers[3]	50-70

Geographically, the north coast of Bali is characterized as dry relative to the southern part of the island. Due to the presence of volcanic mountains immediately to the south, the land resources of many communities are characterized by steep slopes, located within just a few kilometers from the coast (Zuryani 2006). The shoreline and adjacent seafloor across Buleleng varies, with some regions dominated by sand, and others by large rocks (as at Les). Among other factors, this feature directly influences the local marine ecology; shapes tourism-related activities; and affects the ease with which fishers can access the water with their boats. Additionally, the bathymetry along the eastern portions of the north coast is steeper than in the south, reaching a depth of 30 to 40 m within 100 m of the shore.

Across different communities, important economic activities that occur on the reef or immediately adjacent to the sea include fishing and collection (for both ornamental and food species); aquaculture (shrimp, fish, seaweed, pearls); salt production; boat building and repair; and tourism. Tourism revenues are commonly received by hotels, 'homestays' (*losmen*), and restaurants; dive operators and other providers of ecotourism; and personal charters and guides (usually with some level of foreign-language ability). In this regard, the economic benefits of tourism in the region tend to accrue to a limited number of individuals, and are often poorly

[2] Farming activities here include production of grain, root, tree and other crops; raising cattle; and farm labour.
[3] Figures based on interview data. The number of ornamental fishers fluctuates over time, and reflects seasonality. The number of active fishers at the time the research was conducted was closer to 50 individuals.

distributed across communities, as well as across social and gender lines (Long & Kindon 1997).

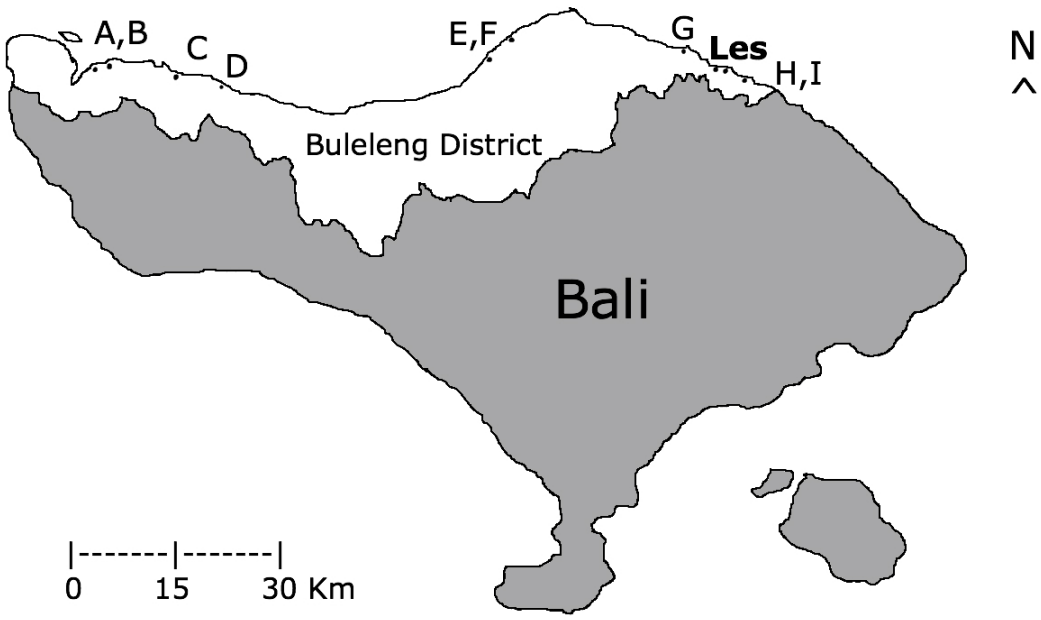

Figure 2.1: Map of study area. Buleleng District is shown in white. Les, the primary site for data collection, is on the east side of the north coast. Other sites where data was collected are labeled on the map A through I: Pejarakan; Sumberkima; Pemuteran; Pidada; Kampong Baru; Tejakula; Penuktukan; and Sembirenteng, respectively. One additional community was considered in this study; however, because of ongoing tensions between cyanide users and cyanide-free fishers, that community wished to remain unnamed in this thesis, and is not shown on the map. (Adapted from Google Earth, Ver. 6.1.0.5001.)

The environmental damage to reefs that has occurred in Buleleng is similar to damage in other parts of Indonesia, where healthy coral reef cover has declined precipitously (Sukarno et al. 1986). This decline can be linked to a number of practices, including blast (dynamite) fishing; pollution and sedimentation; elevated seawater temperatures (bleaching events); and unsustainable fishing practices associated with the marine aquarium trade (Pastorok & Bilyard 1985; Smith & Buddemeier 1992; Hoegh-Guldberg 1999; Pet & Pet-Soede 1999; Fox et al. 2005). As damage occurs to reefs, the individuals engaging in livelihood-related activities (e.g. ornamental fishing) may increase the scope and intensity of their activities,

resulting in further damage. The dependence of many coastal inhabitants on coral reefs for their livelihoods makes the development of strategies for sustainable resource use of critical importance.

Changes to national policy over the time period addressed in this thesis (i.e., the post-Suharto period) created an enabling environment for conservation. Challenges remain, however, and resource management in Indonesia remains characterized by political uncertainty, weak law enforcement, and inconsistent laws and regulations (Resosudarmo 2005).

2.2 Philosophical approach

Previous work with a social development NGO in Northeast Asia has provided me with firsthand experience interacting with individuals and communities, and has significantly impacted my worldview. I see the participants as having a direct role in shaping the results of the research, not only by providing data, but also by collaborating with the researcher to bring validity to the findings. This viewpoint is best summarized as a participatory worldview (Creswell 2009).

This research will demonstrate that the initiative to develop a cyanide-free fishery and promote reef restoration at Les has resulted in successful social-ecological outcomes. However, many other communities (including some of those referred to in this thesis) are only starting out on the long road to social-ecological transformation. The insights of this research concerning the processes of adaptive governance and knowledge co-production, and their links to social-ecological transformation at Les, can play an important role in shaping that journey.

2.3 Research methods

An overview of the data collection procedures used to conduct this research is presented here. The total number of interviews, organized by location and respondent type, are expressed in *Table 2.*2.

Table 2.2: Total number of interviews by location and respondent type

Interview type	Ornamental fishers[4]	NGO staff	Gov't staff	Other[5]	Total at Les	All other communities
Semi-structured	30	1		9	22	18
Key informant	3	3		2	8	
Focus group	1	2			3	
Informal discussion	20	10	3	7	33	7
Total					**66**	**25**

The study data can be grouped into 3 categories:

1. Interview data (semi-structured and key informant interviews; focus groups; network diagramming; timeline reconstruction)
2. Observational data (participant observation and diving transects)
3. Secondary data (review of archival material)

The procedures for recording this data varied according to category. In general, the following procedures were used:

- Interview data was recorded using handwritten notes[6]. These were later transcribed to a digital file on my lap top computer. Written notes were descriptive (including details about the respondent, place, and time) and reflective (including my thoughts, ideas, and impressions).
- Observational data was recorded using jottings, field notes, and when the situation permitted, photography.
- Secondary data was photocopied and scanned (with permission), and copied by hand when this is not possible.

2.3.1 Participant observation and diving transects

During the 16 weeks that I stayed at the research sites, I had numerous opportunities for informal interaction with members of the community, fishers' associations, and NGO staff. My role as a researcher during these interactions was

[4] At Les, 16 of approximately 50 active ornamental fishers at were interviewed.
[5] "Other" here includes marine aquarium fish distributors; entrepreneurs; researchers; community organizers; and spouses of fishers.
[6] To avoid the lengthy process of transcribing interviews, I did not use an audio recording device to collect interview data. Because responses were in Bahasa Indonesia or Balinese, transcripts of recorded interviews would also have required translation.

sometimes as a pure observer, and at others, as a participant-observer. Examples of the type of activities for which this method was used include ornamental and artisanal (food) fishing; construction and installation of artificial reef structures; meetings between various stakeholders (fishers, government or NGO staff, entrepreneurs, and researchers); religious and cultural celebrations; snorkeling on the reef; and numerous other day-to-day activities.

Diving transects and other more formal opportunities for participant observation (PO) occurred during reef monitoring activities, and training of individuals at one community in SCUBA diving skills. These activities provided me with firsthand views of the rehabilitated reef (including coral and other species populations), as well as capacity-building activities.

A second important function of PO was to build relationships with individuals across communities, to develop social capital, and to enrich my understanding of various activities. My participation in a broad range of family and community events allowed me to meet (or be seen by) local residents. This increased awareness of my presence in the community, and appeared to make people more open to talk with me about my research objectives. As an outsider with no prior experience in coral reef-related activities or Balinese culture, PO played an essential role in helping me to overcome my own cultural perspectives, or "expectations informed by an extraneous normative system" (Ezeh 2003:203).

2.3.2 Semi-structured interviews

The data obtained from semi-structured interviews (SSIs) with various stakeholders (detailed in the previous section) formed the backbone of my research. The decision to conduct SSIs (instead of structured interviews) reflects Bariball & While (1994:334), who suggest that the method allows researchers to address the "varied professional, education, and personal histories of the sample group … [and] to explore respondents' opinions, clarify interesting and relevant issues, elicit complete information and explore sensitive topics within each interview."

Consistency between interviews (i.e., validity and reliability) was achieved by stressing the equivalence of meaning of the questions, rather than the exact

wording. This was especially useful for situations in which barriers to language existed between the interviewer and the respondent (Barriball & While 1994). Although some of the respondents across study sites had some English language abilities (particularly among NGO and government staff), I most often worked with a local translator. Placing an emphasis on equivalence of meaning helped to minimize the barriers to communication resulting from language differences.

The individual selected as a translator for this research is a resident of Les—an ornamental fisherman and employee for a local NGO focused on marine issues. These affiliations provided him with a thorough understanding of issues related to the marine aquarium trade, and also allowed him to act as a "gatekeeper" for this research into other communities (Creswell 2009). The presence of a friend or peer served to put fishers at ease, especially when in the company of a foreign researcher.

To ensure that the research data obtained from semi-structured and key informant interviews requiring the use of a translator did not simply reflect the interpretations and opinions of one individual, care was taken to triangulate and cross-check important themes and responses with other English-speaking individuals.

Translation (for all interview types) occurred in a two-way process—that is, I posed a question that was then relayed in the appropriate language (Bahasa Indonesia or Balinese) to the respondent. The translator then provided me with the answer given by the respondent. This manner of translation allowed me to have a rapid understanding of the respondent's meaning, and to explore the answer with follow-up questions and probes. This would not have been possible if I had been working with a translated interview transcript.

Interview data presented in this document reflects the translation process described above, and responses are therefore not intended to be direct (verbatim) quotations. They nevertheless reflect the meaning of the response as closely as possible.

2.3.3 Key informant interviews

Through participant observation and semi-structured interviews, it became possible to identify individuals of instrumental importance to the initiative at Les. These individuals were targeted for key informant interviews. Typically, these individuals possessed unique knowledge of processes and events, or had important leadership roles within the community or participating organizations.

Interviews with key informants allowed the research to explore specific issues at a greater depth than was possible during initial rounds of SSIs, or with individuals who possessed unique knowledge (i.e., knowledge not held by most respondents). Furthermore, discussions with key informants provided multiple opportunities to cross-check and validate information obtained through SSIs, participant observation, and other methods of data collection.

2.3.4 Focus groups

As the information obtained from semi-structured and key informant interviews provided a clearer picture of the social-ecological transformations at Les and other communities, it was helpful to initiate discussions among groups of three to five individuals for the purpose of clarifying and validating information. Focus groups differed from the questions-based data collection procedures described above in their use of open-ended questions about the marine aquarium trade; past and present social-ecological initiatives; and future objectives.

Focus groups occurred at a late stage in the research, and provided opportunities to "test out" research findings in a group setting, as well as to identify important themes that had not been addressed in the research. I facilitated discussions among respondents, shaping the conversation with occasional questions or comments. It was beyond the scope of the research to explore all the themes addressed during the focus groups; nevertheless, a number of prominent themes have been included in Chapter Six as areas for further research.

Not all communities participating in this research (see *Figure 2.1*) were involved in focus groups. However, the NGO personnel involved in two of the focus

groups were actively involved in those other communities, and were able to provide insight into ecological and social processes across the study area.

2.3.5 Timeline reconstruction

The reconstruction of a timeline of events at the study sites was a crucial step in gaining an understanding of the social-ecological transitions in those communities. Because the data used to construct this timeline was obtained primarily from SSIs, it not only provides a chronological sequence of events, but also insight into resource users' changing perceptions over time. This timeline is used to build a narrative of events in Chapter Three, and also informs the usage of a conceptual three-phase framework in Chapter Four.

2.3.6 Network diagramming

The complex and changing nature of stakeholder interaction made the use of network diagramming an invaluable method for this research, and strengthened the understanding of organizational linkages within and across communities, NGOs, and other institutions. Additionally, this type of diagramming allowed the identification of key individuals who contributed significantly to the initiatives in the study area. Finally, developing a clear perception of organizational linkages was an important step in determining whether learning had occurred across organizational levels. The data used to create network diagrams was obtained from interviews and focus groups.

Network diagrams were developed on both an individual and organizational scale, with strong overlap between these scales. For example, interview data showed that two ornamental fishers at Les played instrumental roles in bridging the gap between the NGO, Yayasan Bahtera Nusantara (YBN), and the larger group of ornamental fishers in that community. Diagramming of this network would demonstrate a linkage between two groups (YBN and the ornamental fishers) on an organizational level, but also acknowledge the key role of individuals within that network.

2.3.7 Review of archival materials

A final method for data collection involved a review of archival material related to social-ecological initiatives at the study sites, such as documents, photographs, and maps. These materials provided the research with an important historical perspective, and were critical to gain an understanding of formal and informal learning activities. Archival material also provided the research with insights into what information the participants deemed to be "worth sharing" with others (i.e., why was the information important enough to be archived?). Additionally, the review allowed me to obtain information about activities in communities that I was not able to access personally (such as communities on other islands), and to assess the validity and accuracy of the information obtained using other data collection procedures.

The type of materials that were examined includes:

- Reports on reef restoration and monitoring activities
- Publications in scientific journals or other locations
- Economic data on ornamental fishers' harvest
- Training activities at Les and other communities

The methods are summarized and linked to research objectives in *Table 2.3*.

Table 2.3: Research objectives and associated data collection procedures

Objective	Data collection procedure
1. Characterize transformation	Semi-structured and key informant interviews; focus groups; timeline construction; document review
2. Examine adaptive governance and knowledge co-production	Semi-structured and key informant interviews; focus groups; timeline construction; document review; network diagrams; participant observation
3. Explore implications of the research findings	Key informant interviews; focus groups; network diagrams

2.4 Data analysis procedures

Some analysis of data was possible while still in the field—a feature that contributed to the process of cross-checking and validation. The overall process of data analysis followed the steps outlined in Creswell (2009):

1. Organizing and preparing data for analysis
2. Reading through all data to obtain a general sense of overall meaning
3. Beginning detailed analysis, sorting for themes

The main themes examined in this research reflect those suggested by Creswell (2009), and were selected to provide a broad-based approach to obtaining data relating to social-ecological processes relating to coral reefs in Buleleng. The main themes included:

- Setting and context
- Social structure and relationships
- Processes or activities (e.g. learning activities; reef restoration)
- Participants' perspectives and ways of thinking (about people; processes; environments; and activities)

2.5 Validation of findings and dissemination

Some of the steps taken to ensure the reliability and validity of the research findings have been detailed in the preceding sections, and include cross-checking and triangulating data from different sources and stakeholder groups. In general, validation strategies followed Creswell (2009), and included:

- Clarifying my biases and assumptions
- Checking interview notes with participants
- Examining data from different sources to build a central theme
- Presenting specific findings to participants to check for factuality
- Recording detailed description and noting discrepant information
- Ensuring consistency when examining data for themes

During the last two weeks of the field study period, I summarized my main findings and presented them to different stakeholders for validation. The purpose of this validation step was to cross-check my interpretation of the data with stakeholders, and to make revisions where necessary.

The writing phase for this thesis began following my return to Canada. As analysis and interpretation of research results has occurred, different strategies for disseminating the findings have presented themselves. In addition to this thesis, some of the opportunities for dissemination include:

- Conferences (such as the International Symposium on Society & Resource Management [ISSRM])
- Posters and/or oral presentations
- Papers for academic journals
- A plain-language document for sharing information with communities[7]
- A podcast oriented towards consumers (i.e., marine aquarium hobbyists), and based on interviews recorded for that purpose during the field study period

The NGOs, in particular, are uniquely equipped to disseminate the findings of this research across Bali and greater Indonesia. Other candidates for the dissemination of research findings include Bogor Agricultural University and other universities; the Ministry of Marine Affairs and Fisheries (MMAF); and development agencies such as the United Nations Development Programme.

[7] This document will include relevant photographs taken during the field study period, and will be developed together with Bogor Agricultural University to obtain an appropriate translation into Bahasa Indonesia.

Chapter Three
The Narrative: Characterizing a transformation

3.1 Introduction

Seixas & Davy (2008) state that resource crises (or more broadly, ecological crises) may serve as a trigger to motivate a community of resource users to address destructive usage patterns. This chapter will describe how ornamental fishers' actions precipitated an ecological crisis for coral reefs at Les and across Buleleng in general. The social drivers behind those transformations will also be presented here. Finally, this chapter will introduce the ways in which ornamental fishers and other stakeholders have begun to address the resource crisis.

The damage to coral reefs in Buleleng has reduced ecological stability and levels of marine biota, and has placed economic pressure on the people that depend upon those reefs for their livelihoods. Some of the ecological changes have been natural (non-anthropogenic) in origin; however, many of the most devastating changes have been directly caused by humans. Nevertheless, it is humans—in some cases, the very individuals who caused the initial damages to the coral reefs—who have begun to work together to ensure that their activities on the reefs support livelihoods while remaining ecologically sustainable.

3.2 Before the marine aquarium trade (1960s and 1970s)

Although the activities associated with the marine aquarium trade have had devastating effects upon the coral reefs in Buleleng, and across the Indo-Pacific in general (Barber & Pratt 1998), damage from other causes was nevertheless incurred earlier. As Jaap (2000:347) points out, "ship groundings on coral reefs have occurred ever since humans first built boats and began going to sea," resulting in damage to the coral. According to that author, additional damage can be caused by anchoring, as well as various types of fishing gear and techniques.

One particularly harmful form of fishing is blast fishing (also referred to as bomb or dynamite fishing), in which fishers drop explosives into the water to kill or

stun fish for easy capture. This practice also causes severe damage to living coral and the underlying skeletal framework of the reef (Fox et al. 2005). Subsequent wave action and currents cause the loose coral rubble to shift across the seafloor, hindering the natural process of coral recruitment (Clark & Edwards 1995). Although blast fishing has been illegal in Indonesia since 1985, the practice is still widespread (Fox et al. 2005), including in areas of Buleleng.

> "*It was commonplace to hear seven bombs go off on the coast of this village each day.*"
>
> M_8.10 (Dive operator)[8]

> "The reef just became worse and worse. All day long we heard boom, boom, boom."
>
> M_10.6.3 (Ornamental fisher)

In Buleleng, blast fishing was reported as having been learned from the Japanese during their occupation of Bali in World War II (this information is supported by Pet-Soede et al. [2000]; and Elliott et al. [2001] in reference to blast fishing in Southeast Sulawesi). Although respondents from other parts of Buleleng stated that, at one time or another, blast fishing was fairly commonplace on the reefs adjacent to their communities, the practice was not used on the reefs at Les. This is important because, although other damages to the coral reefs at Les did occur, the underlying structures of the reefs nevertheless remained intact. Consequently, when the stressors to the reef were eliminated, the reef was architecturally capable of rapid regeneration, relative to reefs that had been bombed (Fox et al. 2005)[9].

Another early cause of damage to the coral reefs in Buleleng was mining of coral (Reksodiharjo-Lilley & Lilley 2007). This activity occurred at Les and other parts of Buleleng during the 1960s and 1970s, and reflects the extractive policies of the Sukarno Era (Aspinall 2001). Unlike regions lacking in stone and other building

[8] Interview in English.
[9] Additionally, the absence of blast fishing at Les may have provided local fishers with a unique perspective to identify cyanide as a principal cause of damage to coral reefs. At other communities, the effects of cyanide may have been masked by the damage caused by blast fishing.

materials, where coral is typically used as a building material directly (cf. Clark & Edwards 1995), the coral extracted at Les was used to obtain calcium carbonate for cement. Nevertheless, the effect on the reef remains the same: mining removes the upper 0.5 m of the coral, leaving the reef bare (Clark & Edwards 1999). This activity was declared to be illegal in Indonesia in 1992 (Elliott et al. 2001).

Despite the negative impacts of these activities on the coral reefs across Buleleng, respondents indicated that, at the beginning of the 1980s, the majority of reefs nevertheless remained in healthy condition overall. It was during that decade that a new livelihood option reached Buleleng—one that would precipitate drastic changes to the state of the region's coral reefs.

3.3 Skills from East Java: The marine aquarium trade reaches Les (1980s)

Anecdotally, the first commercial aquariums in North Jakarta were built in 1922 (Lilley 2008). However, it was not until the 1970s and 1980s that the marine aquarium trade gained significant economic momentum in Indonesia (Lubbock & Polunin 1975; Reksodihardjo-Lilley & Lilley 2007). Initially, exporters of marine organisms were concentrated in Jakarta, and the majority of ornamental fishers were from Java. Nevertheless, those fishers traveled to other islands to collect marine organisms, and in the process, shared their skills with locals.

The marine aquarium trade first arrived in Les in 1982 with ornamental fishers from East Java. At that time, the fishers from East Java used nets and potassium cyanide or sodium cyanide (often called *potas* in Indonesian, and hereafter referred to as cyanide) in tandem to capture reef fish. A few individuals from Les learned the practice by observing the fishers from East Java, and subsequently became ornamental fishers themselves.

> "*Ten other men followed my example and became ornamental fishers. The thing that attracted them to it was that it is relatively easy. They didn't have to work too hard to earn a decent living.*"
>
> M_9.27 (First ornamental fisher in community)

Unlike the fishers from East Java, however, the earliest ornamental fishers at Les did not use cyanide, which was not readily available until 1986; instead, they used only barrier nets with approximately 5/8-inch mesh-size and small hand-nets. Cyanide use began earlier in other communities of Buleleng, particularly those closer to East Java or to Singaraja (the District seat, or capital, of Buleleng), where cyanide could be purchased easily.

> "*I bought cyanide in the local shops. The police sometimes told the owners they should not sell to fishers or fish distributors, but they did anyway. Farmers also bought cyanide to clean vegetables, so it was always available.*"
>
> M_10.6.4 (Ornamental fisher and guide)

In addition to damage caused by cyanide use, fishers at Les report that large amounts of branching corals were damaged during the acquisition of "fire shrimp" (*Lysmata debelius*). Because of this species' tendency to hide within the branching coral structure, fishers used metal hooks to break the coral. Fishers estimate that by 1990, up to 20% of branching corals were damaged by this harvesting activity. The impacts of this and other negative harvesting practices on coral and other reef species in communities across Buleleng accelerated rapidly throughout the 1980s. By 1990, fishers at Les report that up to 75% of the coral at Les was dead. This transition was accompanied by a precipitous decline in reef organisms, as reflected in *Table 3.1*.

Table 3.1: Ecological conditions of coral reefs at Les, Buleleng, Bali, 1986-2011

	Corals	Other marine organisms
1986	Live coral cover = ≤40%[10]	Food fish = 40% Ornamental fish = 40% • 50% "oversize"[11] • 50% marketable Invertebrates = 20%
1990	Live coral cover[12] = 25%	All species decreased in number; estimated to be 50% of 1986 population[12]
2000	Live coral cover[12] = <10%	Food fish = 60% Ornamental fish = 20% • 50% "oversize"[11] • 50% marketable Invertebrates = 20% All species decreased in number; estimated to be <10% of 1986 population[12]
2003	Live coral cover[13] = 30%	Marginal increases to fish and invertebrate populations; still lower than 1986 population levels
2011	Live coral cover[13] = 45%	Increases to fish and invertebrate populations; estimated to be 70% of 1986 population[12]

[10] Estimate based on Sukarno et al. (1986) study figures for Bali.
[11] For ornamental species, juvenile and small-sized fish have higher commercial value. Ornamental species over a certain size do not have commercial value, and may be consumed locally as food fish.
[12] Figures based on data from interviews with fishers at Les and the Indonesian Nature Institute (LINI), also based on data from Les.
[13] Figures based on data from surveys conducted by Marine Aquarium Council and LINI. Note that live coral cover here comprises primarily of smaller, less mature corals.

3.4 Coral reefs in crisis: A socio-ecological "downward spiral" (1990s)

3.4.1 Ecological damages to coral reef ecosystems

From an ecological standpoint, the long-term effect of using cyanide and other negative fishing practices on a coral reef is to reduce an ecosystem that was initially characterized by high biodiversity and structural heterogeneity (Jaap 2000) to one that is comparatively devoid of life, and structurally homogenous (Jones & Steven 1997). Cyanide use in particular is closely associated with the damage to coral reefs caused by the marine aquarium trade (Jones & Steven 1997). This highly toxic, rapidly absorbed compound inhibits cellular respiration in animals, and is lethal at high concentrations (Simeonova & Fishbein 2004). Ornamental fishers use cyanide because it causes fish to become sluggish, or even paralyzed (Pyle 1992), making them easier to catch. However, the high toxicity of cyanide can result in mortality of the captured organism, either in the possession of the fisher, or later, during distribution. Rubec et al. (2001) estimate that up to 90% of aquarium fish caught using cyanide may die between the reef and the retailer.

Exposure to cyanide also has devastating effects on coral communities in general. Because cyanide solution is squeezed onto the reef in a diffuse cloud, fishers cannot always target single organisms (*Box 3.1*). Consequently, non-target

Box 3.1: Preparation and use of potassium cyanide

Preparation

Cyanide is purchased in tablet form. Fishers dissolve the tablets in water and put the solution in a plastic squeeze-bottle fitted with a long spout. The strength of the cyanide solution, as well as the rate at which it is used, varies from fisher to fisher and is a function of personal preference, economy, and skill level. Sixty tablets comprise one kilogram of cyanide, and the fishers interviewed formerly used between 1 and 25 tablets per day.

Use

Fishers chase the target organism into a cranny on the reef (often into the branches of a coral) or into a barrier net, and then squirt out a cloud of cyanide solution. If the stunned organism is inaccessible, the fisher may also need to break apart the corals with a pry bar or hook. Because a diffuse squirt of cyanide solution cannot target a single individual, other non-target species (including coral) are also affected.

species and organisms are killed (Barber & Pratt 1998; Rubec et al. 2001), including the eggs and larvae (i.e., reproductive units) of species desired by fishers (Johannes & Riepen 1995, as cited in Mak et al. 2005). Overfishing in general also results in a critical reduction of gravid individuals of desired species (cf. Pet & Pet-Soede 1999), reducing that species' ability to reproduce, and can fundamentally alter habitats (Bellwood et al. 2005). For corals, the effect of cyanide is to kill the algal symbionts responsible for photosynthesizing between 40-100% of the corals' energy (Jones & Steven 1997; Falkowski et al. 1984). Diminished photosynthetic capabilities of the coral equate with a decreased capacity for growth and reproduction, and can result in mortality. Over time, the net effect of diminished ecological capacity and overall productivity of the reef will be a reduction (or elimination) of fishers' incomes.

Another significant source of damage to coral reefs in Buleleng from the 1990s onward is pollution (most notably sewage effluent and solid waste, such as plastic bags) and sedimentation[14]. Pastorok and Bilyard (1985) state that the increased nutrient loads of sewage effluent on reefs can enhance algal biomass and primary production, favouring invertebrates. This altered ecological state may out-compete corals and other reef-building organisms. Pollution may also contain toxic substances, which adversely affect corals and other reef organisms in a variety of ways (Pastorok & Bilyard 1985). Sediment can be borne in sewage effluent, and can also be deposited on reefs as the result of land use changes, such as clearing forests for agricultural land, or coastal construction (Smith & Buddemeier 1992). Sedimentation can diminish further coral growth rates by inhibiting light filtration, and may also increase the incidence of disease.

> "*Some of the forest above the village was being cleared to make fields,*
> *and the rains carried the soil down through the village into the sea.*
> *Near the river, the coral was covered by silt.*"
>
> M_10.5 (Former ornamental fisher)

[14] This pollution and sedimentation may be linked to increasing population density and changing consumer behaviour. Non-biodegradable waste is abundant close to both urban centres and smaller villages and, during the rainy season, is washed onto the reefs and carried on ocean currents.

In many communities across Buleleng, the damaging activities and processes detailed above (namely, blast fishing; cyanide use and overfishing; and pollution and sedimentation) occurred simultaneously (Yahya et al. 2008). The ecological interplay of these features is detailed in *Figure 3.1*. Some of the social drivers of ecological damage to coral reefs are discussed in the following section.

3.4.2 Social drivers of ecological damage

Referring to the social drivers of ecologically damaging fishing practices, Barber & Pratt (1998) write that ornamental fishers who use cyanide, "[respond] to very specific incentives: a new technology, a ready market for the product [ornamental species], lax government enforcement of anti-cyanide laws, and the lack of viable alternatives to make a living." Discussions with ornamental fishers from across Buleleng reveal a number of prevailing perspectives that additionally affect (or affected) fishers' decision to use cyanide (*Table 3.2*).

Above all, cyanide was viewed as a simple and relatively inexpensive way to capture fish:

> "*Using cyanide was easy. I learned in five minutes.*"
>
> M_10.27 (Ornamental fisher)

Some fishers were even provided with cyanide by local fish distributors:

> "*The distributor regularly gave me cyanide, but if the police ever asked him about cyanide-use in this community, he would say he knew nothing about it. It was entirely my fault if I got caught.*"
>
> M_10.5 (Former ornamental fisher)

Additionally, the sharp decreases in ornamental fish stocks of the 1990s actually served to reinforce fisher behaviour, due to the economic phenomenon of diminished supply with constant (or increasing) demand resulting in higher prices.

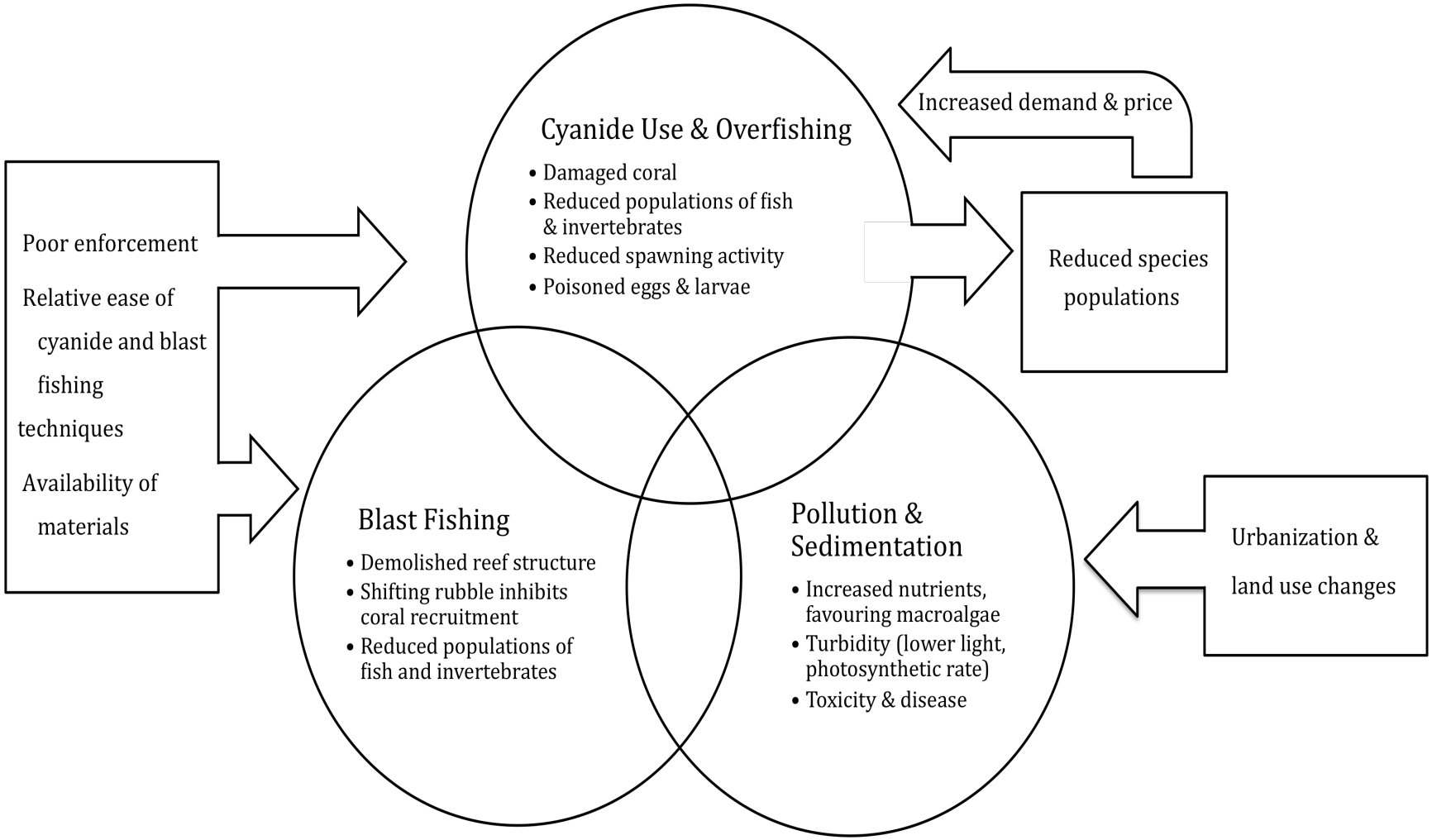

Figure 3.1: Overlapping sources of damage to coral reef systems and social drivers of sources. Each circle represents geographic areas where a type of damage occurs to reefs; overlapping circles represent areas where more than one type of damage is present.

> "*Over time, the coral and the reef fish were disappearing, but prices kept rising, so my income was stable. I was comfortable, but I worried about my future income.*"
>
> M_8.9 (Ornamental fisher)

Prior to their encounters with NGOs, not all fishers were aware of the effects of cyanide on coral reefs. In fact, some fishers were unaware that cyanide not only posed a danger to the reefs, but also to human beings. For example, one fisher reported using his teeth to break a tablet of cyanide in half. He lost all sensation in his mouth for about 30 minutes, but suffered no serious long-term consequences. For fishers like him, the damage observed on the reefs was ascribed to some other cause, such as pollution, blast fishing, or coral bleaching events (associated with climate change).

Table 3.2: Fishers' perspectives influencing their decision to use cyanide

Perspective	**Description**
"It's my family or the reefs"	Fishers identify ecological problems for reefs, but lack alternatives. They are willing to exchange the long-term health of coral reefs to meet their immediate financial needs.
"The real culprit is…"	Fishers perceive ecological problems for reefs, but fail to identify cyanide use as one of the causes. Other causes of damage, such as pollution, blast fishing, and climate change (bleaching) are blamed instead.
"It's somebody else's reef"	Fishers identify the ecological problems associated with cyanide use; however, because they often travel to other communities to collect fish, they lack a sense of ownership of those problems. They are willing to pass the problems along to another community.
"The reefs are dying, but prices are rising"	Fishers identify ecological problems for reefs caused by cyanide use and overfishing, but continue to use cyanide because of strong financial incentives. This perspective stems from the economic phenomenon of diminished supply resulting in higher price.

Furthermore, because many fishers traveled away from their home communities to collect fish and other organisms, they did not observe long-term changes to any one particular reef. Conversely, some fishers working in remote locations were aware of the impacts of cyanide of coral reefs, but lacked a sense of "ownership" of the ecological problems they were contributing to.

> "*I travelled to Sulawesi in a big boat with many fishers, and learned to use cyanide there. It was so easy. I only thought about making money for today.*
>
> *Over time, I saw a gradual change to the reefs in the places we travelled to, but I thought it was because of rubbish, bleaching, and broken coral. But I saw no evidence that cyanide was killing coral .*"
>
> M_10.15 (Ornamental fisher)

Of the fishers who understood the impacts of cyanide and perceived the reefs to be in crisis, many were caught in a perceived dilemma of choosing between their "family or the reefs", in which they saw no option but to damage the reefs in order to earn a livelihood. Regarding cyanide use, Richmond (1993:533) writes that, "poverty reduces the alternatives for fishermen who must feed their families." Many fishers in Buleleng own no land, and do not own a boat or other fishing gear. To turn away from ornamental fishing often means finding work as a wage labourer outside their village, perhaps as far away as Denpasar (about 3 hours from Buleleng).

> "*I knew that cyanide was killing coral. I even knew it was possible for all the coral near my village to die, and that it might not be around for my children. But I needed to feed my family.*"
>
> M_10.6.2 (Ornamental fisher)

Meaningful alternatives to using cyanide were not made available to ornamental fishers in Les until 2000, with the arrival of the first NGO to work in that community. In many cases, it was from that organization that fishers in Les first

became aware of the impacts of cyanide, and also learned new techniques for harvesting ornamental species.

3.5 Skills from NGOs: New techniques reach Les (2000s)

3.5.1 Cyanide-free fishing skills

In 2000, an Indonesian NGO, YBN, made inquiries with marine aquarium exporters to identify a target community with whom they might share ecologically improved fish harvesting techniques. Importantly, those techniques did not include the use of cyanide, but instead relied on the use of barrier nets and hand-nets to capture fish[15] (Yahya et al. 2008). YBN decided to work at Les because of the large number of fishers working there (~100 in 2000).

In order to gain fishers' interest, YBN personnel entered Les posed as employees of a marine aquarium exporter who wanted to purchase fish caught without the use of cyanide. Because no fishers had the necessary skills at that time to catch fish without using cyanide, YBN offered to provide training in the use of nets. Initially, just two fishers were willing to learn the new techniques; nevertheless, those fishers were closely observed by their peers, and over time, greater numbers of fishers expressed interest in learning the new techniques.

The new harvesting techniques provided fishers with a sustainable alternative to using cyanide. This is important, because although some fishers at Les had already become aware of the negative impact that cyanide use was having on reef health (and their livelihoods), prior to the arrival of YBN, they had lacked alternatives. In this sense, the gradual increases in fisher awareness of the impacts of cyanide acted as the first trigger for social-ecological change at Les (i.e., a desire to protect fishers' livelihoods). The second trigger came in the form of new skills (i.e., a viable alternative to harvesting reef species using cyanide). Alternatively stated, some fishers at Les desired an alternative, and YBN provided it. When that alternative proved to be effective and capable of providing fishers' with income, greater numbers of fishers became interested in learning the new techniques.

[15] See *Appendix A* for a description of the fishing gear and harvesting skills taught to fishers by NGOs.

After a period of several months training the two initial fishers, YBN revealed its true identity as an NGO, and explained its goal of teaching the new techniques to fishers at Les. The fishers apparently did not resent or otherwise question the initial deception used by the NGO. A series of discussions began between YBN, the village authorities at Les, and the fishers to determine what types of social action were best suited to getting fishers "on side."

Those discussions led to the formation of an ornamental fishers' association (*kelompok nelayan ikan hias*) in 2001. Fishers' and other community associations are widely established in Indonesia in general, and reflect the government's policy to encourage such institutions (Satria & Matsuda 2004; Satria et al. 2006b).

Not all ornamental fishers at Les became members of the fishers' association. Nevertheless, YBN was able train both members and non-members in the new harvesting techniques, as well as improved handling techniques of marine organisms. Non-members of the fishers' association also learned by observing members who had received training, and by 2003, cyanide usage was completely abandoned at Les.

As of the writing of this document, the Ocean and Air Police (OAP) continues to monitor the area for cyanide use; however, a greater incentive to abandon the practice came from the social cohesion between fishers and a collective willingness to try a radically new approach. If a fisher were to be caught using cyanide on the reefs at Les, they would be warned once; if the infraction were to occur again, that individual would be turned over to the authorities. However, according to fishers at Les, no warnings have been necessary to date.

As fishers at Les further developed their skills with nets and techniques for effective communication, they adopted a central role in the dissemination of the new techniques to fishers in other villages. Although cyanide use persists in some communities where this extension has occurred, in many cases, after fishers have been convinced of the usefulness of the new fishing techniques, they welcome an alternative to using cyanide.

> "*I used to experience many problems using cyanide, such as run-ins with the police or village authorities, so I was grateful to have an alternative. I thought it was possible to earn a living using the new techniques.*"
>
> M_10.9.6 (Ornamental fisher)

3.5.2 Reef restoration skills and strategies

Also in 2003, YBN began collaborating with Marine Aquarium Council (MAC) and other NGOs. This collaboration allowed those organizations to broaden their vision for the coral reefs at Les, and to begin reef restoration activities in the newly cyanide-free fishery. Restoration strategies at Les and other communities in Buleleng have taken various forms, depending on available resources and the broader social-ecological goals of the individual community.

Early coral reef restoration activities at Les involved raising coral stock in shallow-water nurseries and transplanting it onto the reefs. This strategy, however, is both costly and labour-intensive (often relying on the fishers' volunteer labour), and presently the majority of ongoing coral propagation activities at Les are done by a company which sells coral cuttings to marine aquarium exporters[16].

Alternative strategies for reef restoration include the use of artificial reef structures (ARSs), typically made of concrete. These structures provide a textured surface upon which corals and other organisms can grow, and also provide refuge for reef species, effectively creating a "micro-reef". In 2005, the MMAF proposed a program to build 1000 ARSs across Buleleng; however, for reasons of funding, that project did not materialize, and just one structure was built at Les[17].

> *"The restoration activities at this village are like the reef itself. Fishes come and go, but the coral is permanent. In the same way, we are willing to try new things, and if they do not work, we let them go. But*

[16] Note that the sale of natural (i.e., wild) coral is prohibited by Indonesian law. All coral for the marine aquarium trade must be third generation growth—that is, commercial coral must be harvested from corals propagated from natural cuttings.
[17] The pagoda-shaped concrete structure stands 2.5 meters tall, and remains onshore.

> *using nets and not cyanide is permanent* [that is, the village has long-term commitment to using net techniques and not cyanide]."
>
> N_10.25 (Head of fishers' association)

In 2009, LINI developed three new types of ARSs. The production methods of these structures were taught to local fishers at Les and other parts of Buleleng:

1. Fish dome: Approximately 100 cm tall and 60 cm in diameter, this hollow structure provides habitat for fishes (which access the dome through small holes), and supports coral and other organisms on its surface.
2. Roti buaya[18]: Approximately 40 x 30 x 10 cm (L x W x H), this solid structure stands on four legs, and provides both a surface on which coral can grow, and a sheltered area beneath for cryptic organisms.
3. Shrimp pot: Approximately 20 cm tall and 20 cm in diameter, this hollow structure has narrow gaps in its sides which allow ornamental shrimp species to pass through and to shelter inside. This ARS type does not support coral on its surface.

The ARSs developed by LINI have been installed in locations across Buleleng. The shrimp pot is particularly popular with fishers at Les, and as of March 2012, approximately 800 shrimp pots, 60 roti buaya, and 30 fish domes had been installed on the reef, or were under construction (M.P., personal communication). Importantly, the use of ARSs allows fishers to work in a localized area, reducing the need to travel from reef to reef in search of ornamental species.

> *"In the past, ornamental fishers from Les used to fish along the coast of Buleleng. The problem for them now is that many of these former fishing areas are closed to them because of hotels and marine protected areas. Artificial structures allow the fishers to develop microhabitats in their village waters, so that they do not need to go elsewhere.*

[18] Literally, *crocodile bread*. The structure resembles a traditional bread used for wedding ceremonies in parts of Indonesia.

> *These artificial reef structures are built and installed by the fishers, and supported technically and financially by LINI.*
>
> *There was some discussion within LINI as to whether we should freely share information on how to build and use artificial reef structures. The question was, if the information is shared, will there still be a need for LINI? The final decision was to freely share the information.*"
>
> N_9.15 (Director of NGO, LINI)[19]

Here, the partnering approach exercised by LINI is evident—fishers have been equipped to build ARSs, and to teach their construction to other fishers. Importantly, some fisher-led innovation is now occurring with these structures, and experimentation is occurring with different spacing on the reef, as well as construction techniques, resulting in a type of knowledge co-production.

At other locations in Buleleng, reef restoration activities have taken other forms. For instance, at Penuktukan (located immediately east of Les), some ARSs have been installed on the reefs. Additionally, a portion of the community's reefs has been closed to ornamental and other types of fishing, and is being developed as a diving site for tourists. Stakeholders, including ornamental fishers from Les, express the belief that this protected area (PA) not only allows the enclosed reefs to rejuvenate without fishing pressure, but also results in increased numbers of ornamental species that "spill over" into the areas that are open to fishing.

> *"The ornamental fishers from Les had already developed an understanding of reef ecology, so they were willing to cooperate with us to develop a protected area at this village. They stopped fishing* [in the PA] *and the coral and fish populations grew rapidly. The fish are able to move to other areas on the reef as well.*"
>
> M_10.27 (Community leader)[20]

[19] Interview in English.
[20] Interview in English.

Another widespread strategy for reef restoration seen in Buleleng is to create PAs that encompass a community's entire reef, and to prohibit all fishing activities. This strategy is typically associated with the tourist industry, and may allow the reef to regenerate naturally, or may use artificial structures. A notable example of this strategy can be seen at Pemuteran (located 60 km west of Singaraja), where local stakeholders have learned from German and American scientists to use Biorock® technology to create over 50 ARSs, some measuring as much as 11 m in length[21]. The reef-creation activities at Pemuteran are aimed at increasing tourism, and are funded by local hotels, dive operators, and tourist donations. The relatively high cost of creating these structures, and of purchasing the necessary electrical equipment to amplify them, necessitates strong and ongoing sources of funding. Consequently, other communities without strong links to tourism or alternative sources of funding may not be able to pursue this reef restoration strategy on a meaningful scale.

The range of strategies for reef restoration used across Buleleng includes, at one extreme, no control over fishing (i.e., no restoration and unrestricted use of cyanide), and at the other, total prohibition of fishing to allow for maximum reef rejuvenation. Also on that spectrum are communities such as Les, where ornamental fishing is allowed, but controlled, and also Penuktukan, where fishing activities are prohibited in some areas, and allowed in others (*Figure 3.2*). In areas where fishing is prohibited, reef rejuvenation may occur at a natural rate through coral recruitment, or may be anthropogenically assisted in some way (Edwards & Clark 1998). In Buleleng, areas where fishing has been partially or completely prohibited are typically associated in some way with tourism, which may offset fishers' loss of income. However, fishers may also voluntarily close a portion of their own fishery for a limited time period to enhance the process of ecological recovery (Yahya et al. 2008).

[21] Biorock® structures are made of iron rebar and charged with a low-ampere electrical current. This current accelerates the accretion of calcium carbonate from seawater onto the structure, and is reported to increase the growth rates and overall health of corals.

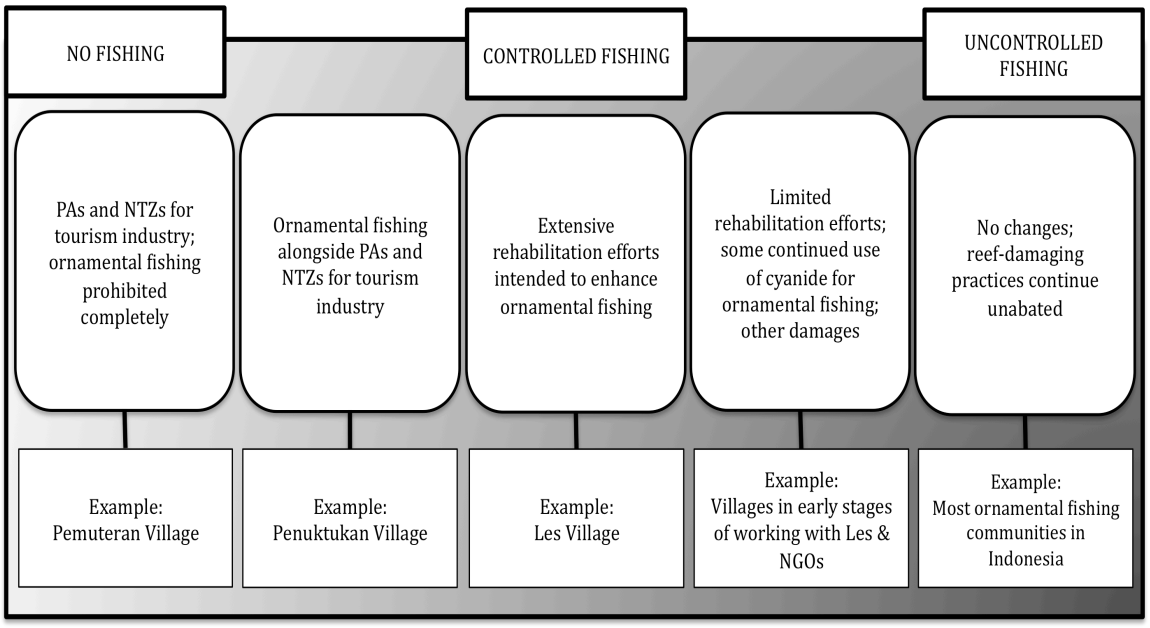

Figure 3.2: Spectrum of strategies for coral reef restoration in Buleleng

3.6 Summary: Transformations of the reef, transformations of the mind

The coral reefs at Les and other parts of Buleleng have still not recovered from the damage incurred over the past 30-40 years, and in many places, the damage is ongoing. Nevertheless, the events at Les demonstrate that it is within the power of organizations and individuals to bring about positive ecological transformations for coral reefs.

In addition to the ecological gains at Les, a high degree of economic (livelihood) stability has been achieved. In contrast to just over a decade ago, when some fishers in that community anticipated a total collapse of the reef (and consequently, of the ornamental fishery there), fishers are now confident that their livelihoods will remain viable into the foreseeable future. For those fishers, the ecological crisis created "space for reorganization, renewal, and novelty as well as [providing] opportunities for new ways of social self-organization for resilience" (Folke et al. 2005:455). A critical factor in this process has been to address the worldviews and perspectives held by fishers in the past, a feature that will be examined in detail in Chapter Four. A timeline of events associated with the marine aquarium trade in Buleleng, from the 1960s to the present, is included in *Table 3.3*.

Table 3.3: Timeline of marine aquarium trade (MAT), Les, Buleleng (1960s-Present)

1960s-1970s:	– Damage to reefs caused by coral mining, vessel anchoring and groundings (at other villages, damage also caused by blast fishing)
1980s:	– MAT expands in significantly in Bali
1982:	– First ornamental fishers in Les, taught by fishers from East Java
1986:	– Cyanide first used by fishers on reefs at Les – Reefs still "healthy" (40%[22] live coral cover)
1990:	– All fishers at Les adopt cyanide use – Damage by pollution and sedimentation – Precipitous decline in health of reefs (25% live coral cover) – Numerous ornamental fish distributors
2000:	– Coral reefs in state of crisis (<10% live coral cover) – Inquiries about Les by YBN – YBN at Les, identifying themselves as exporters – MMAF founded[23]
2001:	– Dialogue between YBN, village authorities, and fishers – *Kelompok nelayan ikan hias* (fishers' association) formed – Training in using nets begins
2002:	– Training expands in scope; more fisher participation
2003:	– All fishers at Les abandon use of cyanide, adopt new net techniques – Marine Aquarium Council (MAC) begins working at Les – Earliest coral reef restoration work
2004:	– Fishers take central role in training fishers from other communities across Indonesia in new techniques – NGO network expands, develops partnerships with government – Community-based export business established at Les
2005:	– MMAF develops closer ties with Les and NGOs – Two fishers from Les hired as part-time MAC staff
2005-2008:	– Certification of MAT by MAC International
2008:	– MAC Indonesia dissolved; LINI established by former staff – Community-based export business at Les declares bankruptcy – YBN ends program at Les – Protected area established at Penuktukan, reducing the harvesting area available to fishers from Les
2009:	– ARSs (shrimp pot, *roti buaya*, and fish dome) introduced at Les and other villages
2009-Present:	– Fisher-led experimentation with ARSs at Les
2011:	– ~45% live coral cover (LINI survey data)

From interview data; also, [22] Sukarno et al. 1986; and [23] MMAF 2008

Fishers moving a newly-made "fish dome," a type of artificial reef structure (ARS), to the reef. The pot-like structures in the truck are also ARSs, called "shrimp pots."

Fish domes after two years of coral growth. (Photo used courtesy of LINI.)

Chapter Four

Examining adaptive governance and knowledge co-production in the context of coral reef resources

4.1 A three-phase conceptual framework for interpretation

To better understand the transformations discussed in the preceding chapter, this fourth chapter will focus on how aspects of governance and knowledge co-production have contributed improved social-ecological outcomes at Les. Governance is here used as a more inclusive term than management, not merely concerned with actions, but also involving "politics, sharing rights and responsibilities, and setting objectives and the policy agenda" (Berkes 2010b), with an emphasis on trust-building, institutional development, and social learning (Armitage et al. 2011). Knowledge co-production involves processes or mechanisms that help bring together local and traditional knowledge with scientific knowledge to enable learning (Armitage et al. 2011).

Following Habermas (1981) and Prabhu et al. (2007), Berkes (2010b) provides a useful conceptual framework for analysis, consisting of three phases—namely, communicative action, self-organization, and collaborative action (*Figure 4.1*). The conceptual framework helps to explain the complex and interrelated processes observed by this research. In particular, the depiction of each phase as a cog or gear is intended to show how no individual process can occur without affecting the overall process of adaptive governance and knowledge co-production in some way. The information in this chapter will be presented in a *topical* (rather than *linear*) fashion. For a linear presentation of events at Les (i.e., a timeline) see Chapter Three (especially *Table 3.3*).

4.2 Communicative action

The first phase of the framework is concerned with processes of communication between stakeholders for the purpose of establishing a shared vision and shared understanding of issues (Berkes 2010b). Prabhu et al. (2007:18) state that a shared vision "is necessary for the shared ownership of processes,

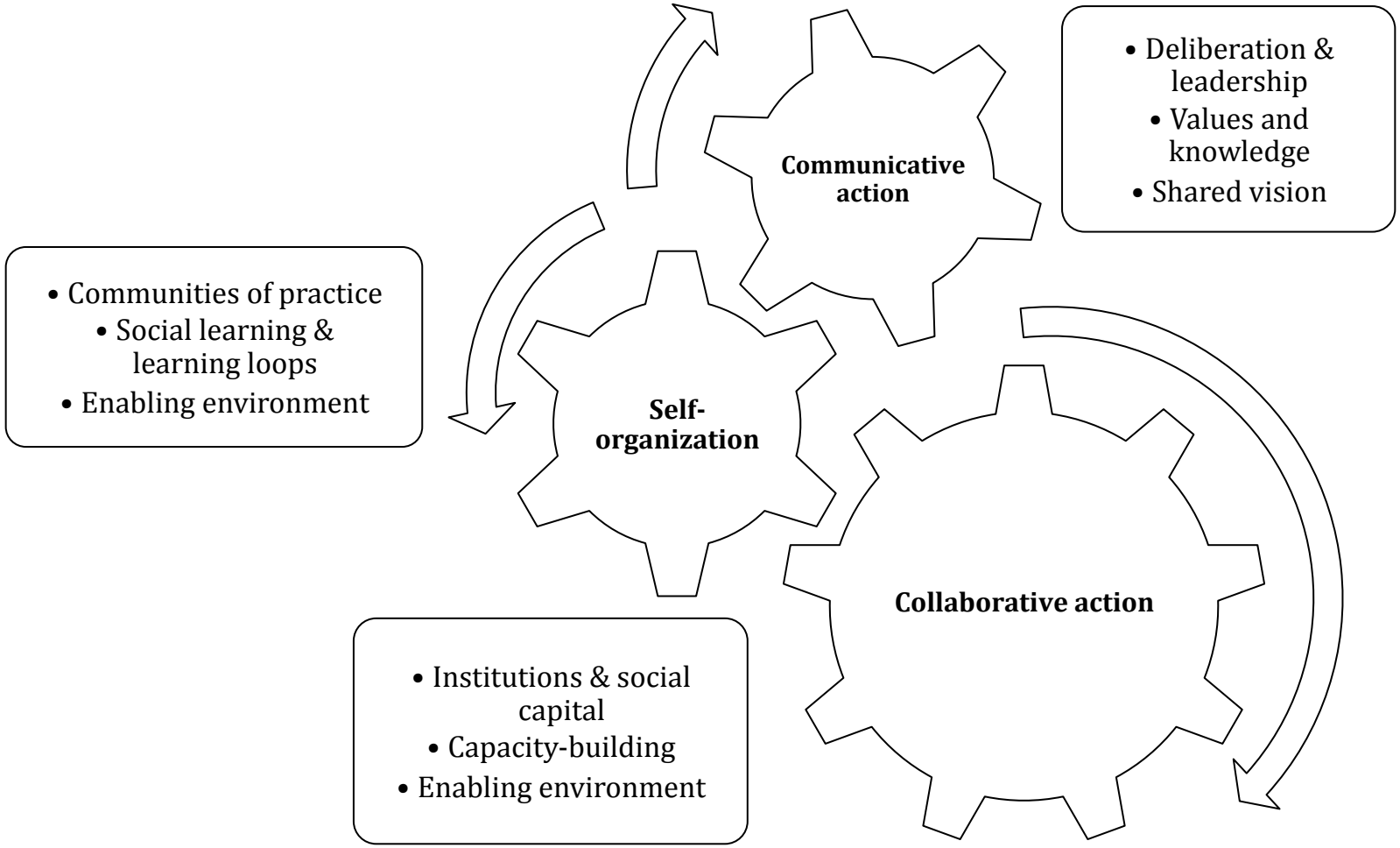

Figure 4.1: Conceptual three-phase model for understanding the processes of adaptive governance and knowledge co-production in the context of coral reef resources at Les, Buleleng. Adapted from Berkes (2010b) and others (see text).

decisions, and outcomes," and likely becomes increasingly important as stakeholders' individual interests and resource use patterns diverge (cf. Borrini-Feyerabend 1997).

4.2.1 Deliberation and the role of leadership

Deliberation is described by Berkes (2007) as the processes for communication between various parties, in which issues are discussed and considered, information and viewpoints are exchanged, and outcomes are assessed. It is an opportunity for the actors to persuade one another (Stern & Fineberg 1996). Stern (2005:979) writes that when deliberative processes occur in an environment that upholds democratic norms, practices, institutions, and laws, the result(s) will be "more consistent with the evidence, more robust against criticism, and more acceptable than what would result from universally adopting any single individual's judgments or any particular analytical technique." Armitage et al. (2008) summarize that deliberation allows for different interests, perceptions, and interpretations to be examined among stakeholders.

At Les, the processes of initiating changes to governance and knowledge co-production began with the arrival of YBN. That NGO initiated the communicative action phase by establishing contact with two ornamental fishers. From the beginning, YBN communicated its vision of developing an environmentally sustainable ornamental fishery at Les; however, they initially employed deception, claiming to be exporters. It was believed that fishers would not only be more accustomed to working with an exporter (fishers at Les had no prior experience working with NGOs), but would also respond well to perceived financial incentives.

After approximately two months, YBN acknowledged its true identity as an NGO. During subsequent meetings with fishers, YBN clarified its objective of creating a sustainable (i.e., cyanide-free) fishery at Les. At that time, the two fishers who had initially cooperated with YBN played key leadership roles, providing other fishers with firsthand evidence that the skills they had acquired from the NGO were viable. The continuing support of those individuals, who had already established relationships of trust with other fishers in their community, was an important factor

in the early success of YBN's activities at Les (see Seixas & Davy 2008; Seixas & Berkes 2010).

> "*Certain individuals in this community have been willing to try new things, and when they do, other people watch them. If they are successful, the others will usually follow.*"
>
> N_10.25 (Head of fishers' association)

The deliberative process at Les expanded in scope when both of the village authorities[24] became involved. As additional actors (such as the MMAF, researchers, and other NGOs) were invited to become involved, the deliberative process enlarged further, reflecting the viewpoints and relative expertise of each actor.

Fishers at Les also played a part in the larger discourse surrounding the marine aquarium trade in the Indo-Pacific in general. For example, the Marine Aquarium Market Transformation Initiative (MAMTI), which occurred across Indonesia and the Philippines from 2004-2007, involved three different NGOs[25], each with its own foci and areas of expertise. That initiative's goal was the eco-certification of the marine aquarium trade, including individual fishers, distributors, and exporters (Shuman et al. 2004).

4.2.2 Sharing and clarifying values and knowledge

Berkes (2010b) writes that because the governance approach and practice reflects the worldviews and knowledge of the participants, sharing and clarifying those points will help to coordinate activities. The approach and practice also provides participants with the opportunity to provide improved (sometimes scientific) information to all participants (Stern 2005). For example, prior to their interaction with NGOs, fishers at Les and across Buleleng did not fully understand the impacts of using cyanide on coral reefs, and lacked a substantive perspective of reef ecology in general. During meetings with fishers, the NGOs were able to

[24] At Les, as at other villages in Bali, there are two authorities—namely, the traditional (*Adat*) and administrative (*Dinas*) authorities (Zuryani 2006).
[25] Namely, MAC; Conservation and Community Investment Forum; and Reef Check.

directly address misconceptions about cyanide use and to provide instruction in ecological concepts[26].

> "*The first time I associated cyanide with dying coral was when MAC came to my village and showed a movie* [about the impacts of cyanide on reefs]. *It really got me thinking. It was my first 'ecological' education.*"
>
> M_10.6.4 (Ornamental fisher)

Importantly, theoretical training was combined with practical skills training (such as the use of hand-nets and coral restoration activities). This likely had the effect of presenting information in a meaningful and contextual manner (especially as many fishers have received a minimum of formal education), and of keeping the fishers engaged in the learning process (Habermas 1981; Mezirow 1997). It also provided fishers with information they were capable of "passing along" to other fishers in the form of applied knowledge.

> *"I was taught to use nets in 2007 by five fishers from Les. A few people from MAC were with them. We learned some theoretical aspects for half a day, and then we spent two days learning to make nets. After that, we spent a full day with the teachers on the reef, using our nets.*"
>
> M_10.6.4 (Ornamental fisher and guide)

At Les, as at other communities in Buleleng, the process of sharing and clarifying values and knowledge has served to erode negative perceptions concerning the fishers' relationship with the reefs (see *Table 3.2*), and to provide fishers with an ecological basis for understanding how sustainable reef management practices can result in improved coral reefs and sustainable livelihoods.

[26] Fishers were first shown an informational video; later, the NGOs addressed ecological issues in greater detail.

> "*The coral that is growing on the reef now is the result of colonization* [natural recruitment] *and coral gardening* [transplantation]*. The coral helps to draw the fish.*"
>
> M_8.8.2 (Ornamental fisher)

> "*I am happiest with the increase in fish on the reef. My work is easier now, and I can work closer to my home than when I used cyanide.*"
>
> M_8.8.1 (Ornamental fisher)

It should be understood that this process did not occur overnight; neither did it entail all participants arriving at a common understanding simultaneously. In actual fact, some fishers were quicker than others to explore new avenues of thought and modes of practice. Others were slower to change, and it was often only when their peers' actions proved to be successful that they were willing to change their own perspectives and behaviours. This differing response of fishers to change is likely a reflection of different preferences for risk taking, based on broad socioeconomic factors (Eggert & Lokina 2007).

4.2.3 Creating a shared vision

Effective communication between stakeholders can be improved through the creation of a shared vision—that is, an ideal, desired future (Prabhu et al. 2007). Berkes (2010b) states that an explicit vision of management goals and an understanding of the system being managed are essential to achieving adaptive co-governance of resources. Following that author, adaptive co-governance is here used to mean governance involving various stakeholder groups, and that occurs in a dynamic manner that learns from experience.

The process of developing a shared vision requires time and concerted trust-building among stakeholders, and necessitates that participants discuss and acknowledge trade-offs associated with different resource management strategies (Brown 2002). Related to the development of a shared vision is the anticipation of future challenges and uncertainties (Prabhu et al. 2007).

As fishers at Les and other parts of Buleleng have engaged with NGOs, government agencies, researchers, and others, relationships of trust have been built, and a shared vision has emerged. This vision merges a desire for ecological health of the coral reefs with a desire for sustainable livelihood opportunities for resource-dependent individuals. Central to this vision are ecologically healthy coral reefs. The envisioned sustainable livelihood opportunities include not only those associated with the marine aquarium trade, but also ecotourism and other potential activities.

As suggested by Berkes (2010b), the creation of a shared vision for resource governance has resulted in the empowerment of local resource users in Buleleng. In the process of talking with partners and developing new skills, ornamental fishers have gained valuable insights into how to work collaboratively towards improving their coral reefs, and many have developed a new sense of confidence in interactions with both fishers and non-fishers (such as government personnel and researchers).

4.3 Self-organization

The second phase of the framework elaborated upon by Berkes (2010b) is concerned with self-organization. Generally, Holling (2001:391) describes self-organization as the "development of complex adaptive systems, in which multiple outcomes are possible depending on accidents of history." Self-organization, assert Epstein & Axtell (1995:33), emerges from the "bottom up." Following those authors, Levin (1999) suggests that human and ecological landscapes share similarities in their capacity for self-organization, and act in response to the distribution of resources.

In the context of adaptive co-management, self-organization of resource users involves the development of both formal and informal networks, and occurs as a result of collaborative, creative processes (Armitage et al. 2009). The objectives of this self-organization process will vary according to the vision of different resource users, and are linked to the process of creating a shared vision described

above. The ability of actors to self-organize becomes, in itself, an important source of social relationships on both a local and regional scale (Marín & Berkes 2010). An important function of self-organization is to translate the visions and goals developed during the preceding communicative phase into plans that can be turned into action (Berkes 2010b). In that sense, the visioning process becomes a catalyst for self-organization (Seixas & Davy 2008), which in turn leads to action. Moreover, self-organization is about the development of relationships (Berkes 2010b).

Within the framework described by Berkes (2010b), self-organization occurs in three principal ways: by establishing communities of practice; through social learning and the application of theory to practice (i.e., praxis); and developing networks. These three points, and their applications at Les, will be discussed in detail here.

4.3.1 Developing communities of practice

Gutierrez et al. (2011) write that there is a tradition of self-organization associated with successful fisheries co-governance. A critical step towards self-organization lies in developing communities of practice, which can be defined as groups of individuals who share a common concern for something they do (i.e., practice), and who learn to do that activity better through regular interaction (Wenger 1998). Additionally, communities of practice function as fora for engagement, where individuals can synergistically address shared concerns.

As of this writing, there are presently four fishers' associations for consumption (food) fishing in Les. As described in Chapter Three, a community-based ornamental fishers' organization came into existence in 2001, following discussions between fishers', village authorities, and YBN personnel. This move was seen as a critical step towards enabling fishers and YBN to accomplish their shared goals of developing an environmentally sustainable ornamental fishery at Les.

Prior to the arrival of YBN at Les, ornamental fishers shared information (including skills and market information) through informal networks of kinship, community, and shared occupation. Decision-making by fishers was a dynamic process, made in response to new information and techniques becoming available.

Fishers generally played a passive role in being exposed to new knowledge, and were in engaged in a continual process of evaluation, experimentation, and trial and error (Halim 2002).

> *"Some ornamental fishers from southeast Sulawesi came to our community, and they were using cyanide. So my friends and I followed them and watched. It looked easy."*
>
> M_10.6.1 (Ornamental fisher)

> *"When fishers from* [a nearby community] *came to this village, they invited me to follow them. They didn't want any money to teach me to use cyanide. I just dove with them, and learned that way."*
>
> M_9.2 (Ornamental fisher)

Furthermore, the number of ornamental fishers at Les changed over time, with individuals entering and exiting the profession (or supplementing income through ornamental fishing) according to personal circumstances. In this sense, ornamental fishers at Les were involved in communities of practice even before the formal creation of an ornamental fishers' association. It was with those complex, pre-existing informal communities that NGOs worked; as Prabhu et al. (2007:32) point out, ignoring or working against them limit the sustainability of community-based management, and potentially jeopardize it altogether.

The formal creation of an ornamental fishers' association was, in part, in anticipation of the fundamental changes that fishers and NGO staff hoped to enact at Les. The fishers' association provided a forum in which fishers could exchange views and ideas, and where completely new knowledge could be shared in an efficient manner. The fishers' association also provided outsiders (such as government staff, researchers, and NGOs) with a representative body with whom they could interact, as well as the physical space in which to conduct those interactions.

> *"Government and NGO personnel, researchers, and other visitors come here to train, or to share information. In this way, the fishers' association is an important tool for networking, as well as organizing ornamental fishers, and settling some disputes* [between fishers]."
>
> N_10.25 (Head of fishers' organization)

The fishers' association at Les was established according to democratic principles: the executive structure[27] is re-elected every two years, and every member has one vote. The handling of funds is conducted in a transparent manner, with money physically counted in the presence of members during meetings. The measures taken by NGOs to ensure appropriate leadership of and participation in the fishers' association parallel those described by Hingco (1995). In reference to four case studies of community-based fisheries management in the Philippines, that author writes that skills training (such as management skills) can strengthen fishers' confidence in dealing with both the day-to-day and long-term aspects of sustaining a successful fishers' association (see also Heinen's [2003] description of fishers' activities in Danao Bay, Philippines).

The skills training described above is just one type of the broader social learning associated with self-organization. A more far-reaching perspective of that social learning will be explored here.

4.3.2 Social learning and learning loops

Prabhu et al. (2007) highlight several important characteristics of the social learning that ideally occurs in the context of community-based resource management. Firstly, learning occurs both on an individual level and for groups of interacting individuals. Additionally, learning in or among groups often intersects power-related (such as political or economic) issues, and may require the resolution of long-standing conflicts. Finally, effective social learning necessitates learning that

[27] The executive structure of the ornamental fishers' association at Les consists of five positions, including: Chairman; Secretary; Treasurer; Marketing Officer; and Public Relations Officer. An advisory group also works with the Village Head Office.

is both reflexive (i.e., learning from situations that have been experienced or observed) and anticipatory (i.e., considering potential future situations).

Because different communities of practice exist across multiple domains (Wenger 1998), effective social learning must occur collaboratively, and in a manner that addresses not only the issues within those domains, but also the barriers between them. One perspective that deals with learning across domains suggests that learning occurs in loops (Argyris & Schon 1978):

Single-loop learning is concerned with fixing errors in routines, but may fail to address the worldviews and values underlying those routines. This type of learning may rely heavily on outside stimuli, such as financial incentives or temporary programs; therefore, the potential remains for individuals to resume negative activities when outside intervention has ceased (Pretty & Smith 2004; Cao et al. 2009; Sinclair et al. 2011). When underlying worldviews and values have also been addressed, double-loop learning is said to have occurred, resulting in fundamental changes not only to stakeholder behaviour, but also to motive (i.e., why behaviours occur) (Armitage et al. 2008). Following King and Jiggins (2002) and Keen et al. (2005), Armitage et al. (2008) suggest that an additional type of learning—triple-loop learning—may occur when learning also focuses on the norms and protocols upon which single- and double-loop learning are based.

Discussions with fishers across Buleleng indicate that, prior to contact with NGOs, ornamental fishers who used cyanide engaged in a type of informal learning process with other fishers and authorities (principally, the OAP). Fishers were exposed to limited amounts of education from authorities.

> *"There were posters put up by the police telling fishermen not to use cyanide because it was bad for coral, but I didn't understand* [the information]*. I believed the damage I saw was from bombs.*"
>
> M_10.6.1 (Ornamental fisher and guide)

A more important type of learning by fishers occurred as a result of the authorities' efforts to eradicate (or at least to limit) the use of cyanide. Fishers caught using cyanide faced steep fines, confiscation of fishing gear, and possible imprisonment.

> *"The* [ecological] *condition of the reef was becoming so poor, and I was harassed by the police so often that I decided to stop ornamental fishing. I moved to Denpasar and worked in the construction industry."*
>
> M_10.27 (Ornamental fisher)

Although these punitive measures were enough to encourage some fishers to seek alternative livelihoods, many simply resorted to secrecy, fishing in locations that were infrequently monitored by the OAP. Anecdotally, some fishers are said to have hidden prepared bottles of cyanide underwater, thereby reducing their chances of being caught during use. However, even when caught, fishers indicated that many were able to avoid punishment by paying a bribe. Overall, the ability of the OAP to meaningfully reduce cyanide use by fishers in the communities involved in this study was negligible. In light of this and the issues outlined above (secrecy, corruption, and the abandonment of ornamental fishing by some individuals), the type of learning that occurred in Les and other villages across Buleleng conforms to definitions of single-loop learning (*Figure 4.2*) (Armitage et al. 2008).

When NGOs began working in Les and other parts of Buleleng, they were able to achieve better results. This was partly due to the ability of NGOs to focus their attention on a single community or group of communities, and consequently, to devote more resources per capita than the MMAF towards achieving their goals. However, their improved results were also due to a fundamentally different strategy, which focused on educating fishers in ways that linked theory and practice, as well as addressing the fishers' underlying worldviews concerning coral reefs. The NGOs helped to establish an enabling environment in which to provide fishers with important ecological perspectives, explaining not only the impacts of cyanide on coral, but the role of coral in sustaining viable populations of fish and other reef

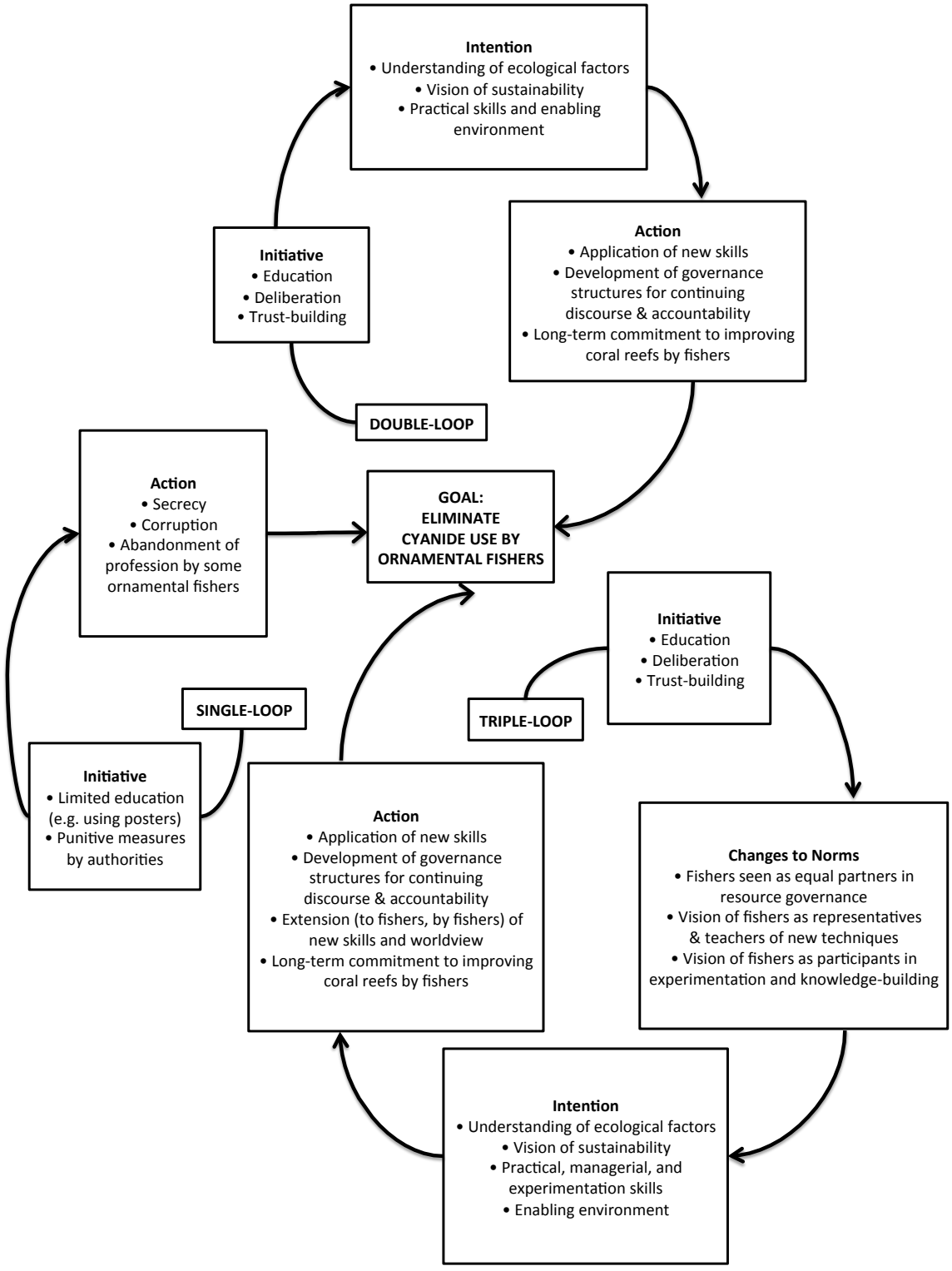

Figure 4.2: Comparison of single-, double-, and triple-loop learning processes and outcomes in the context of coral reef management in Les, Buleleng. Loops move inwards towards the goal of eliminating cyanide use by ornamental fishers. In this case, the single-loop process did not adequately meet this goal.

organisms. Other hurdles were addressed more gradually, such as fishers' reluctance to openly discuss their collective guilt concerning damages to the reef.

> *"We* [ornamental fishers] *didn't want to think or talk about the poor condition of the reef, because it was a problem we had caused ourselves. We were guilty, and we knew it, but we did not want to acknowledge it.*"
>
> M_9.2 (Ornamental fisher)

> *"There is a strong desire to talk about 'happy' and 'good' things. Issues that are embarrassing are avoided. Because of the collective guilt associated with cyanide use, discussions with ornamental fishers require tact. It must be conveyed that when they stop using cyanide, they are changing their practices for themselves and their families, and not necessarily for other people, or for the authorities.*"
>
> N_9.15 (Director of NGO, LINI)

Importantly, unlike the punitive measures exercised by the OAP, the NGOs provided fishers with a practical alternative to using cyanide that did not necessitate finding a new profession. Consequently, the NGO-led initiatives achieved rapid success in positively altering both fisher behaviours and motives, describing a type of double-loop learning (*Figure 4.2*).

Finally, a case can be made for the occurrence of triple-loop learning at Les, where the success of education initiatives have prompted NGOs and MMAF staff to reexamine the role that fishers should play in achieving the goal of eliminating cyanide use by ornamental fishers. The resulting changes to underlying norms have included: perceiving fishers as equal partners in marine resource governance; developing a vision of fishers as the representatives and teachers of new techniques; and adopting a strategy that places fishers at the centre of research and extension involving the use of artificial reef structures. To better understand the possible occurrence of triple-loop learning at Les (and to better distinguish it from aspects of double-loop learning), further research is necessary.

Mascia (2002:632) writes that making research and monitoring activities participatory, and "enlisting stakeholders in data collection and analysis will educate participants, build capacity, and foster trust." Raymond et al. (2010) take knowledge integration further, and argue for acknowledgement of multiple valuable ways of knowing; a focus on social processes and values involved in producing new knowledge; and continual discourse between actors.

At Les, fishers' involvement with ARSs demonstrates aspects of knowledge co-production. Because some of the ornamental fishers across Buleleng began fishing after the introduction of cyanide fishing as the dominant form of fishing, they lacked (or continue to lack) significant local (indigenous) knowledge of reef ecology. However, because of their frequent contact with the reef, they are ideally equipped to observe changes to the reef over time. Additionally, they have a thorough understanding of ornamental fishing and what does or does not "work," and are therefore able to evaluate the impact of new techniques and technologies.

Through experimentation with ARS construction methods, placement, and management, fishers can improve knowledge outcomes, and fine-tune what is otherwise "outside" knowledge to local conditions. In this way, fishers are an important source of relevant, "on-the-reef" knowledge which can be combined with knowledge inputs from other stakeholder groups to produce new knowledge. Importantly, LINI (the initial developer of several ARS designs) receives this knowledge from fishers through local fisher personnel, creating an ongoing discourse among actors.

The shifts in perceptions detailed above have also provided the MMAF with a more effective strategy for reaching their objectives concerning cyanide use by fishers. It is generally acknowledged that the MMAF lacks sufficient resources to address the problem through patrolling and enforcement alone (cf. Elliott et al. 2001). Working with fishers in a more inclusive, participatory manner allows for ecological gains that are cost effective and sustainable. In fact, among fisher-instructors disseminating the new, cyanide-free techniques, their confidence in the effectiveness of their work is such that, in areas where fishers have adopted the techniques, those individuals propose a reduction in police patrols.

> *"Ornamental fishers in this community have not used cyanide since 2003, and so there is no need for continuing police patrols here. Really, it* [monitoring] *just wastes money that could be used to buy more useful things, such as nets and other equipment for ornamental fishers here."*
>
> N_10.25 (Head of ornamental fishers' association)

4.3.3 The importance of networks

The participatory, reflexive approach to governance described above is characterized by a high degree of complexity, relying on numerous players and institutional linkages to remain effective. These linkages, or networks, may exist across both spatial (horizontal) and organizational (vertical) scales, and may involve the participation of community-based associations, local and international NGOs, entrepreneurs, government agencies at various levels, and researchers and other civil science networks (Berkes 2004). Networks can be focused on learning, research, technical support, research, political representation, fundraising, identifying new partners, and providing access to markets and capital (Seixas & Berkes 2010; Marín & Berkes 2010; Berkes 2010b). Because of the potential for the strength of interactions between any two players in a network to fluctuate over time, the redundancy of interactions within these networks has been linked to resilience (Seixas & Berkes 2010). However, Marín & Berkes (2010) caution that relationships across networks may not only be facilitatory and collaborative in nature, but may also hinder and cause (or result from) conflict.

Closely related to pre-existing communities of practice, some linkages and networks were already in place at Les prior to the arrival of YBN and other NGOs; however, the number (and arguably, the intentionality [Wenger 1998]) of networks increased after 2000. *Figure 4.3* provides a conceptual picture of social interactions between networks at Les and across Buleleng (note that this depiction was developed during a focus group with fishers from Les and LINI staff, and is not based on a social questionnaire). The networks include: fishers from various communities (including fishers who have moved to or away from Les); local,

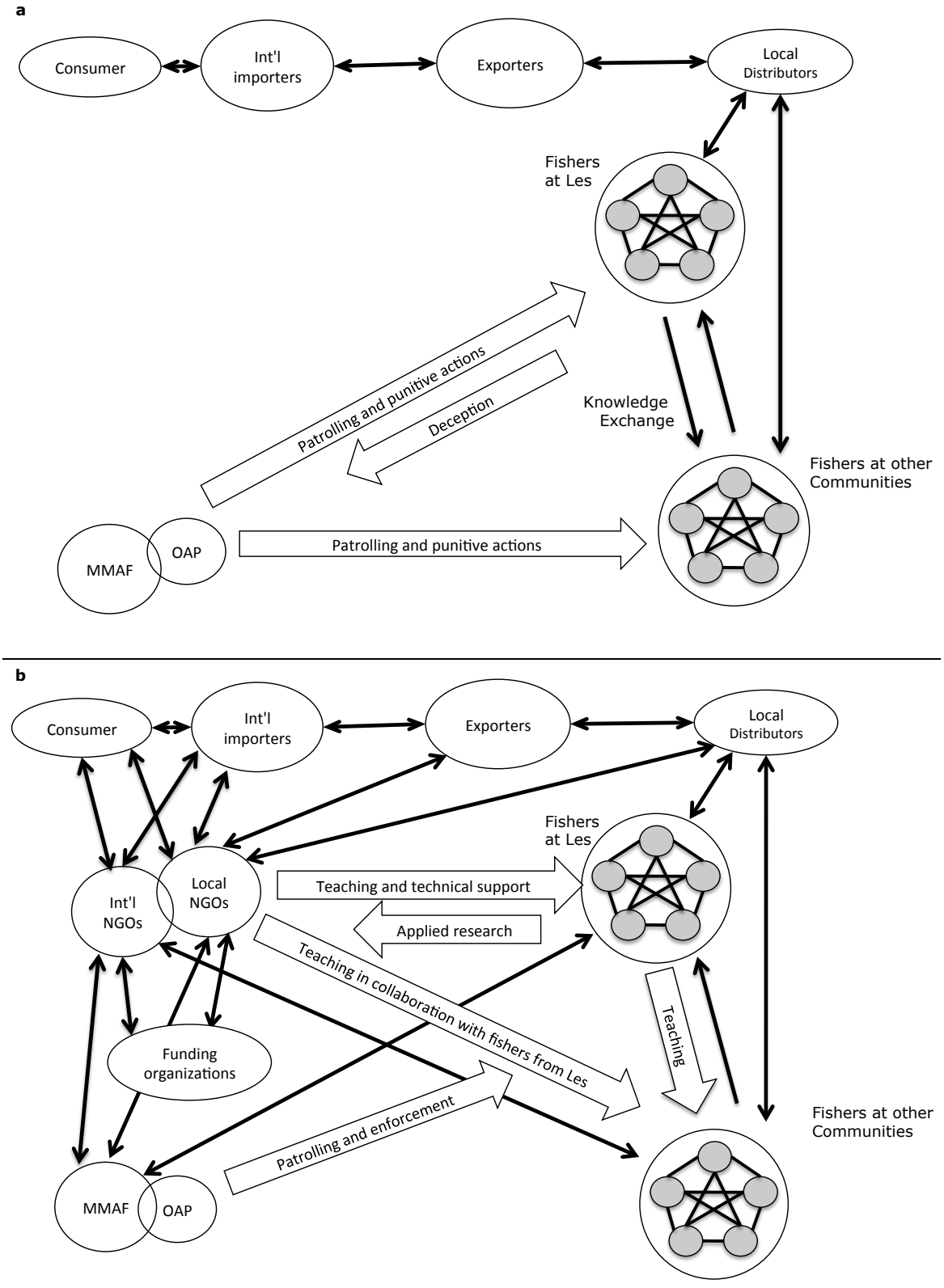

Figure 4.3: Comparison of networks at Les, Buleleng, (a) before the arrival of NGOs; and (b) after. Black, two-headed arrows represent linkages with exchange of information in two directions. White arrows indicate important sources of information and other inputs. The

two diagrams shown here are based on diagrams developed during a focus group with ornamental fishers and NGO personnel.

national, and international NGOs (with linkages to funding agencies); the MMAF at the national and local levels (which provides important resources, and also receives technical training from NGO marine scientists); entrepreneurs (such as tourist operators and exporters in the marine aquarium trade; and researchers (from both Indonesian and international institutions). Networks are frequently overlapping (that is, they involve players from multiple networks), and tend to evolve over time. For example, there is significant overlap and exchange between NGOs in terms of personnel, skills training, policies, and goals.

The increase in the number and complexity of networks depicted in *Figure 4.3* shows the importance that individual organizations (or clusters of organizations) can have in facilitating exchange. Notably, the introduction of local and international NGOs into the network radically changed both the number of linkages, as well as the way in which actors interacted. Similarly, as the role of ornamental fishers from Les in teaching and sharing new techniques to other fishers expanded, the importance of that community within the network also grew. Finally, the involvement of local and international NGOs has created linkages between the ornamental fishers and the consumer (i.e., end purchaser) of ornamental species. While this interaction presently remains a weak one, the potential exists for this linkage to become an important means for improved public understanding of sustainability issues related to the marine aquarium trade. (At least one NGO, LINI, has plans to develop interactive, online ways to connect consumers and ornamental fishers in a more direct manner, thereby "putting a face" to sustainable ornamental fishing.)

Within the ornamental fishing communities where LINI works, that NGO has taken care to identify individuals with whom they can network directly. Two such individuals from Les (both in their mid-twenties at the time that activities began in that community) can be characterized as "boundary people"—that is, prolific networkers with contacts across communities. One of these individuals has since relocated to another community, where he works to disseminate sustainable

harvesting techniques. The other maintains an active role at Les and in ornamental fishing communities across Bali.

Communication by mobile phone has greatly facilitated this connectivity, and the boundary people mentioned above can easily contact fishers in different communities. During my research, telephone calls made by those individuals allowed me to arrange meetings and access information across communities.

The functions of the network interactions generally follow those described by Seixas & Berkes (2010), with most contributing to knowledge sharing and knowledge creation, acquisition of fishing gear, technical support, and research[28]. Weaker network interactions exist to facilitate access to capital and markets, raise funds (primarily for LINI's and fishers' activities), and enable political networking.

After the successful transition away from cyanide use at Les, two fishers from that community were identified by LINI for further training and capacity-building (this discussed in greater detail in *Section 4.4.*2). As of this writing, the fishers are part-time employees of that NGO. One of these individuals remains at Les, and another lives in a village in Banggai, Sulawesi. A constant presence in Banggai allows the NGO to better provide new information to fishers there, as well as to be better informed of needs, local knowledge, and changing social-ecological circumstances.

Other networks can emerge as fishers in other villages receive training in cyanide-free techniques. In circumstances where the community receiving training is far from Les (either in a remote location of Bali, or on another island), the fishers providing training may remain in that community for several weeks, or even months. During this time, ongoing training and evaluation occurs, and important social linkages (such as trust and friendship) are formed. Following the completion of this training period, the fishers who provided the training continue to play a critical role in facilitating networks across communities.

Another example of the importance of networks for fishers can been seen in the acquisition of fishing gear: for fishers to adopt the new harvesting techniques,

[28] Specifically, research pertaining to the use of artificial reef structures.

completely new types of fishing gear were required[29]. Initially, although there was strong interest among fishers in the new techniques, not enough appropriate nets were available to meet demand.

> *"Even after the fishers' association was founded, I had no access to a net. The demand* [for nets] *was too high, and I could not afford one."*
>
> M_10.27 (Ornamental fisher)

Through networks facilitated by YBN, MAC, and now LINI, members of the ornamental fishers' association at Les have been able to obtain the new gear at prices significantly below market value. Non-members are also able to acquire gear at lower prices, but not through formal channels. Additionally, fishing regulations at the time the fishers' association was established meant that the preferred net mesh-size for the new techniques was locally unavailable to fishers; YBN was able early on to assist fishers in obtaining appropriate nets from Taiwan and the Philippines.

At other locations in Buleleng, different relationships have played a more prominent role in minimizing ecological damage to coral reefs. For example, at Pemuteran, coral reef-building activities have used Biorock® technology. Due to the relatively high cost associated with using this technique, networks at Pemuteran have focused more on financial linkages, such as with local hotel owners and tourists (who provide funds in the form of one-time or continuing donations). Other players include local and marine authorities, who patrol the waters against the use of illegal fishing techniques. There are presently no NGOs involved in the restoration work at Pemuteran, and ornamental fishing is prohibited.

4.4 Collaborative action

The third phase of the framework builds upon previous (or ongoing) communicative action and self-organization, and is chiefly concerned with actions that have material results (such as improved ecosystems, livelihoods, and human well-being) (Prabhu et al. 2007; Berkes 2010b). The phase comprises of three

[29] See *Appendix A* for a description of the fishing gear and harvesting skills introduced by NGOs at Les.

components—namely, building institutions and social capital; capacity-building; and establishing enabling environments. These components will be examined here individually.

4.4.1 Building institutions and social capital

Following Ostrom (1990), Berkes (2010b) describes new institutions—that is, revised rules-in-use—as emerging as a consequence of communication and self-organization. Such institutions play an important role in the governance of common-property resources (such as coral reefs), and act as a safeguard against open access exploitation and depletion (Berkes 2004). For example, communities may establish rules-in-use restricting the amount, timing, and technology of resource harvesting (Ostrom 2000). Where such institutions are indigenously present, they can be strengthened and incorporated into broader conservation activities. Where they are absent, institutions must be created through the processes of communication and self-organization (Berkes 2010b).

When ornamental fishers still used cyanide at Les, the rules-in-use concerning coral reef resources were only loosely defined. Fishers routinely engaged in activities that may or may not have been perceived as destructive. Fishers from outside the community were allowed access to the village's reefs; similarly, fishers from Les fished in other communities' waters. Some fishers explained that the prevailing perspective at many locations is that "the sea is open to everyone," implying that no one can—or perhaps even should—control others' behaviours.

> *"Some villages don't care what methods ornamental fishers use, as long as they have fishing permits. Usually, village officials just read the fishers' permit letter, and they allow them to fish. They don't ask if the fishers use cyanide. They believe that the sea is open to everyone."*
>
> M_8.16 (Ornamental fisher)

As fishers learned new harvesting techniques from the NGOs, and as their skills with those techniques increased, fishers collectively decided to establish a cyanide-free fishery at Les. This outcome was the result of initial discussions between the NGO, YBN, authorities from Les, and a number of prominent ornamental fishers. Those discussions also led to meetings to which all ornamental fishers at Les were invited, and resulted in the decision to create a fishers' association.

Although technically supported by Indonesian law, both the cyanide-free fishery and the fishers' association remain informal institutions. Therefore, a critical component is social capital, a concept that describes the following interconnected issues: trust; reciprocity; shared rules, norms and sanctions; and connectedness (of groups and networks) (Pretty & Ward 2001; Pretty & Smith 2004; Berkes 2010b). Although limited monitoring by the OAP does occur in the area, fishers express the belief that they can trust one another not to use cyanide—a belief that is supported by a shared understanding that fishers can now catch greater numbers of desirable species using the new techniques without cyanide.

At Les, reciprocity—used here to mean exchanges of goods or services of roughly equal value that are repaid and balanced immediately or over time—occurs in many forms, including voluntary labour, shared catches of food fish, use of fishing gear, and even the lending of small sums of money. This reciprocity (and social capital in general) effectively lowers the cost of fishers working together (Pretty & Smith 2004), and encourages cooperation by providing individuals within the community with access to goods and services that might otherwise be unavailable.

When asked what would happen if a fisher from Les was caught using cyanide, fishers responded that the fishers' association would attempt to convince the individual of their error, and would restate the new rules-in-use. If this form of intervention failed, and a repeat offense occurred, the individual would be handed over to the authorities. However, fishers emphasized that such an event had never occurred at Les.

Nevertheless, not all sites examined during this research have been able to establish completely cyanide-free fisheries. At those communities, some fishers use

new techniques, and the remainder use cyanide. This situation begs the question of whether institutions remain effective if they are only being adhered to be a portion of resource users. Clearly, in those locations, ecological gains are necessarily hindered. The development of social capital also appears to be hindered, as cyanide-free fishers must employ some components of social capital more than others—namely, trust-building, sanctions, and connectedness.

Fishers and local distributors continue to watch for opportunities to educate cyanide users in the new approaches, and illegal fishing activities are sometimes reported to the authorities. However, fishers in communities where cyanide use continues expressed that they prefer to maintain positive, neighbourly ties with all fishers, in hopes of developing relationships of trust, which in turn might foster cyanide users' acceptance of the new harvesting techniques.

> *"Some ornamental fishers from this village still use cyanide here, and others who come from other villages do as well. We* [cyanide-free fishers] *don't force them to stop, because they are our friends and neighbours. But we have told the authorities that cyanide is still being used. So far, the authorities have not responded.*"
>
> M_10.9.1 (Ornamental fisher)

> *"After five years of not using cyanide, some young corals are now growing on the reef. There are also more fish, and one species that was completely wiped out on this reef has returned. But the improvements are limited, because some fishers still use cyanide on our reefs. I hope that soon they will all use nets.*"
>
> M_10.6.6 (Ornamental fisher)

> *"I saw the positive changes that had happened at Les, and I wanted to try it here. But there were some difficulties in persuading the ornamental fishers here to stop using cyanide. They found the new techniques difficult, and they began to reject my invitations to come for training. They wanted money for their time, and in the end, I provided*

them with a small sum of cash for each training session. In fact, I even picked up some fishers with my car to bring them to the meetings."

M_9.25 (Ornamental fish distributor)

4.4.2 Capacity-building

Capacity is the sum of a resource management system's norms, rules, institutions, and leadership, as well as other resources, such as knowledge, relationships, skills, financial capital, and other assets that groups can use to achieve their goals (Prabhu et al. 2007:42). Building this capacity can take many forms, and may address the ability of a group to engage in any of the following activities: governance and community organization (Armitage 2008; Seixas & Davy 2008); innovation (Pretty & Ward 2001); responding to environmental change, complexity, and uncertainty (Folke et al. 2005); small-business development and financial management (Seixas & Davy 2008); influencing external actors (Prabhu et al. 2007); communicating and asserting needs (Marschke & Sinclair 2009); and taking legal action (Berkes 2007).

The fisher community at Les has been the focus of significant capacity-building efforts. Following the successful transfer of new techniques and fishing gear, the NGOs active there began to develop the fishers' overall capacity to manage their newly established institutions, and to network with others.

"When we train new fishers, we try to identify individuals with whom we can work more closely to provide additional training. We've developed a rubric for this type of decision-making. For example, two fishers from Les in their mid-twenties were identified and given training in public speaking. They developed confidence in their public speaking, and now they work part-time for LINI. They even meet with government officials. It's amazing, because some of them have very little formal education."

N_9.15 (Director of NGO, LINI)

Working closely with the fishers' association, LINI has provided other fishers with training on teaching methods, assessing the ecological health of coral reefs (such as measuring species counts and diversity), and recording harvest data. As detailed above, in each new community where training in the new harvesting techniques occurs, individuals are carefully selected who might be appropriate candidates for this type of in-depth capacity-building.

Fishers at Les are now encouraged by LINI to experiment with ARSs, varying the placement, configuration, and construction techniques to meet individual parameters. As the ecological and commercial benefits of ARSs have become increasingly evident to those in the marine aquarium trade, fishers have received requests for the structures from local fish distributors and exporters. Additionally, fishers at Les have provided training on ARS construction, placement, and management to a broad range of individuals. Such training activities may have the potential to provide fishers with an additional source of income.

Seixas and Davy (2008) also point out that capacity-building may also be necessary at times for NGO and government personnel, and researchers. Such capacity-building efforts may focus on participatory methodologies and research for community-based conservation and development. Similarly, they may address barriers (or perceived barriers) between fields of research or practice, with an objective of developing an interdisciplinary science of conservation development (Berkes 2007).

An instance of this type of "capacity-building among practitioners" (Berkes 2007:15190) occurred when MAC offered to provide the staff from YBN and another local NGO with training in the improved documentation of harvest data, as well as monitoring procedures. Similarly, MAC invited five individuals from four different NGOs to receive simultaneous training in the new harvesting techniques at a site in the Philippines. This experience not only increased the practitioners' skills, but also served to create a unified approach for dissemination, and to solidify networks. A final example of capacity-building among practitioners can be seen in the technical, scientific training provided to MMAF staff by LINI marine scientists. This

information plays an important role in informing policy-makers and legislators, who may lack scientific backgrounds or hands-on experience with marine-related issues.

4.4.3 Establishing enabling environments

Pomeroy et al. (2001:201) write that individual and community empowerment is central to successful co-management of marine resources, and will occur on an economic, political, and social level. Establishing an enabling environment for sustainable resource management fosters "creative processes that … generate ongoing, effective, long-term decision making for people and natural systems" (Prabhu et al. 2007:42). The ability of resources users to establish their own rules-in-use, as well as to enforce these rules, is critical (Berkes 2010b), and may be supported by enabling legislation and government policies (Folke et al. 2005).

Finally, Berkes (2010b:497) states that "user participation and devolution of management powers tend to be associated with societies with democratic traditions and strong civil society." It is likely that Les, like many communities in Bali, has an unusually strong tradition of democratic decision-making and deliberation. For example, Korn (1960), in his seminal anthropological work on Balinese village institutions, refers to the Balinese village as a small, independent republic (i.e., an egalitarian political community). Examples of this egalitarian dynamic were observed during public meetings to address community concerns, such as social or environmental issues, where individuals are encouraged to speak in turn. In this sense, decisions affecting the community tend to be made through consensus-building and lengthy discussions between different stakeholders. It is possible that the success of efforts to alter patterns of resource use at Les were at least partly attributable to this cultural feature.

4.5 Summary

The events at Les provide a striking example of a marine resource brought by human activity to the brink of ecological collapse, but restored to relative health

through the intentional efforts and cooperation of many actors. This chapter has depicted that transformation as a process of adaptive governance and knowledge co-production, and occurring in three phases: communicative action, self-organization, and collaborative action (Berkes 2010b). Prabhu et al. (2007) state that the framework used here suggests general progress from one phase to the next; however, the three phases are not mutually exclusive. For that reason, they have been depicted in this chapter as intermeshed gears (*Figure 4.1*), such that to move any one gear (or phase) necessitates movement of all three.

New, cyanide-free fishing gear introduced by NGOs at Les, Bali (see Appendix A).

A fisher weaving a fishing net, using skills taught by NGOs.

Chapter Five

Summary of research findings and implications for conservation-development for the marine aquarium trade and coral reef restoration

5.1 Introduction

The tremendous ecological pressure upon the world's coral reefs from the natural and human-induced threats discussed in chapter three (Wilkinson 2004; Wilkinson & Salvat 2012) is exacerbated by destructive fishing practices associated with the marine aquarium trade, such as the use of cyanide (Rubec et al. 2001). At the centre of this social-ecological confrontation is Indonesia: home to 15% of the world's coral reefs (Nontji 2002), and also the world's largest exporter of marine aquarium species (Reksodihardjo-Lilley & Lilley 2007). To meaningfully address the threats facing coral reefs in Indonesia and across the Indo-Pacific, changes are required to both management practices (Bellwood et al. 2004) and to the underlying policies (or lack of policies) which inform those practices (Mascia 2002). Additionally, other aspects of the marine aquarium trade, such as consumer behaviour and education, should be considered.

This research shows that the actions taken by various stakeholders have been successful in reversing the trend of ecological degradation to the coral reefs at Les. Crucial to that reversal was the reshaping of ornamental fishers' perspectives of the reef and of their power to damage it or to restore it to health. This chapter will summarize the research findings, and link the events at Les and other parts of Buleleng to relevant groups and agencies within the marine aquarium trade. The relatively narrow scope of this research limits the ability to make recommendations that might apply to all coral reef-related conservation-development projects; nevertheless, the findings presented here can serve as a framework for such work in other, similar locations.

5.2 Lessons from Les

The research findings presented here are broadly based on information gathered across 11 different communities, and therefore reflect a range of

experiences and perspectives. Generally, the experience at Les can be characterized as being at a more advanced, or "mature," stage. Other communities (whose transitions away from cyanide began at a later date) are still in a "developing" stage. Some fishers in those communities continue to use cyanide, or express doubts about the effectiveness of the new techniques. The overall experience of stakeholders at Les forms the core of this research, and therefore has the greatest impact on the findings. Data obtained at other communities serves to support and provide context for that experience, and also provides insight into how the initiative begun by the NGOs there has performed in its later, mature stages.

5.2.1 Bringing coral reefs and livelihoods to health

The events at Les demonstrate that it is possible for a community in crisis—that is, a community facing the collapse of its coral reefs and the livelihoods associated with it—to make a rapid and complete departure from the actions that precipitated that crisis. Furthermore, it is clear that this transition can not only improve the ecological state of the coral reefs, but can also address the economic needs of local stakeholders (in this case, ornamental fishers and other individuals associated with the marine aquarium trade).

Finding 1: Meeting ecological objectives for fisheries in use may be assisted by tailoring ecological objectives to address the economic (livelihood) needs of local resource users.

While this finding is hardly novel, it helps to explain the traction that the sweeping changes proposed by NGOs had with ornamental fishers and other stakeholders at Les. For many fishers, the desire to improve the ecological health of the reefs remains a pragmatic one: a healthy reef is a productive reef, and one that enhances the sustainability of their fishing livelihoods. The NGOs, for whom ecological and economic objectives share equal importance, chose to emphasize to the fishers the compatibility and synergistic effects of their goals. Consequently, fishers understood from the onset of the project that the NGOs did not intend to

reduce their access to the reefs or to undermine their livelihoods; rather fishers were to be placed at the centre of efforts to improve reef health.

Nevertheless, it is important to note that the NGOs working at Les did not enter with promises of increased earnings for ornamental fishers, or of higher prices for fish caught without cyanide. The decision against using this strategy was based on prior experiences by MAC, working with ornamental fishers in the Philippines:

> *"Ornamental fishers in the Philippines were told that they would receive a higher price for fish that were caught using hand nets. This price increase was not realized, and fishers became dissatisfied. Eventually, they reverted to using cyanide because it was perceived as being easier."*
>
> N_9.15 (Director of NGO, LINI)

At Les, the NGOs alternatively promoted the economic interests of the fishers by emphasizing that healthy coral reefs would promote stability of incomes, and would reduce the need to travel from community to community in search of ornamental species. As fishers' skills with the new techniques taught by the NGOs improved, they were in fact able to catch more fish, and to target specific organisms as compared to when they used cyanide only. Finally, fishers no longer needed to purchase cyanide, and therefore, the day-to-day cost[30] of ornamental fishing was reduced significantly.

The features described above positively reinforce fishers' behaviour by providing economic benefits that emerge as a result of conservation initiatives. Consequently, fishers express that they now have strong disincentives to resume cyanide use. In their view, the reefs are now more productive, their costs are lower, and fishing incomes are less volatile than under the former governance structure.

<u>Finding 2</u>: Caution should be exercised by NGOs and other organizations when beginning to work with local resource users and other stakeholders, as unrealized

[30] In November 2012, one kilogram of cyanide tablets in the Les area cost up to 200,000 Rupiah (or $25 Canadian). Although most fishers at Les earn from 40-80,000 Rupiah per fishing day, their ability to fish varies greatly, and is dependent on factors such as weather, orders from distributors, and personal health. Thus, cyanide purchases represented a significant cost for fishers.

promises of increased earnings or rapid positive results may cause participants to abandon the program.

5.2.2 So it works, but is it exportable?

If the conservation-development outcomes at Les were the result of exceptional circumstances, then clearly there are few lessons that could be exported to other communities facing similar issues. If, however, the achievements at Les were the result of careful decision-making, discourse with stakeholders, strategic self-organization, and collaboration across multiple organizational levels, then the lessons from Les are strong and exportable. The experiences of one community (or "case"), though necessarily influenced by unique factors (such as preexisting networks, financial resources, and human capital), can serve as a valuable model for other communities (Yin 2009). The critical factor seems to be the intentionality with which problems are addressed (Prabhu et al. 2007).

Furthermore, as stated above, the NGOs that facilitated the transition away from cyanide use at Les had previous experience working with fishers in other communities. In that sense, the experience at Les was an "imported" one[31]. Additional evidence of the exportability of the lessons from Les is seen in the fact that they are already being shared by fishers with other ornamental fishing communities across Indonesia. As this process occurs, fisher agency (that is, having clear input into resource management decisions) is high. This feature, combined with learning features and the reflexive, stepwise nature of the transition, demonstrates certain characteristics of adaptive governance, and provides greater long-term stability to social-ecological changes. Strategies for transitioning fishers away from cyanide use must be continually modified to meet new, local criteria; however, this research nevertheless concludes that the strategies used at Les are highly exportable, and of use to NGOs and government agencies in other, similar communities.

[31] That the NGO's activities were at least partially unsuccessful in those communities where it was first promoted suggests the occurrence of adaptive learning by NGO staff (Berkes 2010b).

<u>Finding 3</u>: Aspects of adaptive governance (i.e., active fisher involvement, fisher agency, learning, and a reflexive, stepwise transition) have resulted in social-ecological outcomes with greater stability.

<u>Finding 4:</u> The overall strategies used at Les for transitioning fishers away from cyanide use and towards more sustainable harvesting techniques is exportable to other similar communities.

5.3 Beyond management: Building conservation ethic

In reference to the host of social-ecological factors threatening coral reefs globally, Bellwood et al. (2004:831) call for "more vigorous, innovative and adaptive management strategies" for reef systems and tropical fisheries. This recommendation is supported by a large body of literature taking both ecological and social perspectives. However, following Berkes (2010b), this research suggests that recommendations for how to best counter threats to coral reef systems should not be limited to "management" strategies, but should instead address the broader, more inclusive notion of "adaptive governance". In this view, "domination and control of nature" is replaced with an emphasis on stewardship, or conservation, ethic (Berkes 2009).

Describing the evolution of conservation ethic, Leopold (1949; 1989) suggests that if humankind operates only according to economic criteria, then the environment will inevitably suffer. It is necessary, according to that author, to develop ethical criteria for economic relationships that can "adjust society to its environment." While useful to some degree, such inherently moralistic treatment of the environment may nevertheless risk heightening the perceived antagonism of economic and conservation objectives (Western & Wright 1994). Furthermore, this manner of envisioning humans' relationship with nature may inadequately express the conservation perspectives of other parts of the world (Berkes 2004).

Although conservation ethic may be a difficult attribute to define, the results of a lack of such an ethic seem readily identifiable: degraded ecosystems, with

devastating consequences for both human and non-human populations. In the context of this research, an appropriate description of conservation ethic involves perspectives and worldviews that integrate resource use and temporary needs with ecosystem health and long-term sustainability. Building conservation ethic among resource users then implies any activity that fosters such perspectives. Although this type of perspective may not originally be present among resources users (Agrawal & Gibson 1999), it can emerge over time, and across different social and organizational levels (Agrawal 2002).

At Les, two important components for building conservation ethic among resource users are: (1) conservation education and knowledge co-production; and (2) horizontal (community-to-community) linkages. These components, as well as risks and incentives for different stakeholders, will be explored here.

5.3.1 Conservation education and knowledge co-production

At Les, the fundamental recasting of fishers' worldview (i.e., building conservation ethic) was only possible through conservation education. As detailed in Chapter Four, this education took three principal forms: (1) a focused introduction to basic reef ecology; (2) in-depth instruction in the use of the new fishing techniques; and (3) training in reef restoration. In the absence of this education, fishers would not only lack the skills required to catch ornamental species without the use of cyanide (the *what*), but would also lack a rationale for changes to behaviour (the *why*). In the case of Les, that rationale was multifaceted and unapologetically pragmatic: fishers made a mental connection between healthier reefs and the potential for stabilized incomes.

> *"When YBN came to Les, they taught us* [ornamental fishers] *ecological knowledge and how to use nets. I believed the ecological information right away, but at first I didn't think it was possible to earn a living using nets.*

> *I practiced, and every time I tried, my confidence went up. I tasted some success, and I kept going. For about three weeks, my income went down, but after that, it stabilized.*
>
> *I learned about coral management through the fishers' association, and was involved with restoration activities. When I used cyanide, about twenty-five percent of certain species of fish I caught would die, and of course, I received no income for dead fish. I can catch more fish now, so my income has improved compared to when I used cyanide.*"
>
> M_10.27 (Ornamental fisher)

Importantly, the majority of the education provided to fishers at Les was delivered through skills-building activities. For example, fishers learned to use and repair nets through hands-on practice. Prioritizing practical, applied knowledge was especially necessary in a context such as Les, where many fishers have received a minimum of formal education. Although some learning of more theoretical concepts was necessary, where possible, fishers were provided with practical applications or examples of those concepts.

Throughout the process of conservation education at Les, fishers were encouraged by the NGOs to engage in open discourse. Rather than simply providing knowledge to fishers, NGO staff drew fishers into an active and ongoing discussion concerning their reefs and their livelihoods (Daniels & Walker 1996). During the skills-building phase, fishers who had already received training in the use of nets assisted by acting as *de facto* instructors, providing one-on-one training for days or even weeks.

Finding 5: Conservation education is necessary to provide skills and ecological knowledge to resource users; however, participants should be free to engage in open (i.e., multi-directional) discourse, and the education should be provided in an applied manner with links to practical objectives.

Knowledge co-production shares many features in common with conservation education; however, knowledge co-production takes learning a step

further, and establishes resource users and local communities as partners in generating new or enhanced knowledge that benefits all stakeholders (Armitage et al. 2011; Davidson-Hunt & O'Flaherty 2007). At Les, aspects of knowledge co-production are seen in the co-experimentation with the configuration and construction of ARSs by fishers and LINI staff. Not only does that NGO see the potential for the fishers' trials resulting in improvements and innovations to the structures—it also recognizes that the fishers are in prime position to conduct experimentation[32] that is far more widespread than could be done on the NGOs own budget. Involvement in this type of experimentation further strengthens fishers' relationships with the NGO, promotes the fishers' confidence in their own abilities, and ensures that ARSs suit fishers' needs as closely as possible. Finally, because LINI has intentionally chosen not to restrict access to information concerning the construction of the ARSs, fishers are able to freely share this information with fishers and interested individuals from other communities.

Finding 6: Aspects of knowledge co-production (including sharing or blending of local and scientific knowledge, as well as community-based experimentation) can be seen in the experience at Les, and have enhanced the richness and applicability of knowledge; made efficient use of resources; and built confidence in local resource users.

5.3.2 Horizontal linkages: Community-to-community

Because ornamental fishers tend to be highly mobile, they come into frequent contact with peers, providing them with opportunities to exchange information (Halim 2002). While this feature was instrumental in the spread of ecologically damaging fishing practices (such as cyanide and blast fishing), it has also played an important role in spreading knowledge of the events at Les among ornamental fishers in other communities. In some cases, ornamental fishing leaders from other communities across Indonesia (including several examined in this research) have

[32] The use of ARSs at Les has been referred to as "fish ranching"; in this sense, the fisher's role is analogous to that of a farmer, whose role in on-farm experimentation is well established (cf. Ashby 1986; Mishra et al. 2006).

approached the ornamental fishers' association at Les to negotiate formal or informal exchanges of knowledge and training. In other cases, NGO personnel have initiated communication with fishers (or commonly, fish distributors) from other communities.

From interviews, fishers with some preexisting knowledge of the events at Les typically expressed that they had a favourable impression of the new techniques, and were more open to training opportunities as a result. Training was typically provided by one or two NGO personnel and up to five or six fishers from Les (although sometimes only one NGO staff and one fisher were able to travel to more remote areas). The interactions between fishers from Les and other communities (i.e., peer-to-peer interactions) rapidly established relationships of trust and friendship, and helped to provide the NGO staff with greater legitimacy.

Nevertheless, after receiving early-stage training, some fishers expressed that they initially did not believe it was possible to earn a living using the new techniques. For those fishers, the long-term relationships that developed between their community and the fishing community at Les proved to be especially important. The fisher-trainers from Les made frequent return visits over a period of weeks or months to follow up on training and provide additional instruction. In several cases, where distances made return visits prohibitively expensive, fishers from Les remained in the target community full-time for several months. This type of ongoing, long-term interaction between trainers and trainees not only served to fine-tune fishers' skills, but also provided "naysayers" with the opportunity to observe that it is indeed possible to earn a living using the new techniques.

Finding 7: Community-to-community linkages can encourage rapid relationships of trust, and may help to provide NGOs with greater legitimacy.

Finding 8: Long-term or ongoing community-to-community relationships provide opportunities for improved transfer of knowledge and skills, and also allow target recipients who remain unconvinced of the benefits to observe the successful experiences of others in their community.

As with the fishers at Les, over time, newly trained fishers from other communities may develop the skills necessary to teach others. Fishers from a number of communities have gone on to provide training to fishers across Buleleng and East Java. In this manner, the experience contains a tendency towards self-replication, with fishers coming into continual contact with other fishers, building relationships of trust, sharing knowledge, and demonstrating the efficacy of the new techniques to their peers.

5.3.3 Risk and stakeholder incentives

At each stage in the development of the events at Les, stakeholders were engaged in a process of taking risks and responding to incentives. The associated risks have shifted over time: early risks included the potential for rejection of the new techniques (and the NGOs in general) by the fishers, or interference in the fishers' and NGOs' activities by local government; later risks included the possibility of widespread abandonment of the new techniques and a return to cyanide use by fishers. Some risks are ongoing, such as the potential for bleaching events, severe reductions in demand for marine aquarium species, and other forms of ecological or economic disturbances.

The incentives for each stakeholder have been similarly dynamic. Fishers at Les were initially interested in the prospect of new channels for the distribution of their catch (via exporters desiring cyanide-free fish). Over time, fishers were drawn to the prospect of learning to use methods that not only minimized the ecological impact of their fishing activities on the reef, but that also lowered the day-to-day cost of fishing (by eliminating cyanide purchases). As conservation ethic emerged among fishers at Les, and as they observed the tangible benefits of their actions, they became motivated to share their experiences with fishers in other communities. In addition to a genuine desire to help their friends, relatives and peers, this apparent altruism on the part of the fishers can also be understood as an effort to protect their profession. Through NGOs such as MAC and LINI, fishers at Les have become aware of consumer perceptions, and the growing concern among some consumers for the effects that ornamental fishing and cyanide are having on

coral reefs. Thus, an additional incentive to extend their experience to other communities has been to safeguard the ornamental fishing profession and the marine aquarium trade in general.

For the NGOs associated with the activities at Les, the incentives are clear: although their individual mandates have varied slightly, they share the common objective of eradicating cyanide use by ornamental fishers, improving coral reef health, and preserving or improving the livelihoods of fishers. Working directly with fishers and other stakeholders has provided the NGOs with the opportunity to achieve those goals, at least on a localized level. New incentives and synergies have emerged over time, with fishers now providing important feedback and participating in program implementation, allowing for efficient use of time and other resources. Furthermore, as fishers have taken an active role in disseminating the new techniques and model for coral reef management, the NGOs' ability to penetrate ornamental fishing communities has increased significantly.

Lastly, the events at Les have provided government agencies, and the MMAF in particular, with the opportunity to see their policy objectives for coastal fisheries (i.e., eradication of cyanide use) met in that community. Importantly, the institutional changes at Les have had lasting impacts that were not achieved by OAP patrols or punitive actions. Finally, although not fully explored by this research, it is likely that the NGOs have been able to facilitate positive conservation outcomes at Les at a fraction of the cost required by a similar, government-funded project, and has also reduced the costs associated with patrols. Similarly, assisting with NGO-fisher-directed methods for extending the experience to other communities likely represents a cost effective means for the government to realize its conservation objectives. If these costs are indeed lower, then government agencies would have additional incentive to promote the work and partnerships of NGOs and fishers.

Finding 9: Working collaboratively with a broad range of stakeholders provides each group with different benefits, including improved ecosystems and livelihoods; knowledge co-production; savings in time and money; and other synergies.

The final policy recommendation concerns the provision of funds to fishers and fishers' associations by outside agencies. Although the adoption of the new fishing techniques releases fishers from the need to purchase expensive cyanide tablets, they nevertheless need to acquire completely new fishing gear. Not only is that fishing gear expensive, but some of the necessary items may also be locally unavailable. At Les, one of the important contributions of NGOs and government agencies was to make this equipment available to fishers at prices that were affordable. During interviews, ornamental fishing leaders at Les expressed that future support from government agencies in particular should focus on providing equipment that will allow fishers to expand the scope of their activities (such as nets, as well as boats and motors for restoration and monitoring activities).

Finding 10: Because the of the relatively high cost of fishing gear required by fishers to adopt the new cyanide-free fishing techniques, it may be advisable for this equipment to be initially made available through financial support from government agencies or NGOs. Where that fishing gear is locally unavailable, supporting agencies can also assist in developing linkages to make it available to fishers.

5.4 Summary

The research findings summarized in this chapter (*Table 5.1*) are based on the experiences of a range of stakeholders at Les and other coastal communities across Buleleng. While the findings remain limited by the overall scope of the research, it is hoped that they will nevertheless be of use to both researchers and practitioners engaged in work with other, similar communities.

Broadly, the pattern for conservation-development at Les has proven to be successful in addressing both long-term coral reef health and the livelihoods of individuals associated with the marine aquarium trade. Critical factors that have made the experience a success include: applied conservation-education and knowledge co-production to empower fishers; horizontal linkages between fishing communities; and synergistic relationships that provide incentives which engage all stakeholders. These factors have helped to build conservation ethic across different

user groups and organizational levels, and to orient institutions towards the goal of sustainable resource use. Importantly, the program initiated at Les has developed into one that is highly adaptive and self-replicating, with the potential to spread organically across all regions where cyanide use by ornamental fishers threatens the health of coral reefs.

Table 5.1: Research findings as relevant to different groups and agencies.

	Groups and Agencies				
Finding #	**Local Resource Users**	**NGOs & Development Organizations**	**Researchers**	**Funding Agencies**	**Government Agencies**
1		✓	✓	✓	✓
2		✓			
3	✓	✓	✓		✓
4	✓	✓	✓	✓	✓
5	✓	✓	✓	✓	✓
6	✓	✓	✓		✓
7	✓	✓	✓	✓	
8	✓	✓	✓	✓	
9	✓	✓	✓		✓
10		✓		✓	✓

Findings:

1. Meeting ecological objectives for fisheries in use may be assisted by tailoring ecological objectives to address the economic (livelihood) needs of local resource users.
2. Caution should be exercised by NGOs and other development organizations when beginning to work with local stakeholders, as unrealized promises of increased earnings or rapid positive results may cause participants to abandon the program.
3. Aspects of adaptive governance (i.e., active fisher involvement, fisher agency, learning, and a reflexive, stepwise transition) have resulted in social-ecological outcomes with greater stability.

4. The overall strategies used at Les for transitioning fishers away from cyanide use and towards more sustainable harvesting techniques is exportable to other similar communities.
5. Conservation education is necessary to provide skills and ecological knowledge to resource users; however, participants should be free to engage in open (i.e., multi-directional) discourse, and the education should be provided in an applied manner with links to practical objectives.
6. Aspects of knowledge co-production (including sharing or blending of local and scientific knowledge, as well as community-based experimentation) can be seen in the experience at Les, and have enhanced the richness and applicability of knowledge; made efficient use of resources; and built confidence in local resource users.
7. Community-to-community linkages can encourage rapid relationships of trust, and may help to provide NGOs with greater legitimacy.
8. Long-term or ongoing community-to-community relationships provide opportunities for improved transfer of knowledge and skills, and also allow target recipients who remain unconvinced of the benefits to observe the successful experiences of others in their community.
9. Working collaboratively with a broad range of stakeholders provides each group with different benefits, including improved ecosystems and livelihoods; knowledge co-production; savings in time and money; and other synergies.
10. The relatively high cost of fishing gear required by fishers to adopt the new cyanide-free fishing techniques may necessitate that this equipment is initially made available through financial support from government agencies or NGOs. Where that fishing gear is locally unavailable, supporting agencies can also assist in developing linkages to make it available to fishers.

Chapter Six
Discussion and conclusion

6.1 Introduction

This thesis has explored the findings of research conducted in Buleleng District, Bali, Indonesia, from July to November 2011. The research was qualitative in nature, and used a single case study strategy of inquiry. The principal community of focus was Les (Tejakula Sub-district), but additional data were collected from ten other communities, as well as from NGOs and other stakeholders. Data were obtained using semi-structured and key informant interviews, participant observation, focus groups, and other qualitative methods. Data received preliminary examination in the field, and were triangulated, cross-checked, and verified using focus groups and informal discussion with key informants.

The research was focused on the objectives presented in Chapter One. Broadly, the research: (1) developed a narrative and timeline for the ecological changes to coral reef systems at Les and across Buleleng, as well as the activities that precipitation those changes; (2) examined adaptive governance and knowledge co-production at Les and other communities to understand the positive social-ecological transformations that have occurred in those locations; and (3) used research findings to develop recommendations for policy formation and decision-making around coral reef resources. The final chapter of this thesis discusses these three objectives and provides conclusions, as well as cross-cutting themes and recommendations for further research in related areas.

6.2 Overview of changes to coral reefs and the marine aquarium trade in Buleleng (1960s–Present)

Chapter Three of this thesis provided a linear (i.e., chronological) narrative of the events that have unfolded at Les and across Buleleng regarding coral reef resources. In addition to non-anthropogenic processes (such as storms, earthquakes, and volcanic eruptions [Jaap 2000]), a number of human activities and

processes in this region have resulted in serious damage to coral reef systems (*Figure 3.1*) over time.

Beginning in the 1960s, the coral reefs at Les were exploited for the purpose of obtaining calcium carbonate for cement production (Reksodihardjo-Lilley & Lilley 2007). This process involves cutting away the upper 0.5 m of the reef, and reflected the extractive policies of the Sukarno Era (Aspinall 2001). At other communities across the district, this form of resource exploitation occurred concurrently with blast fishing, and resulted in serious damage to the architectural foundation of the reefs (Fox et al. 2005). Blast fishing did not occur on the reefs at Les, and in spite of mining activities, the reefs there remained healthy through the 1970s.

The 1980s saw the arrival of the marine aquarium trade in communities in Buleleng. Ornamental fishers from East Java first arrived in Les in 1982, and taught their skills to local fishers, including the use of cyanide to capture fish[33]. At that time, networks for the distribution of ornamental species were poorly developed, and fishers at Les also lacked access to cyanide; however, as a network of fishers, distributors, and exporters evolved in the region, fishers were able to obtain cyanide (sometimes directly from local distributors). By 1990, all fishers at Les used cyanide to capture reef species.

The use of cyanide on the reefs at Les and other communities resulted in rapid, precipitous declines in ecological health. Because of the nature of cyanide use (*Box 3.1*), the impacts are not limited only to species targeted by ornamental fishers, but are distributed across the reef in general. Consequently, non-targeted species (vertebrates and invertebrates) are affected, and at high rates of application, entire reef systems can be killed. Other sources of damage to reefs in Buleleng during this period include increased levels of pollution (both solid waste and sewage effluent) and sedimentation from land conversion (Reksodihardjo-Lilley & Lilley 2007; Yahya et al. 2008).

[33] Potassium cyanide and sodium cyanide inhibit cellular respiration in animals, and are lethal at high concentrations. Fishers use these poisons to stun their prey for easy capture (Pyle 1992); however, the effects of poisoning and other harmful handling practices may cause up to 90% of reef species to die between the reef and the retailer (Rubec et al. 2001).

This type of ecological degradation has severe consequences for human livelihoods: a healthy coral reef may produce as much as 45 tonnes of fish per km^2 per year, whereas the fisheries potential of functionally dead reefs is negligible (Tomascik et al. 1997, as cited in Nontji 2002:20). Importantly, many fishers in Buleleng have received minimal levels of formal education, and often do not own fishing boats or other property. For these individuals, a collapse of the ornamental fishery therefore necessitates finding new sources of livelihood, and often means taking seasonal work in the construction industry away from their communities.

By 2000, fishers generally recognized the reefs at Les to be in crisis, at ≤10% live coral cover (from ≤40% in 1986 [Sukarno et al. 1986]). Populations of fish and other reef species were similarly impaired (*Table 3.1*). Although some fishers anticipated the total collapse of the reefs—and consequently, of the ornamental fishery at Les—they nevertheless expressed a willingness to continue with their harvesting practices. The different perspectives held by fishers towards the reef as it related to their livelihoods and the use of cyanide are reflected in *Table 3.2*.

It was at that moment of crisis, in 2000, that the first NGO (YBN) arrived in Les. That organization had identified the community through discussions with local exporters, and elected to work there on the basis of its relatively high population of active ornamental fishers. The NGO's objectives included: (1) creating a cyanide-free fishery at Les; (2) supporting ornamental fishing livelihoods of local fishers; and (3) rehabilitating coral reefs. The NGO's emphasis on sustainable fishing livelihoods provided its activities with the early support of fishers, who did not see the NGO as attempting to prevent them from using local resources.

6.3 Adaptive governance and knowledge co-production

The new millennium marked a positive change not only for the ecological state of the coral reefs at Les, but also for fishers' livelihoods. The process through which these social-ecological transformations were realized can be characterized as one of connecting stakeholders; engaging in deliberation; developing a shared understanding; learning over time; and establishing networks—embodying aspects of what Folke et al. (2005) and others refer to as adaptive governance. These issues

were explored in detail in Chapter Four, using a conceptual three-phase model adapted from Berkes (2010b) (*Figure 4.1*), and will be reexamined briefly here.

6.3.1 Communicative action

Although ornamental fishers across Buleleng interacted within informal communities of practice prior to 2000 (Wenger 1998), it was only after the arrival of YBN at Les that the communicative action phase referred to in this thesis was initiated. Communicative action is here used to mean processes that facilitate communication among stakeholders, with an objective of creating a shared vision for resource governance (Berkes 2010b). This phase is characterized as consisting of three components: deliberation (with an emphasis on the role of leadership); sharing and clarifying values and knowledge; and creating a shared vision.

The deliberative process was initiated at Les by YBN, and resulted in the training of two local fishers. Those individuals' experience was closely examined by their peers. When the two fishers had successfully learned to use the new, cyanide-free techniques, they took on leadership roles, advocating for the new techniques and providing the NGO with greater legitimacy in the community. Leadership has continued to play an important role in shaping fishers' perceptions and values, and in the communities where the cyanide-free techniques are now being extended, teachers and NGO staff work to identify potential leaders at an early stage.

The timing of the activities at Les was important. It is likely that YBN found a receptive audience for its proposed initiative among the fishers at Les due to the poor condition of the reef, and fishers' understanding of the impending ecological collapse (Folke et al. 2005; Seixas & Davy 2008). Had YBN arrived a decade earlier, fishers may have felt less compelled to address what was, at that time, a less significant problem; a decade later, and the ornamental fishery at Les might have already been functionally destroyed. Also critical was the importance that YBN and subsequent NGOs at Les placed upon the livelihoods of fishers there. This allowed all stakeholders to develop a shared vision for the creation of a sustainable ornamental fishery, and has allowed the reefs at Les to be restored from a low of <10% live coral cover in 2000 to approximately 45% in 2011 (*Table 3.1*).

Over time, as the scope of the initiative at Les has expanded to include other communities across Buleleng and Indonesia, a greater number of stakeholders have become engaged in the deliberative process, and now includes fishers; government personnel (MMAF); researchers from national and international institutions; NGOs; and entrepreneurs.

6.3.2 Self-organization

Berkes (2010b) describes the self-organization process as involving the creation of communities of practice; social learning; and networks. In the context of the events described in this thesis, self-organization has been an iterative and highly flexible process, involving the numerous stakeholders listed above. Furthermore, some elements of this process have occurred through intentional actions, while others have developed organically, or through serendipitous events.

An example of an intentional self-organization activity can be observed in the formation of an ornamental fishers' association (*kelompok nelayan ikan hias*) at Les. This association was seen as a critical means to provide fishers ("insiders") and other stakeholders ("outsiders") with a social forum and a physical space in which to engage. Established in 2001, the fishers' association has evolved to support the material needs of fishers by providing nets and other gear at affordable rates, as well as some ongoing training. Importantly, the association now facilitates some of the extension activities of fishers in other communities, and helps to correspond with local and regional authorities.

Examples of unintentional self-organization (including the development of networks) can be observed in requests by fishers from other villages for training in cyanide-free techniques, or in the research initiatives of universities and other institutions. Both intentional and unanticipated forms of self-organization have been important for the development of events across Buleleng (*Figure 4.3*).

Learning has featured prominently in the self-organization process, and has been characterized by this thesis as occurring in loops (Armitage et al. 2009) (*Figure 4.2*). Early forms of learning (prior to 2000) were aimed at eliminating the use of cyanide by ornamental fishers, and predominantly served to reinforce negative

fisher behaviours (namely, secrecy and corruption). The activities associated with this form of learning also caused some fishers to abandon the marine aquarium trade. Later types of learning were initiated by YBN and other NGOs, aimed at creating a cyanide-free ornamental fishery at Les, challenged the fishers' underlying worldviews and perspectives, and provided important alternative skills to harvest ornamental species. Finally, this thesis argues that as fishers' worldviews have been transformed, a learning of a more complex type has emerged that encompasses the norms of those who first initiated and encouraged the process of change (in this case, practitioners and administrative entities). It is as a result of this type of dynamic, adaptive learning that fishers are now seen as equal partners in resource governance, and that a vision has emerged of fishers as representatives and teachers of new skills and paradigms to fishers in other communities. Fishers are also seen as important partners in knowledge co-production (Davidson-Hunt and O'Flaherty 2007), and take an active role in experimentation with artificial reef structures and other forms of reef restoration.

6.3.3 Collaborative action

The third phase of the framework described by Berkes (2010b) is concerned with actions that have material results (such as improved ecosystem health, and more resilient human livelihoods), and builds upon previous or ongoing communicative action and self-organization. The phase is characterized by three components: building institutions and social capital; capacity-building; and establishing enabling environments.

Following Ostrom (1990) and Berkes (2010b), institution is here used to mean a social construct that results in revised rules-in-use. In the context of the events Les, the abandonment of cyanide use allowed for new rules-in-use to emerge—namely, a prohibition of cyanide use. This prohibition, though technically supported by Indonesian law, remains informal in practice; consequently, fishers rely heavily upon social capital (Pretty & Ward 2001; Pretty & Smith 2004; Berkes 2010b). The success of the institutions developed at Les has allowed them to become models for initiatives in other, similar communities.

Even so, not all such initiatives have met with the same degree of success as the one at Les. This is likely a function of the relative newness of other initiatives (some communities only received initial training in cyanide-free techniques in 2007 and 2008), as well as the different social factors at work in individual communities.

An important factor in the long-term success of the institutions at Les has been an ongoing emphasis on capacity-building. Adaptive resource governance occurs within a complex and changing social-ecological system (Armitage 2008); ongoing capacity-building has provided stakeholders with the ability to "keep up" with that evolving complexity, and to improve the resilience of institutions. Fishers have received a wide range of new skills, including ornamental fishing techniques; management and communication skills; and monitoring and reporting practices, among others. Capacity-building has also been important for NGO and government personnel, who have received training in extension of cyanide-free techniques; monitoring and reporting practices; and marine science and ecology.

The three-phase framework used in this thesis is not intended to portray the processes of adaptive governance and knowledge co-production as linear or sequential; rather, these processes tend to occur in an interconnected, cyclic fashion (Prabhu et al. 2007; Berkes 2010b). Furthermore, the framework here is not intended to act as a blueprint for action, but as a tool that is both explanatory (of an ongoing event) and, ideally, predictive (of processes within other, similar events approached using a strategy of adaptive governance).

6.4 Policy implications and cross-cutting themes

Chapter Five of this thesis explored the policy implications of the research findings on conservation-development initiatives for the marine aquarium trade and coral reef restoration, and provided nine Implications (*Table 5.1*). These can be grouped into three categories: (1) conclusions for beginning conservation-development work in new communities; (2) conclusions for initiatives in communities where work has already begun; and (3) conclusions for extending conservation-development initiatives across communities (*Figure 6.1*).

(1) Beginning work in new communities

- Meeting ecological objectives can be aided by tailoring objectives to address livelihood needs of resource users
- Unrealized promises of increased earnings may cause resource users to abandon initiative

(2) Continuing work in communities

- Discursive conservation education, linked to practical objectives, provides important skills and ecological knowledge to resource users
- Co-production of knowledge can enhance richness and applicability; increase efficiency; and build confidence in users
- Collaborative work among diverse stakeholders provides each group with benefits (social-ecological; financial)
- Initiatives requiring new equipment may need to provide funding for that equipment; where locally unavailable, creating networks to obtain equipment may be necessary

(3) Extending work across communities

- Aspects of adaptive governance and knowledge-production have contributed to exportable conservation-development at Les
- Community-to-community (C-C) linkages can encourage rapid relationships of trust; and may provide practitioners with greater legitimacy
- Long-term C-C relationships allow for improved transfer of skills and knowledge; hesitant individuals have time to become convinced of benefits to community members
- Resilient institutions embrace challenges, adapt, and evolve

Figure 6.1: Conclusions for conservation-development initiatives according to category (based on *Table 5.1*).

Notably, the third category shares similarities with work by Olsson et al. (2010), who consider what features are necessary to make emerging resource governance systems "stick" (that is, what features build resilience into the systems?). Those authors state that emerging (and in the context of the third phase of *Figure 6.1*, expanding) institutions will either embrace challenges in an adaptive manner, continue to evolve and develop, or become unsustainable. Potential ways to build resilience into work across ornamental fishing communities include acknowledging differences between communities; understanding conflict among individuals and groups; and adapting to different resource endowments or access.

This thesis has examined an example of successful conservation-development around coral reef resources, with social-ecological outcomes that are now being extended into communities across Buleleng and other parts of Indonesia. However, the conclusions of this research are not limited to coral reef resources, and can be applied to a broad range of resource types. For example, the three-phase analytical framework used in Chapter Four was similarly used by Prahbu et al. (2007) to describe adaptive governance for forest resources in Nepal. Similarly, the concept of adaptive governance has been widely applied to agricultural and water resources in Sweden, USA, Thailand, and Australia (Folke et al. 2005), as well as to more conceptual resources such as the "concern held by … society for rural communities affected by drought" in Australia (Nelson et al. 2008). Knowledge co-production for natural resources has also been employed in the contexts of indigenous knowledge (Davidson-Hunt & O'Flaherty 2007); sustainable agriculture (Carolan 2006); and knowledge as a resource generally (Jasanoff 2004).

Therefore, although this research is limited in its scope to reef resources, the framework used to interpret the research data nevertheless provides an important analytical tool that can be used across multiple resource types. Situations in which the three-phase framework may be especially useful are outlined here.

A. Resource crises, in which both resource users and outside stakeholders (policy makers, researchers, NGOs, and others) recognize an impending (or unfolding) ecological collapse.
B. Circumstances in which critical techniques or knowledge to counter ecological crises exist, but have not been successfully extended to resource users.
C. Communities or other social arenas in which conservation-development initiatives are occurring, but where interaction between stakeholders has yet to produce satisfactory results (i.e., stakeholders' goals and objectives remain unmet).

In the contexts outlined above, the analytical framework used in this thesis functions as an "interfacing tool" for conservation-development, and provides stakeholders of potentially disparate backgrounds with a lens through which they might examine their own initiative(s). It is at this point of interface, and through the iterative patterns of adaptive governance, that stakeholders have the opportunity to develop practical strategies for effective conservation-development (Prabhu et al. 2007; Berkes 2010b).

6.5 Areas for further research

The events unfolding at Les and other communities across Buleleng have provided this research with a broad range of data for analysis and interpretation; nevertheless, this information represents just the "tip of the iceberg." A number of prominent opportunities for further research exist at Les and other locations in Indonesia, and are summarized in *Table 6.1*.

Although this research provided some analysis of ecological restoration of coral reefs using ARSs, marine scientists working with LINI have identified this as an important area for examination. Additional research would provide insights into the effectiveness of ARSs, optimal techniques for use, and contributions to fisher incomes. The research may potentially also contribute to an improved understanding of whether it is necessary to use live coral cuttings for reef

restoration (i.e., transplantation), or whether natural rates of coral recruitment are sufficient[34].

Another issue identified, but not adequately explored by this research pertains to the revenues provided to fishers for ornamental species caught using cyanide-free techniques. At this time, fishers at Les and other communities do not receive a premium for their catch, and their decision to use the cyanide-free techniques is based on other factors (such as ecological health and sustainable livelihoods). Nevertheless, as consumers become more aware of sustainability issues within the marine aquarium trade, opportunities may exist for fishers to receive more compensation for using ecologically improved techniques[35].

This research examined the social-ecological factors influencing fishers' decision to adopt cyanide-free techniques at Les; additional opportunities were taken to examine those factors at other communities across Buleleng (*Figure 2.1*). Nevertheless, the data obtained at other communities was descriptive, without the depth or breadth obtained at Les. Furthermore, unlike the fishers at Les, some fisher at other communities still engaged in cyanide use. Further research might explore the social-ecological factors influencing the adoption and non-adoption of cyanide-free techniques among ornamental fishers at those communities.

Although this research obtained some limited data from wives and other female family members of fishers, ornamental fishing in Buleleng remains a male-dominated profession, and the perspectives presented here reflect a point of view primarily communicated by male respondents. Examining decision-making around coral reef resources from a gendered perspective is a promising area for further research, and would contribute to the findings of the present research[36].

Research in other parts of Indonesia has identified traditional institutions for coral reef or marine resource governance (c.f. Satria & Adhuri 2010). Opportunities exist to explore not only these traditional institutions, but the way in which they

[34] See Yahya et al. (2008) and Reksodihardjo-Lilley & Lilley (2007) for more information on reef rehabilitation activities in Buleleng.
[35] See Shuman et al. (2004) and Reksodihardjo-Lilley & Lilley (2007) for more information on eco-certification of the marine aquarium trade and the role of consumer awareness.
[36] Zuryani (2006) uses a gendered perspective to examine decision-making around water and agricultural resources at Penuktukan, the sister village of Les, located 2 km to the east.

might be applied to adaptive resource governance. Personal observations during the field research period suggest that the rapid rate of social-ecological change across Buleleng from the 1960s onward may have outpaced the transfer of more traditional forms of ecological knowledge.

Of interest in a location such as Bali is the role of tourism in altering the local economy. This research identified a number of ways in which tourism had impacted rural areas, both positively (e.g. income opportunities; improved infrastructure) and negatively (e.g. rising land prices; disputes over resource user rights). This area provides a broad range of opportunities further research.

A final area for further research includes applications of the three-phase framework used in this thesis to adaptive governance and knowledge co-production initiatives for other resource types. This type of cross-resource examination would improve the explanatory ability of the framework, and further develop its usefulness as an "interfacing tool" for conservation development initiatives.

Table 6.1: Areas for further research at Les, Buleleng, and across Indonesia

- Ecological restoration of coral reefs using artificial reef structures and other techniques (c.f. Yahya et al. 2008).
- Opportunities for increasing the revenue provided directly to fishers for ornamental species caught using cyanide-free techniques.
- Social factors influencing the adoption and non-adoption of cyanide-free techniques among ornamental fishers at communities where both types of ornamental fishing occur.
- Decision-making around coral reef resources from a gendered perspective (c.f. Zuryani 2006).
- Traditional institutions for coral reef and marine resource governance (c.f. Satria & Adhuri 2010).
- Interplay of tourism and rural economies, especially for landless individuals.
- Applications of the three-phase framework used in this thesis to adaptive governance and knowledge co-production for other resource types.

6.6 Summary

This research has provided insights into the processes and initiatives that have enabled a remarkable social-ecological transformation at Les—a transformation that is now spreading organically and with gathering momentum to similar coastal communities across Buleleng and other parts of Indonesia. Building upon the experience at Les, a growing number of communities have achieved important conservation objectives related to coral reefs. Fishers now occupy a central role in the dissemination of conservation education and sustainable ornamental collection techniques, and are actively engaged in coral reef restoration and experimentation with artificial reef structures developed by NGOs. Within the context of this research, these features act as important indicators that aspects of adaptive governance and knowledge co-production are occurring among ornamental fishers in Indonesian coastal communities.

The stakeholders involved in this process have included local and international NGOs; government at various levels (including MMAF, OAP, and village-level authorities); university researchers; and a broad range of local actors. Although specific objectives and outcomes have varied across communities, common characteristics include the community-based nature of the activities, as well as goals that are oriented towards conservation-development.

Numerous challenges to ecological sustainability remain, including conflicts over resource use; negative harvesting practices (including cyanide use), and free-ridership. Nevertheless, adaptive approaches to governance and knowledge co-production have challenged many fishers' former perspectives of the coral reefs, and have resulted in resilient institutions. In the process, the fishers themselves have been similarly transformed, moving from resource exploiters to stewards of the reefs. The shared vision among all stakeholders of creating sustainable ornamental fishing livelihoods while supporting ecologically vibrant coral reefs has been instrumental in allowing this initiative to move towards its objectives for conservation-development.

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Appendix A

Description of cyanide-free fishing gear and harvesting skills

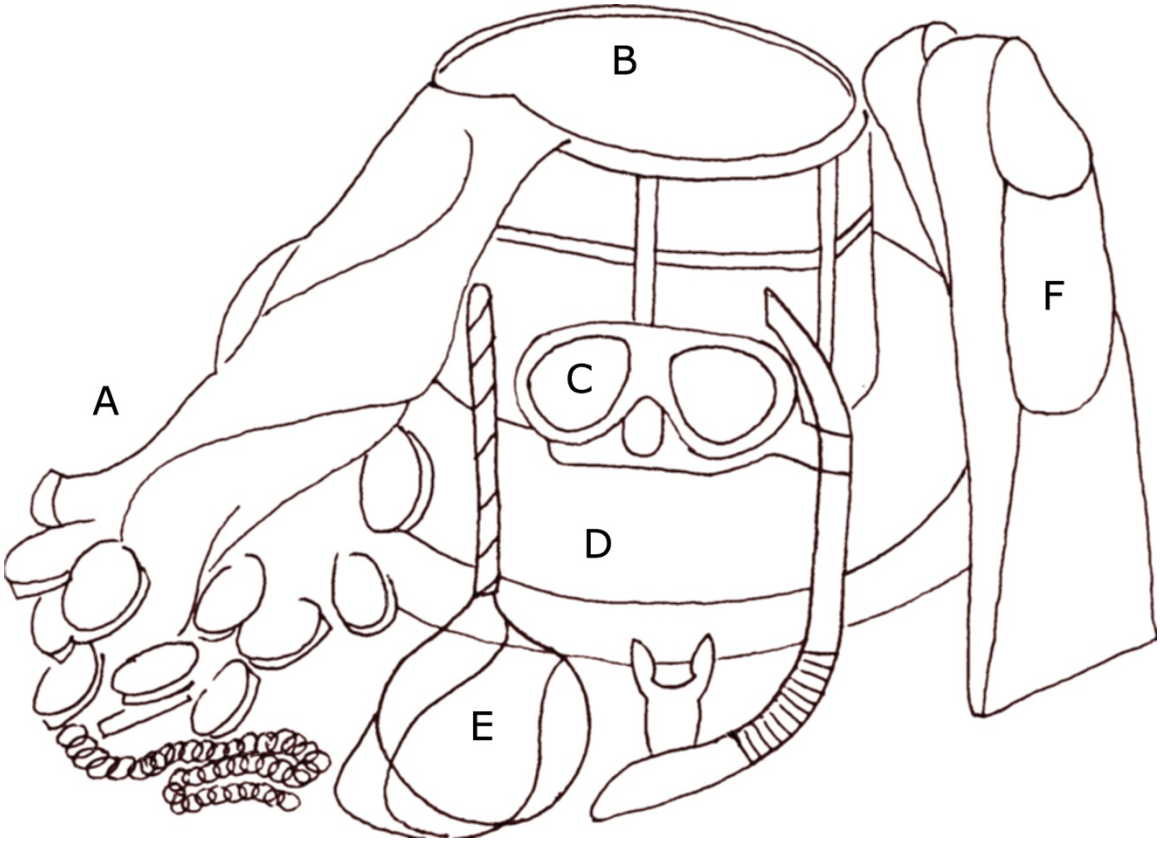

Figure A.1: Cyanide-free fishing gear. (A) 2.5 x 1.5 m barrier net with floats along upper edge and steel chain along lower edge; (B) basket for storing fish, bags, and other supplies; (C) mask and snorkel; (D) inflated inner tube to keep basket at surface (small anchor not shown); (E) hand-net; and (F) fins.

Figure A.1 illustrates the equipment used by cyanide-free ornamental fishers. When desired ornamental specimens have been located on the reef, the fisher puts up the barrier net. The floats along the upper edge cause it to remain vertically oriented, forming a wall into which the fisher chases the desired fish. The fisher is then able to capture the fish using the hand-net. The fish is transferred to a small plastic bag containing approximately equal parts sea water and air. This bag is stored in the partially submerged basket at the surface until the fisher returns to shore. At that time, the fish are brought to the distributor (typically located near the beach).

Appendix B

Semi-structured interview schedule

The interview schedules were conducted in 11 communities across Buleleng District, Bali, Indonesia between July and November 2012. The schedules were approved for human ethics by the University of Manitoba Research Ethics Council.

1. Name of community.
2. What are important sources of livelihood for your family?
3. When did you become an ornamental fisher?
4. Was cyanide already in use by fishers at that time? If so, how did you learn?
5. What was the condition of the reefs when you began ornamental fishing?
6. Were there other destructive practices or factors at the time? If so, what?
7. When did you begin to notice damages to the reef?
8. Were you aware of the impact of cyanide on coral reefs?
9. When and how did your thinking about cyanide use begin to change?
10. Did NGO(s) come to this community? If so, when did they first come?
11. How did the relationship between local fishers and the NGO(s) begin?
12. How did training in the new techniques and/or coral reef restoration occur?
13. What was the content of the training?
14. What was your impression of the new information and techniques?
15. How did using the new skills impact your income?
16. Do some ornamental fishers at this community still use cyanide? If so, is that ever a source of conflict?
17. How do you sell the fish you catch?
18. Are there any restoration activities on this community's reefs? If so, what?
19. Are there indications that the reefs are improving over time? If so, what?
20. Have fishers from this community been engaged in training activities for fishers in other communities? Is so, where?

Appendix C

Key informant and focus group interview schedule

1. What is the function of the ornamental fishers' association in this community?
2. What are the formal and informal networks that exist between this community (or organization) and other communities or organizations.
3. What type of training have ornamental fishers from this community (or staff from this organization) provided to fishers elsewhere?
4. How were those skills transferred?
5. What continuing capacity-building activities occur in those communities?
6. How has the use of cyanide-free techniques impacted fishers' livelihoods?
7. How has the use of cyanide-free techniques impacted the reef?
8. How has the use of artificial reef structures impacted the reef?
9. What role does fisher-led experimentation have in the use of artificial reef structures?
10. What are the future plans of the community (or organization) with regards to training fishers and reef restoration?

APPENDIX D

Research Consent Form

UNIVERSITY OF MANITOBA

Natural Resources Institute
70 Dysart Rd,
Winnipeg, Manitoba
Canada R3T 2M6
General Office (204) 474-7170
Fax: (204) 261-0038
http://www.umanitoba.ca/academic/institutes/natural_resources

Research Project Title:

Collaborative transformation: Community-based learning around coral reef restoration in Bali, Indonesia

Researcher: James Barclay Frey

This consent form, a copy of which will be left with you for your records and reference, is only part of the process of informed consent. It should give you the basic idea of what the research is about and what your participation will involve. If you would like more detail about something mentioned here, or information not included here, you should feel free to ask. Please take the time to read this carefully and to understand any accompanying information.

Proposed script for written/verbal recruitment of the research participants for interviews:

My name is James Frey, and I am a university researcher from Canada. I am coming here with a project partnership with Bogor Agricultural University and Dr. Arif Satria. The focus of my research is to study the ways in which the experience in your community has resulted in a transformation towards more sustainable use of coral reefs and coastal resources. I will be using the results of our conversation to develop a broader picture of the learning processes that have occurred in Les. I am interested in learning and writing about your experiences. If you have any questions at any time, please don't hesitate to ask. In the case of individual interviews, we will meet for about forty minutes. For group interviews, we will meet for about ninety minutes. If you need to take a break before then, please let me know.

Towards the completion of my research, I will share my findings with you and the community at Les. I want to make sure that my understanding of your experiences is accurate. Only my university advisor and I will have access to the information that you share with me, and your identity will protected. However, during a small-group discussion, I cannot assure that the information you share with me will be completely confidential, because there will be other people present who will also hear you. For small-group discussions, I ask that you respect the privacy of all participants. This will be an important part of building trust and relationship between all participants. Therefore, please use the same confidentiality rules that I will use.

The information that I learn during the interview(s) will be kept in a secure file on my password-protected computer. Additionally, I will be using a set of codes to keep your identity confidential. However, if you prefer to be openly identified, please let me know.

Your participation in this study is voluntary, and you are free to withdraw at any time. Please feel free to ask for clarification or new information at any point before, during, or after the interview.

In case of any questions or concerns, you can contact me or my advisor:

James Frey
(Note: my local number will be provided here) Email:
james.b.frey@gmail.com

Dr. Fikret Berkes
204 474-6731 Email:
berkes@cc.umanitoba.ca

Your consent to participate in these interviews indicates that you have understood, to your satisfaction, the information regarding participation in the research project and agree to participate as a subject.

In no way does this waive your legal rights nor release the researchers, sponsors, or involved institutions from their legal and professional responsibilities.

You are free to withdraw from the study at any time, and /or refrain from answering any questions you prefer to omit, without prejudice or consequence.

Your continued participation should be as informed as your initial consent, so you should feel free to ask for clarification or new information throughout your participation.

The Joint-Faculty Research Ethics Board has approved this research. If you have any concerns or complaints about this project you may contact any of the above-named persons or the Human Ethics Secretariat at (204) 474-7122. A copy of this consent form has been given to you to keep for your records and reference.

Thank you very much for your participation in this project,

James Frey

_____
Participant's printed name

_____ _____/____/_____ (dd/mm/yyyy)
Participant's signature Date

_____ _____/____/_____ (dd/mm/yyyy)
Researcher's Signature Date

APPENDIX E

Research Ethics Approval Certificate

UNIVERSITY OF MANITOBA | Ethics
Office of the Vice-President (Research)

CTC Building
208 - 194 Dafoe Road
Winnipeg, MB R3T 2N2
Fax (204) 269-7173
www.umanitoba.ca/research

APPROVAL CERTIFICATE

June 23, 2011 SSHRC

TO: **James Barclay Frey** (Advisor F. Berkes)
Principal Investigator [redacted]

FROM: **Wayne Taylor, Chair**
Joint-Faculty Research Ethics Board (JFREB)

Re: **Protocol #J2011:056**
"Collaborative Transformation: Community-based Learning around Coral Reef Restoration in Lombok, Indonesia"

Please be advised that your above-referenced protocol has received human ethics approval by the **Joint-Faculty Research Ethics Board**, which is organized and operates according to the Tri-Council Policy Statement (2). This approval is valid for one year only.

Any significant changes of the protocol and/or informed consent form should be reported to the Human Ethics Secretariat in advance of implementation of such changes.

Please note:

- **If you have funds pending human ethics approval, the auditor requires that you submit a copy of this Approval Certificate to the Office of Research Services, fax 261-0325 - please include the name of the funding agency and your UM Project number. This must be faxed before your account can be accessed.**

- **If you have received multi-year funding for this research, responsibility lies with you to apply for and obtain Renewal Approval at the expiry of the initial one-year approval; otherwise the account will be locked.**

The Research Quality Management Office may request to review research documentation from this project to demonstrate compliance with this approved protocol and the University of Manitoba Ethics of Research Involving Humans.

The Research Ethics Board requests a final report for your study (available at: http://umanitoba.ca/research/ors/ethics/ors_ethics_human_REB_forms_guidelines.html) **in order to be in compliance with Tri-Council Guidelines.**